ACER Decision on ERAA 2023: Annex I.b

To be read together with the updated results set out in Annex IV

European Resource Adequacy Assessment

2023 Edition

Annex 1: Input Data and Assumptions

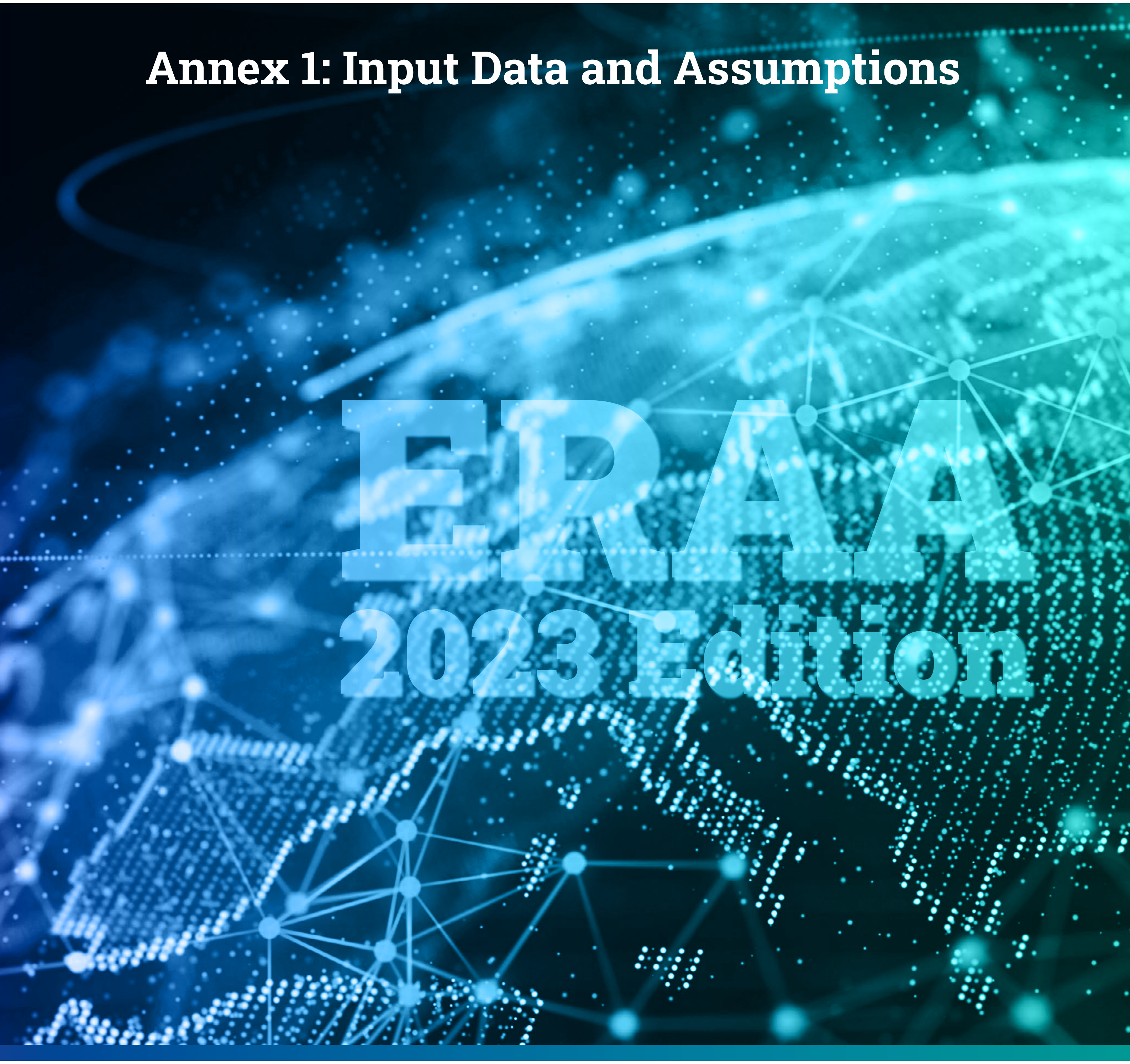

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Table of Contents

1 ERAA 2023 Scenario

1.1 Scenario description

The European Resource Adequacy Assessment (ERAA) builds on the most up-to-date expectations for the selected target years, guided by policy frameworks and stakeholders' expert views. ENTSO-E conducts 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, populate ENTSO-E's databases including the Pan-European Market Modelling Database (PEMMDB). This bottom-up datasets comprise ENTSO-E's National Trends Scenarios. The data collection for the ERAA 2023 began in autumn 2022 and ENTSO-E provided guidance to TSOs on the assumptions for the scenario in addition to 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 conducted continuously throughout this process, with updates being integrated into the assessment until the launching of the study's main simulations in summer 2023. Impacts of the latest country-specific updates that could not be accounted for are discussed – when relevant – in Annex 4.

A pan-European study naturally requires an extensive amount of input data, which are mostly calculated by respective TSOs, but also centrally by ENTSO-E, and are based on national policies and trends. Data collection assumptions can be found in the published data collection guidelines. The National Trend Scenarios of the ERAA 2023 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 Trend scenarios, please see the detailed TSO survey in the next sections.

The ERAA methodology defines the Central Reference Scenario:

Central Reference Scenario: This is based on the National Trends Scenario and is updated through the application of the Economic Viability Assessment (EVA). Note that the scenario without new Capacity Mechanisms (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.

More details on the methodology used to implement the EVA and the adequacy assessment for the Central Reference Scenario without a new CM can be found in Annex 2.

1.2 TSO Survey on the scenario drivers

Eight scenario elements require an elaborate description of the different views of TSOs and their impact on the ERAA 2023, 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 based on survey responses (29 TSOs filled out the survey questionnaire). 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 responses, 24 out of the 29 TSOs submitted data for the National Trend Scenarios that are considered to be either partially or fully compliant with FF55. The survey results indicate varying levels of compliance with FF55. Countries such as Germany, Belgium, and Finland have data that align with FF55 goals, considering ambitious targets for renewable energy, emissions reduction, and electrification. However, countries such as Italy, Hungary, and Serbia have data that partially comply with FF55, either due to ongoing updates in their National Energy and Climate Plans (NECPs) or challenges in covering the entire energy system in their scenarios. Some TSOs have mentioned that their NECPs are not yet updated with the latest FF55 targets and regulations. Overall, although many countries have taken steps towards FF55 compliance, some are still in the process of aligning their energy plans with the EU's FF55 objectives.

1.2.2 Capacity data drivers

1.2.2.1 Conventional generation data drivers

The primary drivers for the data regarding to conventional generation were the NECP, permits, investment plans, connection requests, government decisions, power plant decommissioning assumptions, and information obtained from power plant owners and national studies.

1.2.2.2 RES data drivers

The primary drivers for the data related to generation from Renewable Energy Sources (RES) were the NECP, Fit-for-55 targets, TSO and DSO estimates, national studies, political targets and ambitions, connection requests, transmission grid development plans, and information gathered from independent research institutions, potential investors, and government strategies.

These drivers played a significant role in shaping the data collection process and ensuring compliance with national plans, regulatory requirements and market trends for both conventional and RES generation.

1.2.3 Demand data drivers

Most TSOs have submitted data that are primarily driven by the NECP and the FF55. Primary drivers for demand forecasts and profiles in PEMMDB 3.5 included NECP, TSO/DSO studies, political targets, Fit-for-55, national energy strategies, connection requests and independent research institutions. These drivers considered factors such as sector coupling, electrification, Power-to-X, line gas phase-out, GDP growth, and increasing electrification in various sectors. The data aligned with national resource adequacy assessments and reports.

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 National Regulatory Authority (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, it is considered that third country flows are included in the 70% min RAM.

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, the provision of compliant assumptions depends on the border. For more information on the border per border compliance, c.f. Section 8 Appendix 1: TSO survey on scenario assumptions.

1.2.4.2 Primary drivers for interconnection data

The primary drivers for TSOs' NTC submissions are a combination of the 70% requirements, FF55, National Development Plans and anticipated delays in commissioning projects. 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 event it is not, the most conservative view is kept.

NTC values were coordinated with neighbouring TSOs to ensure consistency, except for specific interconnections where coordination was not possible. Efforts were made to achieve compliance with the 70% target, and variations in NTC values were allowed within the ERAA methodology.

1.2.5 Efficiency

The vast majority of TSOs (28 of 29 responses) anticipate a reduction of emissions through an increase in efficiency. Many countries have plans to reduce emissions by converting/upgrading heating technologies, such as promoting the use of heat pumps (HPs), transitioning from fossil fuels to renewables, providing subsidies, and improving energy efficiency in buildings. These efforts aim to achieve more sustainable heating systems and decrease the reliance on high-emission heating sources.

Most TSOs mention that an improvement in building insulation is foreseen. Countries are implementing various measures to reduce emissions by improving building insulation, such as implementing stricter building codes with higher insulation requirements for new buildings, providing government subsidies for upgrading the energy efficiency of existing buildings, promoting comprehensive renovation of residential and public buildings, and incentivising the population to improve building insulation. These efforts aim to enhance energy efficiency, reduce heat loss and decrease energy consumption in buildings, leading to lower greenhouse gas (GHG) emissions.

Countries are taking various measures to reduce emissions by electrifying transport, including implementing subsidy schemes for electric vehicles (EVs), investing in charging infrastructure, promoting the use of electric and low-emission vehicles in public transport, and introducing policies to replace fossil fuel-powered cars with EVs. These efforts aim to transition to cleaner and more energy-efficient modes of transportation and reduce GHG emissions in the transport sector.

According to the responses, 11 TSOs expect reduction of emissions by reducing the temperature dependent load whereas 6 foresee no such plans by their country. Countries are taking measures to reduce emissions by reducing the temperature dependent load, primarily through improving the efficiency of heating and cooling systems, increasing building renovations and promoting the usage of heat pumps. Stricter building codes for insulation, subsidies for insulation and upgrading air-conditioning units, and the installation of efficient heat pumps contribute to reducing the energy required for temperature control in buildings, leading to lower emissions. However, it is worth noting that in some cases, the shift from combustion heating to electrification may increase the electrical heat demand, which can have implications for emissions depending on the electricity generation mix.

1.2.6 Consideration of the 'Recovery and Resilience Facility' programme

Some TSOs (6) 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 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.

These measures, including strategic reserves, demand-side response, replacement reserves, and voltage reduction, contribute to system adequacy by providing additional capacity, supporting grid stability and managing supply-demand imbalances.

For a detailed table on out-of-market measures per country or zones, please c.f. section 0.

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 scenario. 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.

Market reforms considered in the PEMMDB 3.5 data include the introduction of a fully competitive electricity market model, stakeholder discussions for developing a climate-neutral electricity system, and various reforms such as the participation of demand-side and storage facilities, modification of price caps and interconnection reinforcement. However, some countries have not implemented specific market reforms and rely on existing market structures. Overall, the extent and nature of market reforms vary among countries based on their energy policies and goals.

1.2.8.1 Measures related to interconnection capacity

Many countries plan to increase their interconnection capacity (e.g. Spain, Italy and Slovakia). Slovakia had a significant contribution in the area of integration of wholesale markets with the commissioning of new 400 kV lines on the SK – HU border. This 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. Sweden is investigating the possibility of introducing a capacity market after contract for the current strategic reserve in 2025. In Cyprus, the fully competitive electricity market will be operational soon.

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, and the promotion of European Market Integration. In Spain, the possibility for Demand-Side Response (DSR) to participate in the markets indicates that new developments may play a role in adequacy.

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 2023 focuses on four 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 insights. Important drivers can be plans for coal phase-out, RES deployment targets, DSR deployment, battery deployment, etc. Country energy-mix trajectories are generally in line with national development plans, national studies, and NECPs. Where NECPs are not yet available, TSO estimates were used.

2 Inelastic demand profiles

In the context of the ERAA 2023, 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[1]. (published on the ERAA 2023 downloads section). EVs, HPs and household batteries are considered partly inelastic and partly elastic in the ERAA 2023. 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 Climate Year (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 the climate condition of climate years 1982–2016 (c.f. demand methodology).

The figure shows a clear increase of both YD and Peak Demand (PD) levels throughout the TYs in the ERAA explicit region with a clear dependence on CYs. As shown in the pie chart, Germany (DE), France (FR) and the United Kingdom (UK) are amongst the countries with the highest average YD.

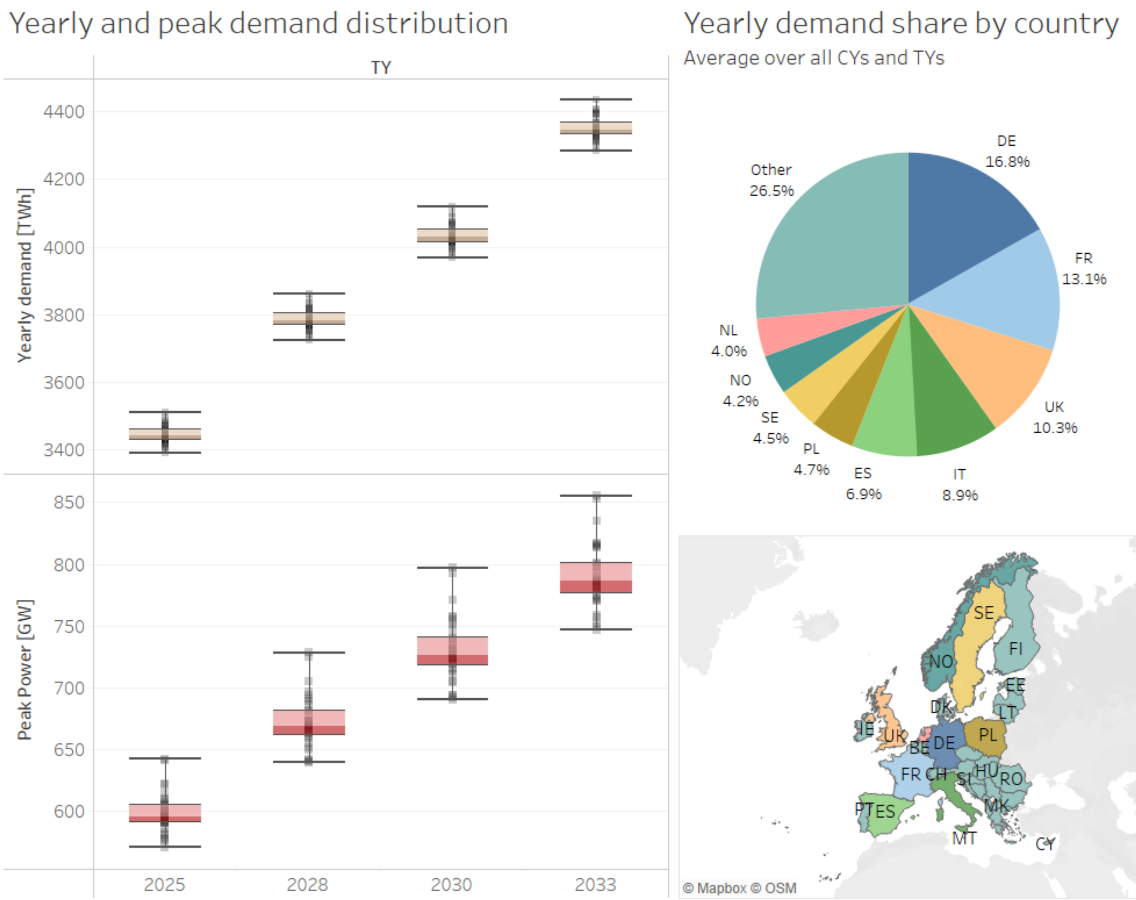

Figure 1: Yearly demand [TWh] and peak demand [GW]

[1] https://www.entsoe.eu/outlooks/eraa/2023/eraa-downloads/

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 which describes 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. the pan-European average temperature is not suitable for all Bidding Zones individually) and temporally (e.g. the annual average temperature is not suitable for representing different seasons). Furthermore, the climate data as a whole must represent a coherent set[2], ensuring that it represents reasonable situations in space (e.g. the temperatures in neighbouring Bidding Zones should be similar) and in time (e.g. the temperature does not change drastically from one hour to another). The PECD was developed to meet these requirements and was used in the ERAA 2023 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 technologies expected to play the most significant roles are onshore wind and solar photovoltaic (PV).

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

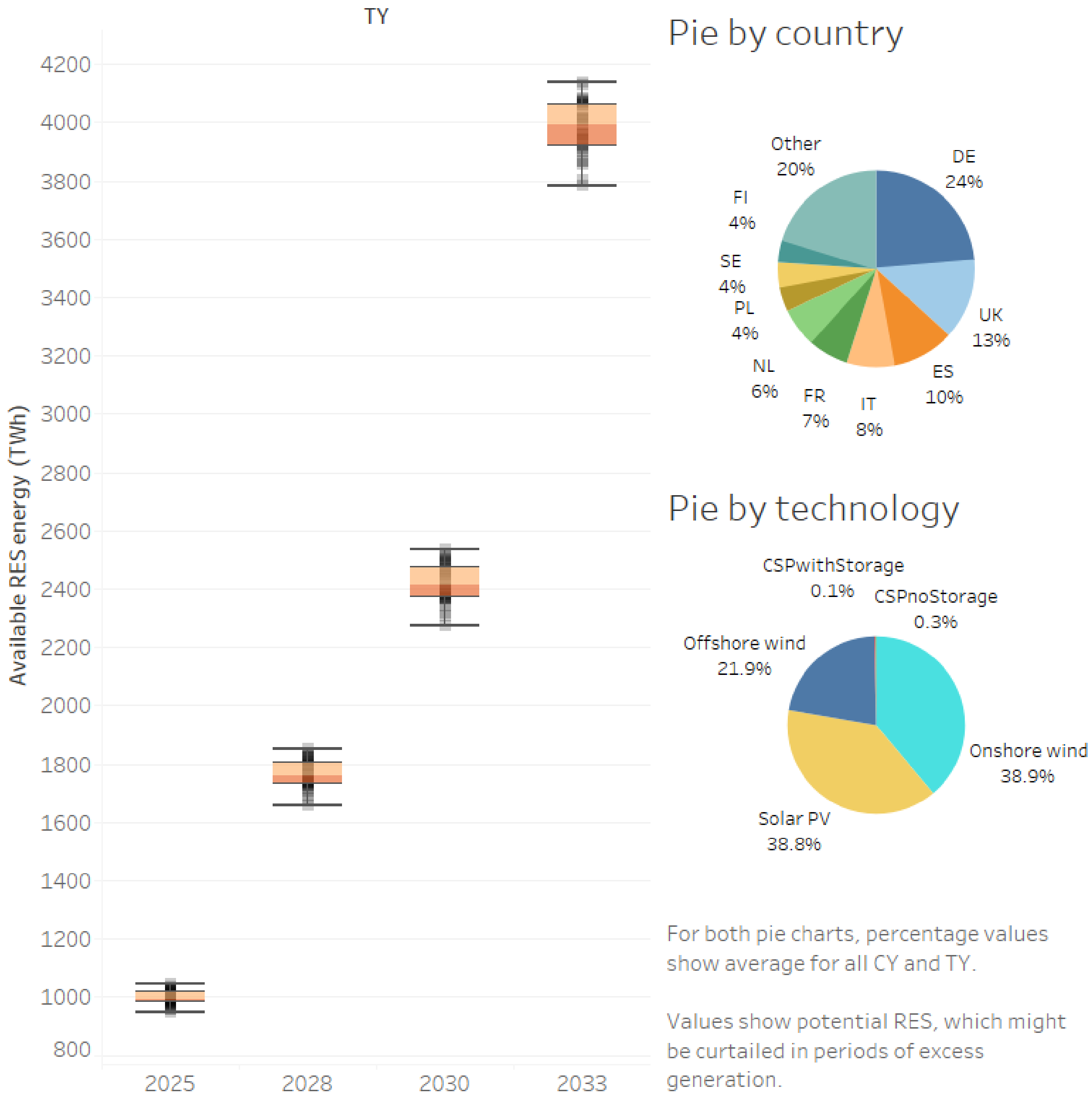

Figure 2: Yearly available RES energy [TWh] and distribution across countries and technologies

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 France (FR) 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.

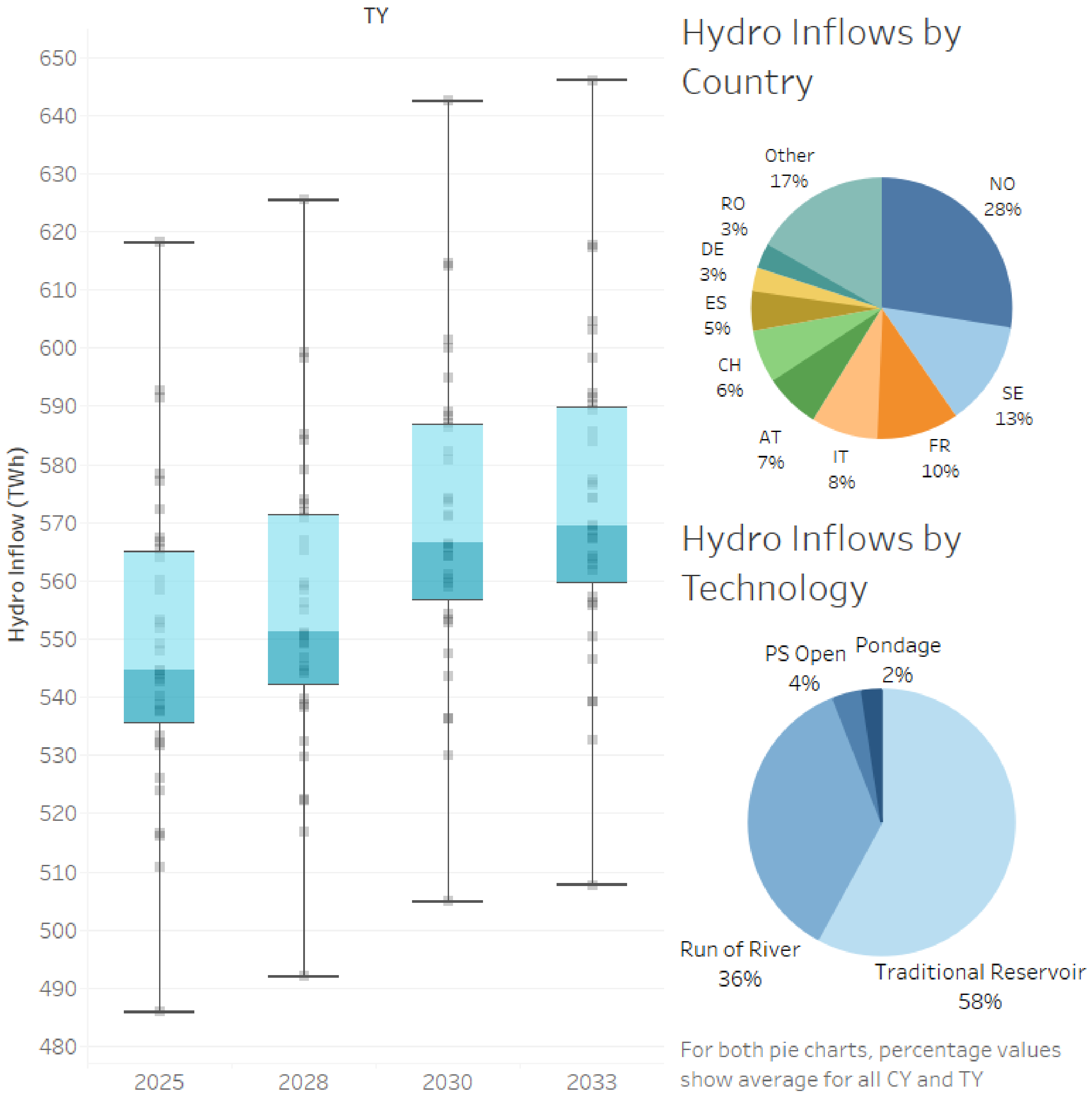

Figure 3: Yearly available hydro inflows [TWh] and distribution across countries and technologies

4 Resource capacities of National Trend Scenarios

As described in section 1.1, the National Trend Scenario is the starting point for the Central Reference Scenario on which the EVA is applied. The EVA modifies the resource capacities between scenarios while the rest of the assumptions under the National Trend Scenario remain applicable.

In the context of the ERAA 2023, 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 in addition to technologies that reduce or shift the demand to be met, such as DSR (only load-reducing DSR is accounted for in the ERAA 2023). DSR can be further categorised as explicit or implicit DSR. Explicit DSR involves market-driven demand changes via accepted offers, including aggregated actions and foregone/time-shifted demand, while Implicit DSR entails customer demand shifts in response to variable prices or incentives, with self-directed or provider-guided adjustments.

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 (farm and rooftop), 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 Trend 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.

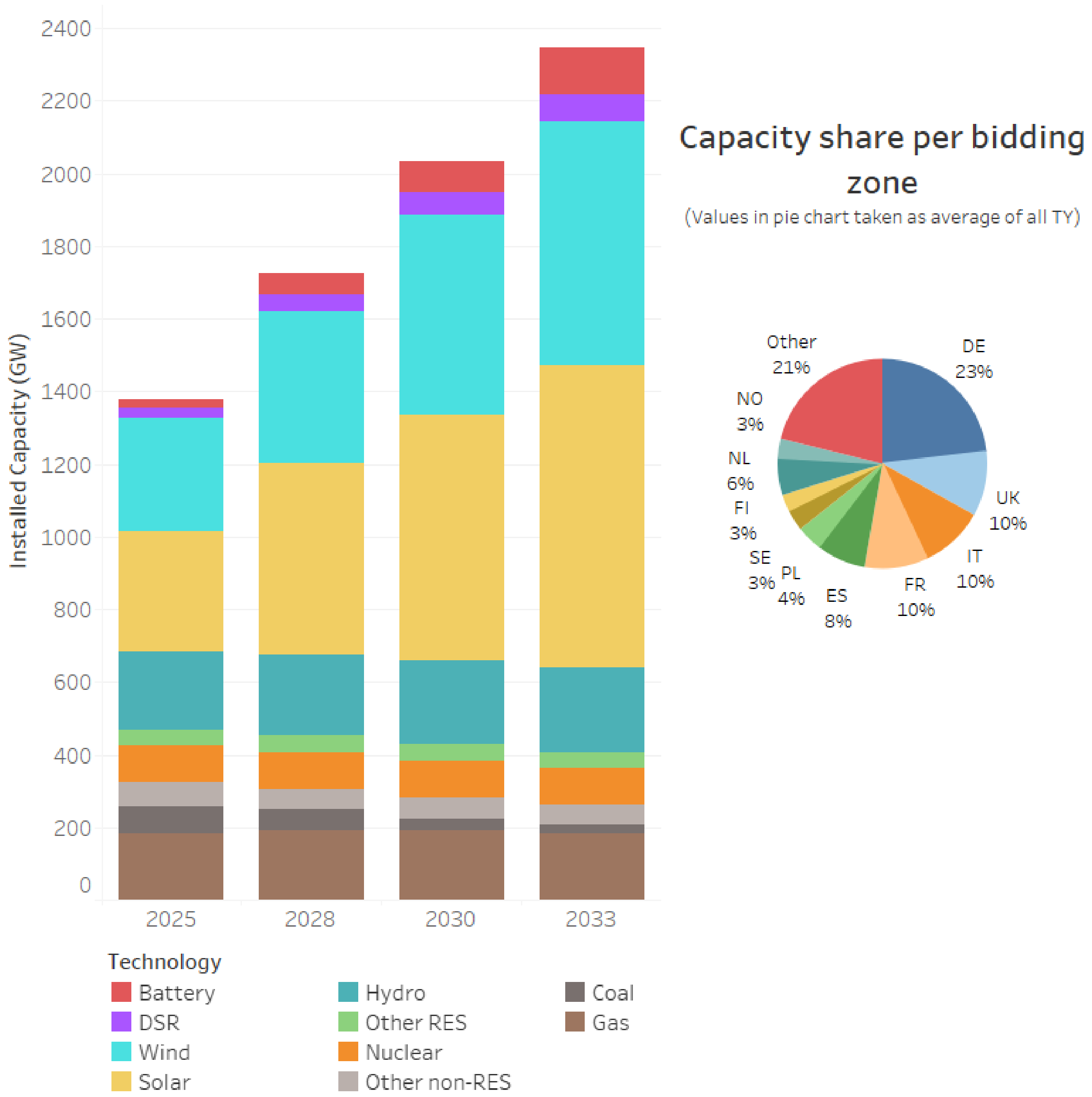

Figure 4: Resource capacity and distribution across countries

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 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. Norway (NO) and Sweden (SE) are forecasted to have the largest shares of averaged storage capacities.

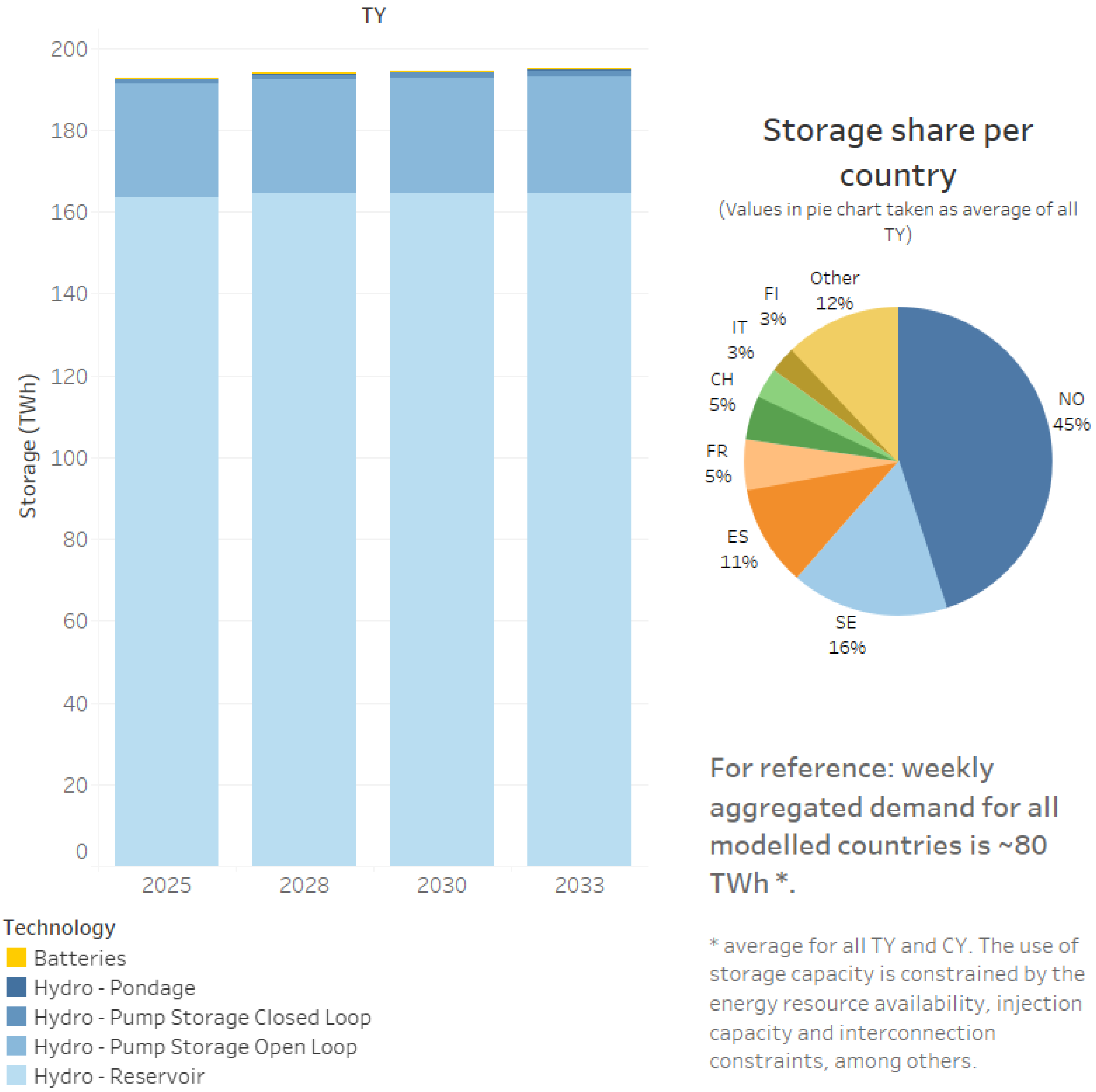

Figure 5: Storage capacity [TWh] and distribution across countries

4.3 Reserve requirements in all scenarios

Some Frequency Containment Reserve (FCR) and Frequency Restoration Reserve (FRR) contracts have already been awarded, whereas 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 or renewable 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 in addition to 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.

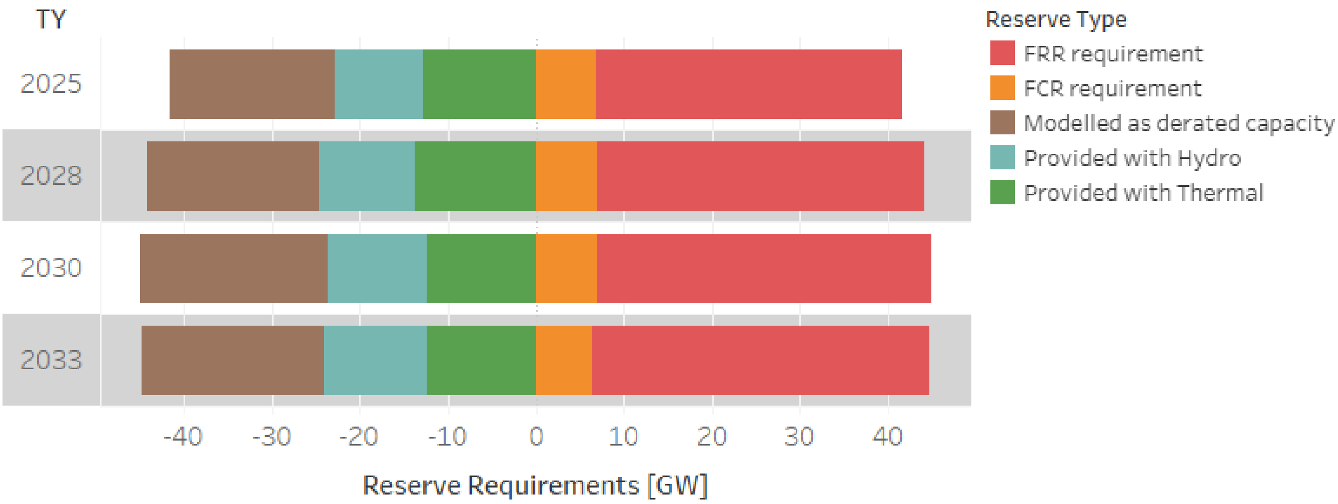

Figure 6: Reserve requirements [GW] for TYs 2025, 2028, 2030 and 2033

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

4.4 Planned maintenance

Planned maintenance of thermal assets is either calculated centrally or provided directly by TSOs to be incorporated in the models. The calculation methodology is presented in Annex 2 of the ERAA 2023. Figure 7 below shows, for illustration reasons the total capacity in maintenance for the whole European perimeter per target year.

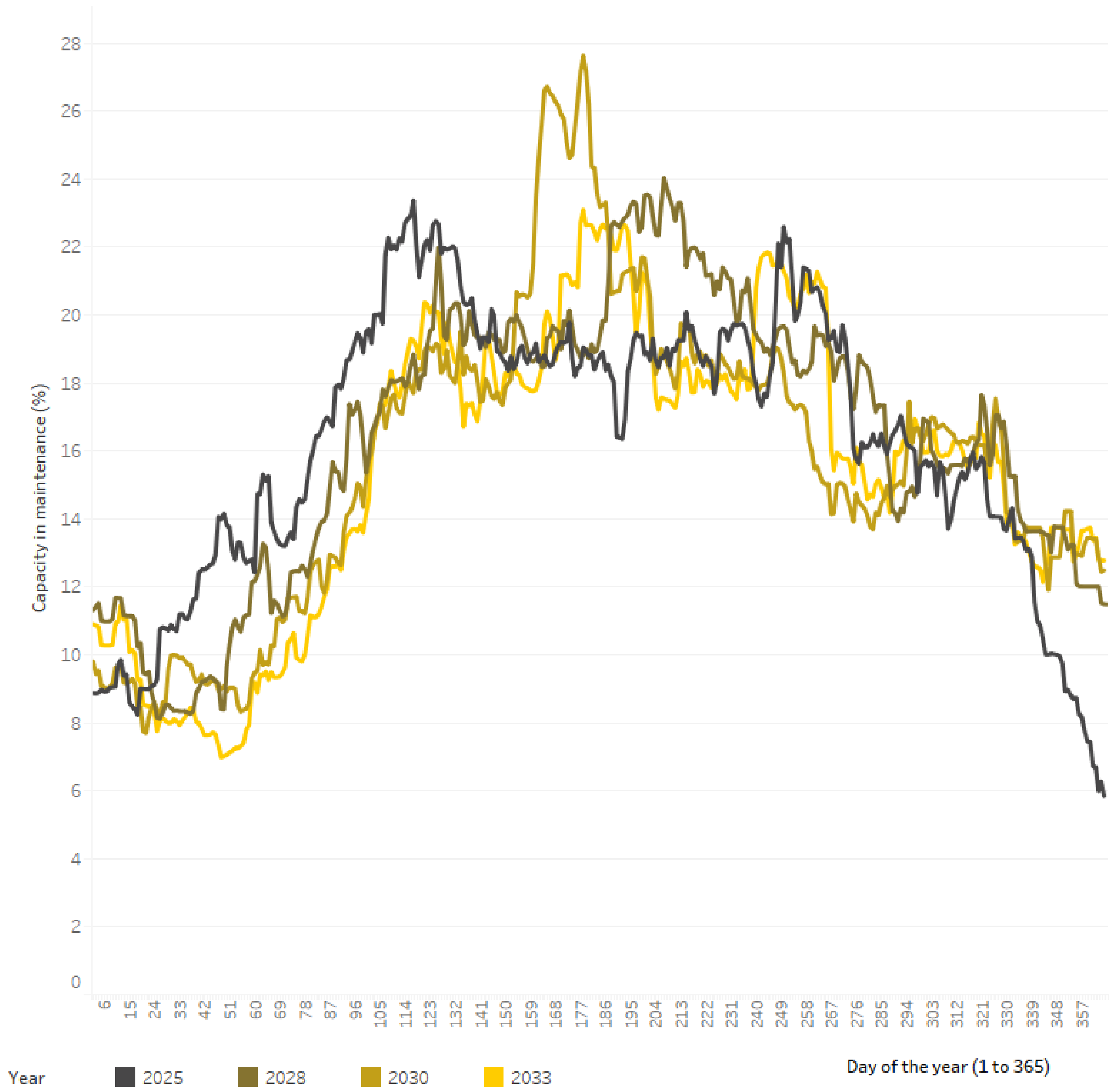

Figure 7: Pan-EU thermal capacity in maintenance

4.5 Forced outage rates

As described in Annex 2, the ERAA 2023 models random forced outages (FOs) only for thermal assets and not for all resources; 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 fairly similar across the TYs. Gas and nuclear technologies show the lowest ratios on average, with a ratio around 5.6%. Coal technologies are slightly more subject to forced outages on average, with a ratio around 8%. Other non-RES are the technologies with the highest forced outage ratios, at around 8.5%.

Table 2: 10th and 90th percentiles and average of FO 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	6.9	10	8.3	5	8	5.6	5	6	5.4	8	10	8.6
2028	4.8	10	8.2	5	8	5.6	5	6	5.8	8	10	8.5
2030	4	10	8	5	8	5.7	5	6	5.7	8	8	8.4
2033	4	10	7.8	5	8	5.6	5	6	5.6	8	8	8.4

5 Network inputs

5.1 Net import/export capacities

Net Transfer Capacity (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. These values were collected from the TSOs and were used in the Economic Viability Assessment. In the Economic Dispatch, NTC values were replaced where relevant by the corresponding FB constraints. Both the NTC values and the FB data can be found in the published dataset[3].

Figure 8 shows the maximum net import and export capacities averaged among all hours of the year. As observed the values increase in most countries throughout the TYs. The countries with the highest import and export NTC capacities are as follows.

[3] https://www.entsoe.eu/outlooks/eraa/2023/eraa-downloads/

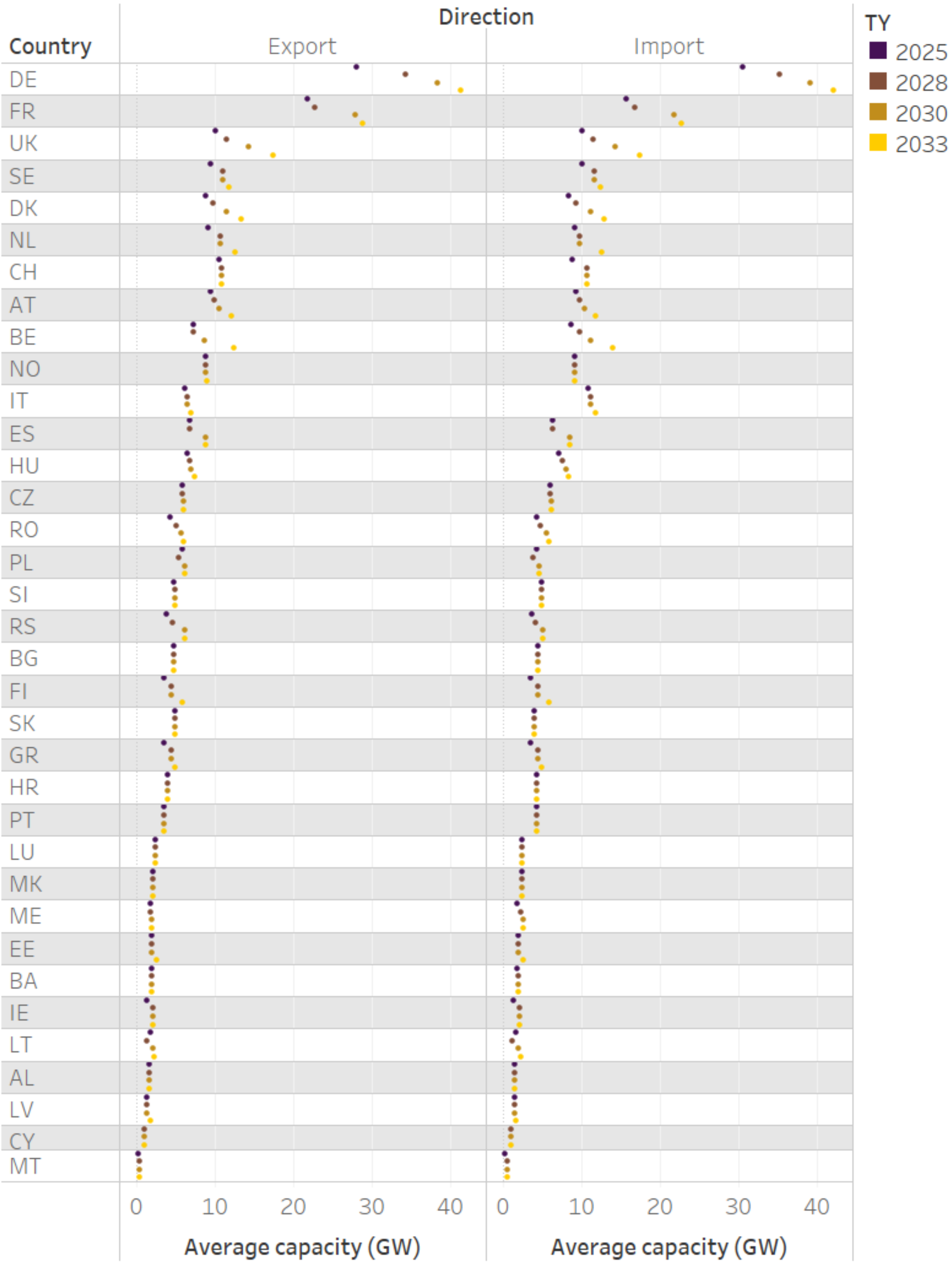

Figure 8: Average maximum net import and export capacity [GW] by country for each TY

5.2 Forced outage rates

Table 3 shows the forced outage ratios (FORs) used per TY and technology type. For HVDC power lines, the average FOR is between 4 - 5%, increasing with the TYs. For HVAC lines, the average remains around 1.4% for all TYs. The default ratio for the HVAC lines is 0% as capacities delivered by TSOs are expected to respect the N-1 principle. In the event this is not respected, TSOs overwrite the default FOR by a non-zero value.

Table 3: 10th and 90th percentiles, average, and default values of FORs (%) per TY and technology type

TY	HVDC				HVAC			
	10th	90th	Avg	Def	10th	90th	Avg	Def
2025	0	8	4.1	6	0	5.1	1.4	0
2028	0	7.9	4.7	6	0	3.9	1.2	0
2030	0	7.9	5.1	6	0	4.4	1.4	0
2033	0	7.9	5.2	6	1	4.4	1.4	0

5.3 Exchanges with implicit regions

As described in section 1 of the Executive Report, the regions modelled implicitly are accounted for due to fixed exchanges with countries within the ERAA explicit region. Figure 9 illustrates the hourly exchanges per border. Spain (ES00) is connected to Morocco (MA00), as well as to the Canary Islands (ESCE) and Balearic Islands (ESBA), Norway (NON1) is connected to Russia (RU00), Romania (RO00) is connected to Moldova (MD00), and Slovakia (SK00) is connected to Ukraine (UA00).

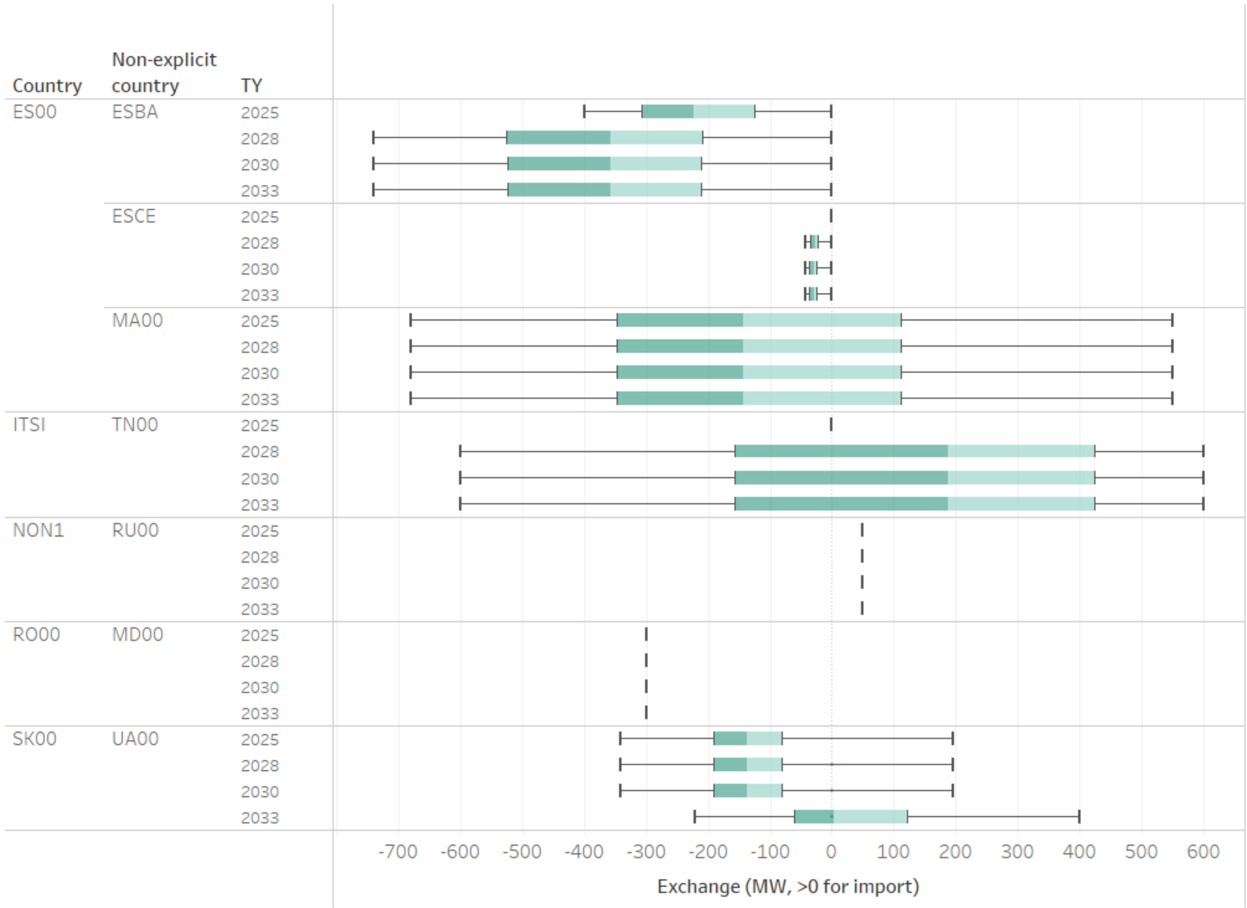

Figure 9: Fixed exchanges between implicitly modelled countries and the ERAA explicit region

6 Economic assumptions

6.1 Fuel and CO_2 prices

Fuel and CO_2 prices are key inputs for the EVA, as they determine the marginal cost of the thermal units, and thus their hierarchy in the merit order, which is the key factor driving their optimal dispatch and ultimately effect the revenue they are capable generating. This sub-section explains the references and assumptions considered to estimate the fuel and CO_2 prices. Table 4 summarises the specific price values used in the ERAA 2023. All prices are reported as 2021 €. When necessary, to convert prices from 2023 € to 2021 €, a 0.905 discount factor has been applied to account for the average European inflation index registered.

a. ***Nuclear:*** the reference for nuclear fuel prices is EIA 2022[4], aligned with current TYNDP estimates for 2030. The prices are considered constant over the horizon.

b. ***Gas blend:*** a blend of natural gas, biomethane and synthetic methane is considered as fuel for the gas-fired thermal units. Average shares of biomethane and synthetic methane are based on internal assumptions derived from different sources (100% natural gas until 2028, 9% biomethane in 2030, 20% biomethane and 4% synthetic methane in 2040). Regarding natural gas prices, the reference used are Bloomberg for 2023 (average of EU monthly prices from November 2022 to February 2023) and IEA WEO 2022[5] (Announced Pledges Scenario, APS) for 2030 and 2050, interpolating between 2023 – 2030 and 2030 – 2050 for intermediate years. Regarding biomethane prices, the reference is the Danish Technology catalogue[6] for 2030 and 2050, interpolating between these values for the intermediate years. Regarding synthetic methane prices, references are IEA WEO 2022 (APS) for 2030 and 2040, interpolating between 2030 – 2040 for intermediate years. 'Natural gas', 'Biomethane' and 'Synthetic methane' fuels are only used for calculating the fuel cost of 'Gas blend', which is the one used for simulations.

c. ***Shale oil:*** the reference for price values is TYNDP 2022[7] for 2025, 2030 and 2040, interpolating between these values for the intermediate years.

d. ***Light oil and heavy oil:*** the price values of light oil and heavy oil are calculated by upscaling the crude oil price with a price premium. Price premium factors are 28% for light oil and 5% for heavy oil. The references for crude oil prices are Bloomberg for 2023 (average of EU monthly prices from November 2022 to February 2023) and IEA WEO 2022 (APS) for 2030 and 2050, interpolating between 2023 – 2030 and 2030 – 2050 for intermediate years. 'Crude oil' fuel is only used for calculating the fuel cost of 'Light oil' and 'Heavy oil', which are the ones used for simulations.

[4] EIA (2022): https://www.eia.gov/electricity/annual/html/epa_08_04.html
[5] IEA (2022), World Energy Outlook 2022: https://www.iea.org/reports/world-energy-outlook-2022
[6] Danish Technology catalogue: https://www.nordicenergy.org/wordpress/wp-content/uploads/2021/09/Technology-Catalogue.pdf
[7] TYNDP 2022: https://2022.entsos-tyndp-scenarios.eu/

e. ***Hard coal:*** the references for hard coal prices are Bloomberg for 2023 (average of EU monthly prices from November 2022 to February 2023) and IEA WEO 2022 (APS) for 2030 and 2050, interpolating between 2023 – 2030 and between 2030 – 2050 for intermediate years.

f. ***Lignite:*** lignite prices are reported for four different sub-groups, reflecting the prices peculiar to one or more regions. The reference for all is Booz&co[8], and constant prices are considered over the horizon.

g. ***Hydrogen:*** the reference for hydrogen fuel price is IEA WEO 2022 (APS), for 2030 and 2040, interpolating backward between 2040 and 2030 values. The reference hydrogen price is the one related to steam-methane reforming with carbon capture utilisation and storage.

h. ***CO_2:*** the references for hard coal prices are Bloomberg for 2023 (average of EU monthly prices from November 2022 to February 2023) and IEA WEO 2022 (APS) for 2030 and 2050, interpolating between 2023 – 2030 and between 2030 – 2050 for intermediate years.

Table 4: Fuel prices [€2021/net GJ] and CO_2 price [€2021/ton] per TY

Fuel Type	Nov. 2022 – Feb. 2023	2025	2028	2030	2033	2040	2050	Reference and assumption
Nuclear		1.68	1.68	1.68	1.68			a
Natural Gas	15.04	12.54	8.80	6.30	6.10	5.65	5.00	b
Biomethane		-	-	18.20	18.00	17.54	16.90	b
Synthetic methane					26.82	25.00	23.50	b
Gas Blend	15.04	12.54	8.80	7.44	7.88			b
Shale oil		1.56	1.74	1.86	2.12	2.71	3.93	c
Crude oil	10.76	10.31	9.63	9.17	9.09		8.60	d
Light oil		13.19	12.32	11.74	11.63		11.00	d
Heavy oil		10.82	10.11	9.63	9.54		9.00	d
Hard coal	4.01	3.38	2.42	1.78	1.74		1.50	e
Lignite 1[9]		1.40	1.40	1.40	1.40			f
Lignite 2[10]		1.80	1.80	1.80	1.80			f
Lignite 3[11]		2.37	2.37	2.37	2.37			f
Lignite 4[12]		3.10	3.10	3.10	3.10			f

[8] Booz&co: https://www.dei.gr/media/qbmj0twz/understanding-lignite-generation-costs-in-europe.pdf
[9] Group 1 applicable to: BG, MK, CZ
[10] Group 2 applicable to: SK, DE, RS, PL, ME, UKNI, BA, IE
[11] Group 3 applicable to: SL, RO, HU
[12] Group 4 applicable to: GR

Fuel Type	Nov. 2022 – Feb. 2023	2025	2028	2030	2033	2040	2050	Reference and assumption
Hydrogen		18.90	18.14	17.64	16.88	15.10	15.10	g
CO_2	77.73	87.92	103.21	113.40	123.48	147.00	168.00	h

Figure 10 shows graphically the evolution of the commodity prices used in the simulation. In general, a decrease in prices is expected, except for CO_2. In the case of gas blend, an increase from 2030 to 2033 is observed because of the higher share of biomethane and synthetic methane in the mixture, although natural gas, biomethane and synthetic methane prices tend to decrease if analysed individually.

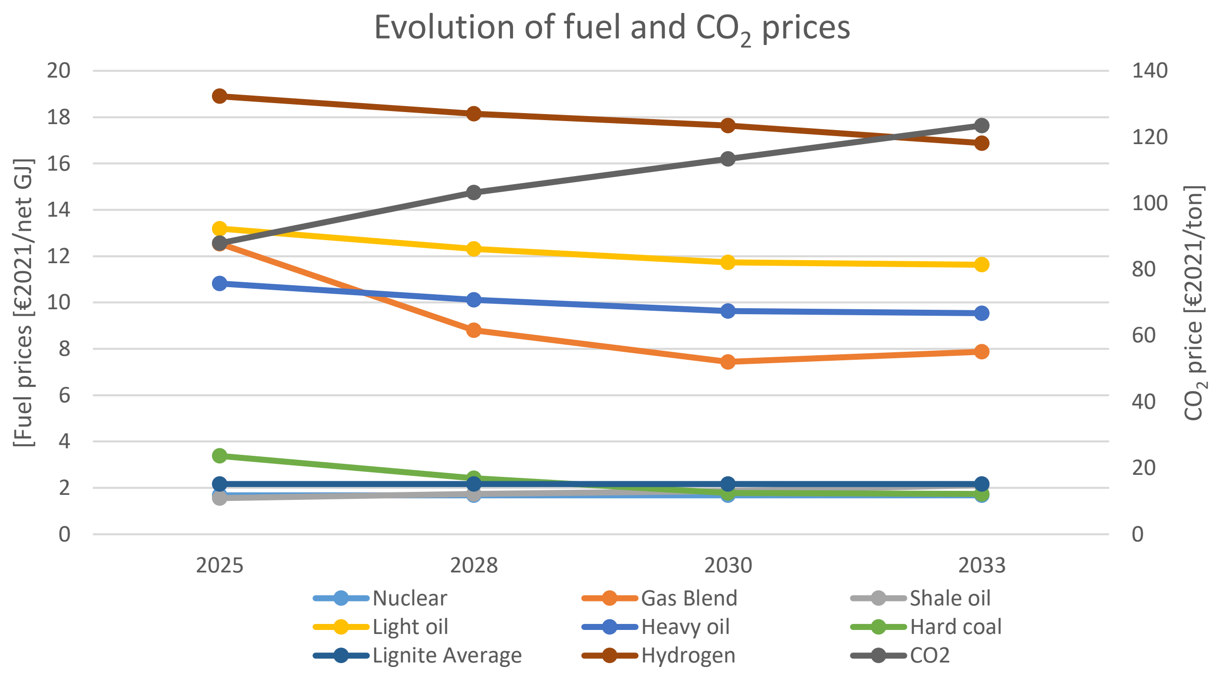

Figure 10: Evolution of fuel and CO_2 prices

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 and add additional economically viable capacities to the system. As presented in Annex 2 (section 10.3), 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 Trend Scenario provided by individual TSOs (see Annex 2, section 2) 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 the (i) (de-)mothballing of unviable capacity, as an alternative to permanent retirement; (ii) consideration of heat and steam revenue stream for Combined Heat and Power (CHP) units; (iii) lifetime extension and (iv) DSR and battery storage expansion.

Figure 11 illustrates the installed capacity subject to the EVA in addition to the capacity excluded from it. As described in Annex 2 (section 10.4), the units with the new 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, 157 GW of gas-fired units (77% of the total gas capacity) are assessed during the EVA, 41 GW of coal units (53% of the total coal capacity), 8 GW of oil (81% of the total oil capacity), whereas nuclear and other non-RES are not subject to the EVA.

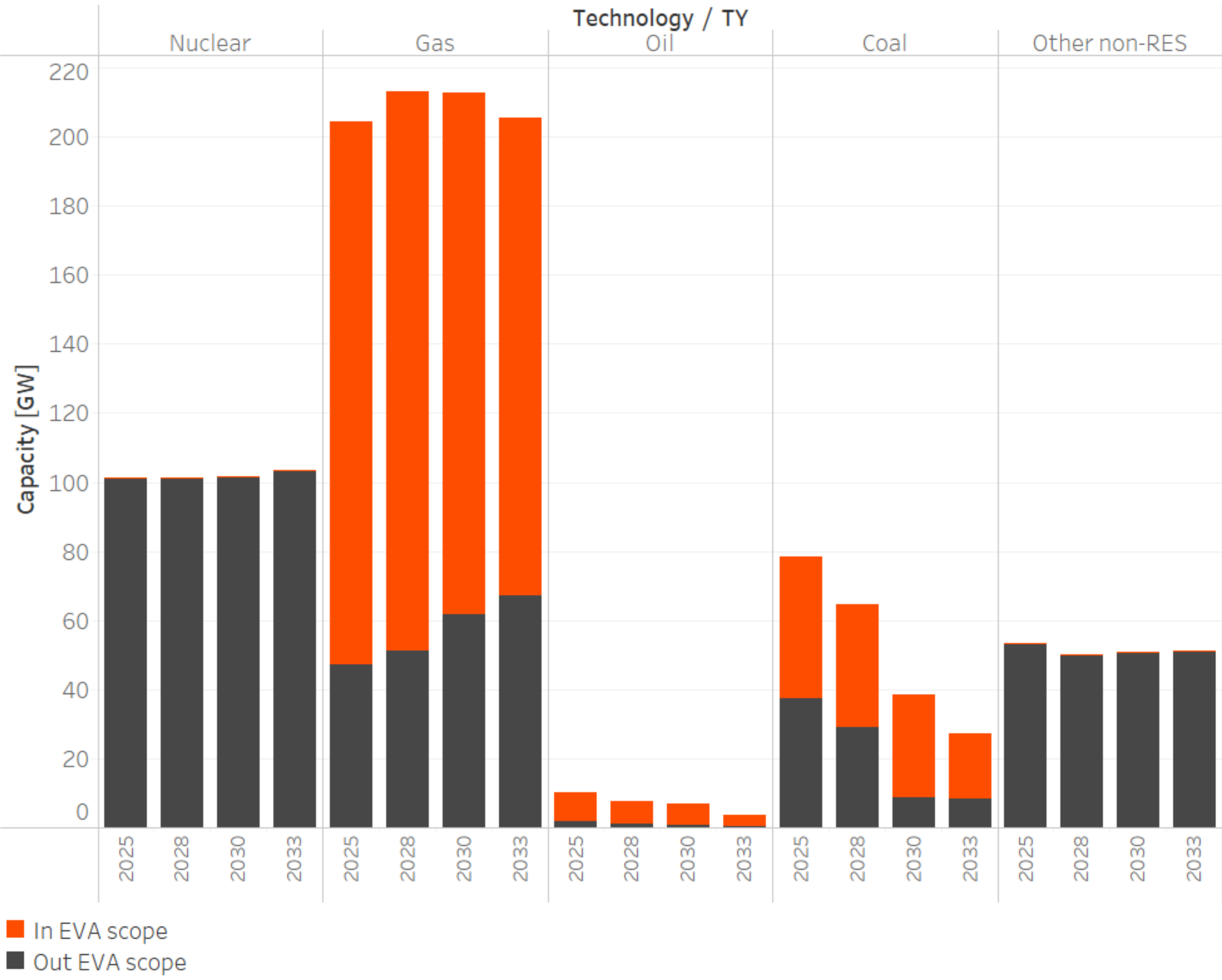

Figure 11: Share of thermal capacity subject to EVA.

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 CMs 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 RS methodology proposed by ENTSO-E and approved by ACER in October 2020. To adhere to this data, EVA uses country-specific values prepared by regulators according to the CONE/VOLL/RS methodology where available, while an estimated average value was used for countries for which these data have not yet been calculated/published.

The actual values are shown in the next sub-section. An update from the values considered in the ERAA 2022 has been included when national data has been updated. Countries with the corresponding VOLL/CONE/RS study are:

Table 5: References to national VOLL/CONE/RS studies

Country	Reference	Year of publication
Belgium	SPF Economie (VOLL) SPF Economie (CONE)	2022
Czech Republic	MPO	2022
Germany, Luxembourg	BMWK	2021
Estonia	Elering	2021
Finland	Energiavirasto	2022
France	RTE	2022
Greece	RAE	2021
Italy	Terna	2020
Netherlands	ACM	2022
Slovenia	Eles	2022
Sweden	EI	2021

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 10.3.

6.4.1 Economic commissioning candidates

The capital expenditure (CAPEX), fixed operation and maintenance (FOM), economic life and weighted cost of capital (WACC) values used in the ERAA 2023 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 subsequently assumed to be representative for the entire horizon. The charts below (Figure 12 – Figure 15) illustrate the CAPEX, FOM, economic life and WACC changes from TY 2025 to TY 2033 (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 the default value. Only the default value and the information provided in the available CONE study are shown.

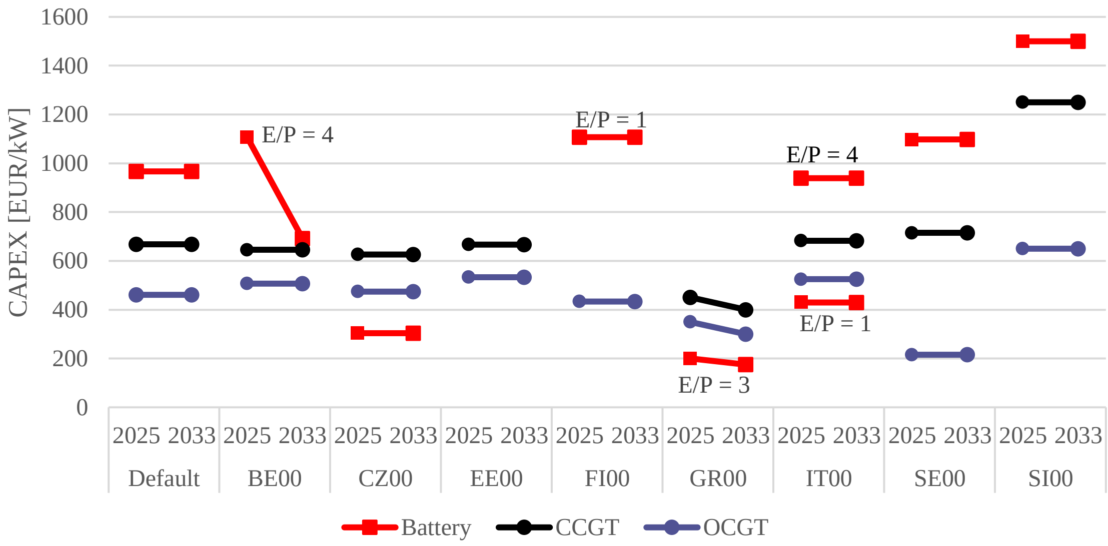

Figure 12: Default values and CONE values for CAPEX

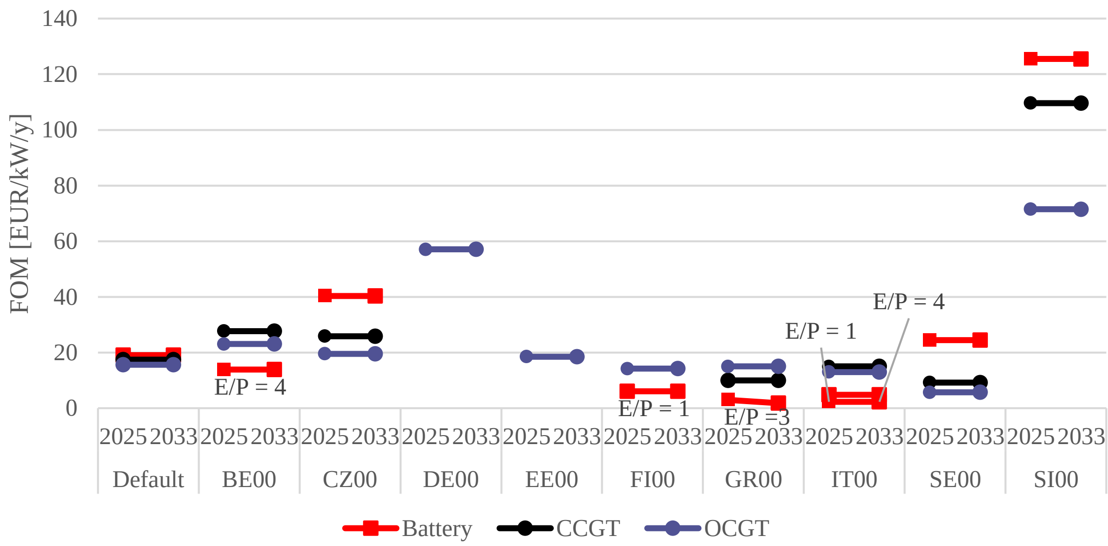

Figure 13: Default values and CONE values for FOM

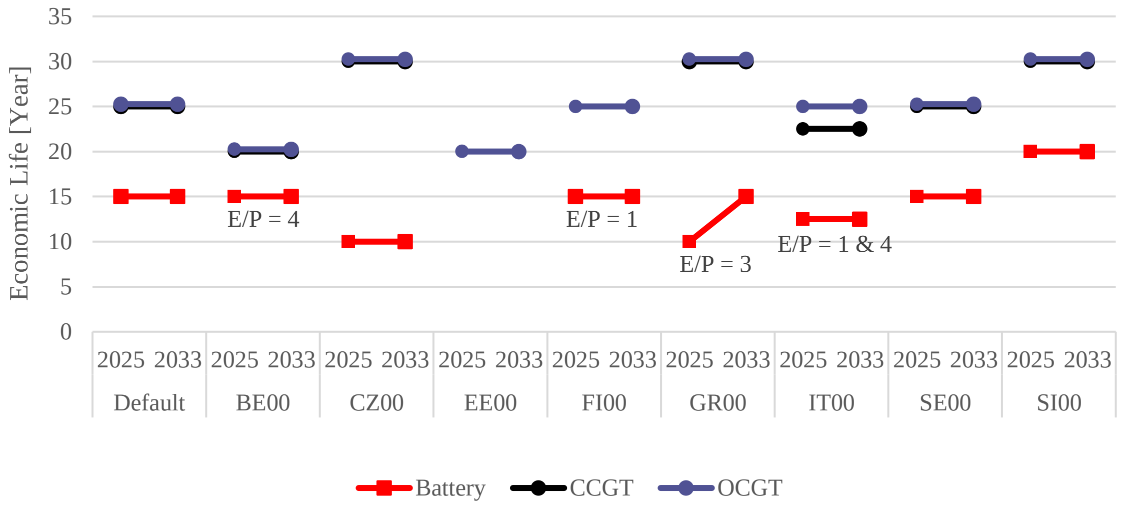

Figure 14: Default values and CONE values for economic life

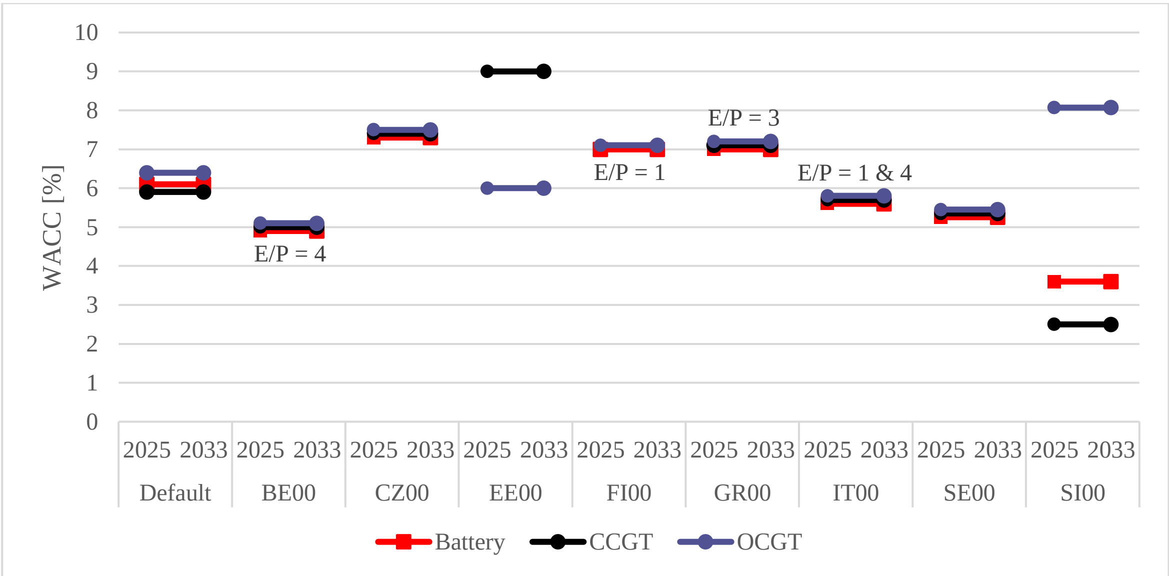

Figure 15: Default values and CONE values for WACC

The hurdle premium values used to compute the hurdle rate together with the WACC differ by technology, as shown in Table 6 (see also Annex 2, section 10.12).

Table 6: Default values for the hurdle premium [%]

Battery	CCGT	OCGT
3.0	4.5	6.0

6.4.1.1 Construction period of commissioning candidates

Due to the construction period of thermal units, the commissioning of Gas CCGT and Gas OCGT units is not possible before the TY 2028. Therefore, the only technologies available for commissioning in 2025 are grid-scale batteries and explicit DSR. Table 6.1 shows a summary of the first TY when a commissioning technology is available for new entry.

Table 6.1: First TY when new entry of capacity is available, according to harmonized construction period (CONE studies)

TY for new entry	
OCGT new	**2028**
CCGT new	**2028**
Grid-scale batteries	**2025**
Explicit DSR	**2025**

6.4.2 Economic decommissioning candidates

A resource unit is considered not viable when its net revenues are lower than its 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 7 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[15].

Table 7: Default 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	26 –39	6.4	3.5	EU reference scenario 2020[13]
Lignite	33 –45	6.4	3.5	EU reference scenario 2020
CCGT	18 –20	5.9	3.0	Average of CONE/ EU reference scenario 2020
OCGT	12 –16	6.4	3.5	Average of CONE/ EU reference scenario 2020
Light Oil	21	6.4	3.5	EU reference scenario 2020/ASSET 2018[14]
Heavy Oil	21	6.4	3.5	EU reference scenario 2020/ASSET 2018
Oil Shale	21	6.4	3.5	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. A single CAPEX, lifetime extension duration, hurdle premium and WACC value are assumed for each technology across all TYs. The values were extrapolated

[13] https://energy.ec.europa.eu/data-and-analysis/energy-modelling/eu-reference-scenario-2020_en
[14] https://asset-ec.eu/home/advanced-system-studies/cluster-3/technology-pathways-in-decarbonisation-scenarios/

from the Elia adequacy and flexibility study[15], the EU Reference Scenario[13] and the ASSET study[14]. Data are available in Table 8.

Table 8: Default economic parameters for lifetime extension in the EVA

Resource Unit Category	CAPEX [EUR/kW]	Life Extension [years]	Hurdle Premium [%]	WACC [%]	Sources
CCGT	103	10	4 – 5	5.9 – 6.4	Elia[15]
OCGT	82				Elia[14]
Lignite	283				Extrapolation
Hard Coal	247				Extrapolation
Oil	193				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.

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 necessary to put the unit out of operation for a long period of time as well as the preparations to put the unit back to operation (e.g. water, grid, new staff). The cost of de-mothballing is significantly higher than the cost of 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[16] following the same approach as that used for the lifetime extension. Among 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 2023 assumes the following values for each technology across all TYs (Table 9).

Table 9: Default 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	0.93 – 2.65	2.65 – 19.86	0.60	3.0	5.9 – 6.4	TenneT
OCGT	0.85 – 2.44	2.44 – 18.28	0.80	3.5	5.9 – 6.4	Extrapolation
Lignite	2.55 – 7.28	7.28 – 54.58	2.2	3.5	5.9 – 6.4	Extrapolation
Hard Coal	2.23 – 6.37	6.37 – 47.76	2.5	3.5	5.9 – 6.4	Extrapolation
Oil	1.74 – 4.96	4.96 – 37.22	1.6	3.5	5.9 – 6.4	Extrapolation

15 https://www.elia.be/-/media/project/elia/shared/documents/elia-group/publications/studies-and-reports/20210701_adequacy-flexibility-study-2021_en_v2.pdf
16 https://tennet-drupal.s3.eu-central-1.amazonaws.com/default/202207/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 the ERAA 2023 come from the EU Reference scenario[13] and the ASSET report[14]. The values are reported in the table below.

Table 10: VOM [EUR/MWh]

Generation Unit Category	2025	2028	2030	2033
CCGT	1.95 – 2.31	1.92 – 2.31	1.90 – 2.31	1.87 – 2.31
OCGT	2.1	2.1	2.1	2.1
Lignite	3 – 4.1	3 – 4.0	3 – 4.0	3 – 3.67
Hard Coal	2.4 – 3.57	2.4 – 3.54	2.4 – 3.51	2.4 – 3.48
Oil	2.76 – 2.8	2.76 – 2.8	2.76 – 2.8	2.76 – 2.8
Nuclear	6.9	7.2	7.4	7.7

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

Table 11: 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 are computed internally in ENTSO-E. The table summarising the values is below.

Table 12: CO_2 emission factor [CO_2kg/GJ]

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

The figure below (Figure 16) shows the calculated SRMC of the technologies. Although gas technologies are heavily penalised by high gas prices in the earlier years, they become more competitive in the later years due to a gas price decrease in addition to CO_2 and hard coal. For each fuel and technology shown in the figure, only the cheapest (plain line) and most expensive (dashed line) technology 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.

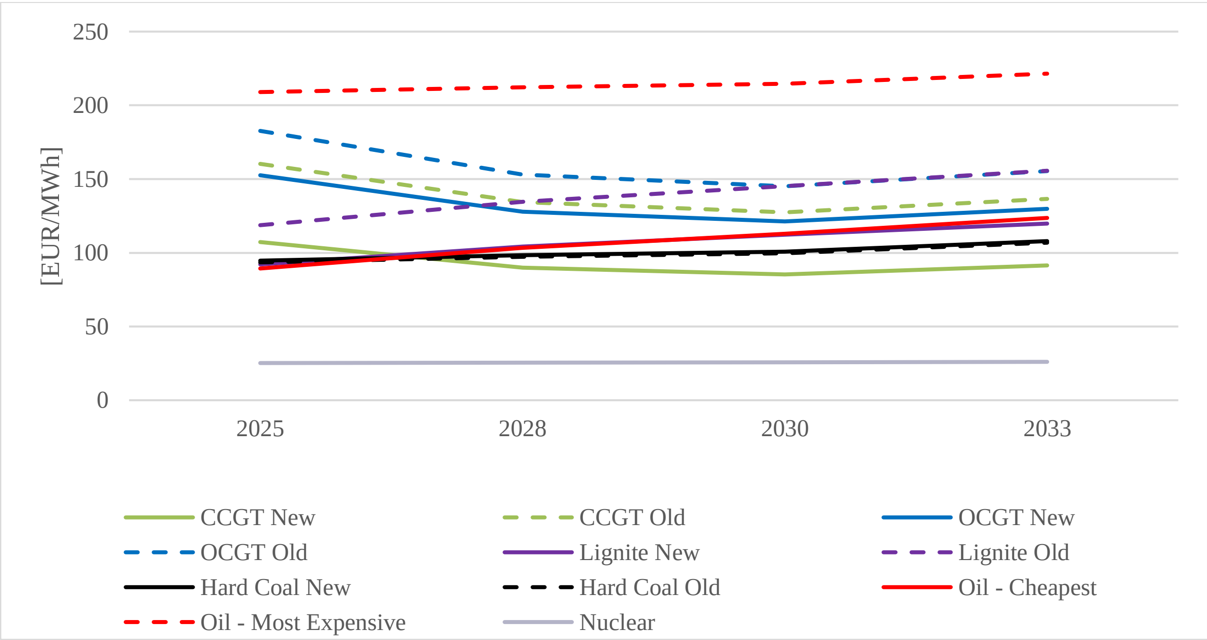

Figure 16: Marginal cost of thermal units

6.5 Explicit DSR commissioning potential

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

- A **published VOLL/CONE study** conducted according to the ACER methodology[17] 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 13 shows which approach is used per country, in addition to the net additional DSR potential that can be invested in by the EVA for selected target years above what is considered in the National Trend Scenario. Note that these are total non-cumulative potentials covering the full horizon until 2033 (e.g. capacity invested in 2025 reduces the potential for 2033.) For the countries of AL, BA, CH, FR, IE, IT, ME, MK, MT, RS, TR, UA and UK, no additional DSR investments are considered, either because the centralised approach could not be applied due to insufficient data or because the estimated potential was lower than the assumed capacity by TSOs in the National Trend Scenario. Note that the 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 13: Net additional explicit DSR potential assumed per target year per zone

Zone	Approach	Net additional DSR potential (non-cumulative) [GW]			
		2025	2028	2030	2033
AT00	Centralised approach	0.89	0.89	0.89	0.89
BE00	National VOLL/CONE study	0.30	0.75	1.05	1.50
BG00	Centralised approach	0.67	0.67	0.67	0.67
CY00	Centralised approach	0.11	0.11	0.11	0.11
CZ00	National VOLL/CONE study	0.18	0.18	0.18	0.18
DE00	National VOLL/CONE study	0	0.83	0.83	0.83
DKE1	Centralised approach	0.29	0.29	0.29	0.29
DKW1	Centralised approach	0.50	0.50	0.50	0.50
EE00	Centralised approach	0.22	0.22	0.22	0.22
ES00	Other national study	2.20	2.20	1.70	0
FI00	National VOLL/CONE study	0.12	0.12	0.12	0.12
GR00	National VOLL/CONE study	1.25	1.60	1.78	1.80
HR00	Centralised approach	0.32	0.32	0.32	0.32
HU00	Other national study	0.06	0.06	0.06	0.06
LT00	Centralised approach	0.27	0.27	0.27	0.27
LU00	National VOLL/CONE study	0	0	0	0
LV00	Centralised approach	0.19	0.19	0.19	0.19
NL00	Other national study	2.93	2.93	3.12	3.12
NOM1	Other national study	0	0	0	0
NON1	Other national study	0	0	0	0
PL00	Other national study	0	0	0	0

[17] 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	2028	2030	2033
PT00	Centralised approach	1.26	1.26	1.26	1.26
RO00	Centralised approach	1.19	1.19	1.19	1.19
SE00	National VOLL/CONE study	5.54	5.54	5.54	5.54
SI00	National VOLL/CONE study	0.08	0.08	0.08	0.08
SK00	Centralised approach	0.73	0.73	0.73	0.73

6.6 Wholesale market price cap

In the ERAA 2023, 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 (also referred to as the 'maximum technical bidding limit') for the wholesale Single Day-Ahead Coupling (SDAC) market is set to 4,000 €/MWh at the time of writing[18]. The methodology for adjusting the harmonised maximum market clearing price (HMMCP) was modified and a triggering mechanism with stricter conditions was introduced, which would lead to a more restrained increase of the price cap.

Following the approach proposed in Annex 2, the price cap evolutions over all the TYs are estimated (Table 14).

Table 14: Price cap [€/MWh] per TY

2025	2028	2030	2033
4,500	6,000	7,000	8,500

7 Additional assumptions

7.1 Electrolyser data

Hydrogen production efficiency was adopted on the basis of data provided by the TSO and ranged between 59–79% (if not specified by the TSO, 68% is the default). Table 4 of section 6.1 presents the hydrogen price assumptions for each of the TY assumptions. The approach used to compute these prices is described in Annex 2 (section 7).

[18] 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. Switzerland is not included in the Fit for 55 regulation, and for this reason they did not submit an answer to the survey.

According to the TSO survey responses, 24 out of the 29 TSOs submitted data for the National Trend Scenarios that are considered to be either partially or fully compliant with FF55. The survey results indicate varying levels of compliance with FF55. Countries such as Germany, Belgium, and Finland have data that aligns with FF55 goals, considering ambitious targets for renewable energy, emissions reduction, and electrification. However, countries such as Italy, Hungary, and Serbia have data that partially complies with FF55, either due to ongoing updates in their NECPs or challenges in covering the entire energy system in their scenarios. Some countries have mentioned that their NECPs are not yet updated with the latest FF55 targets and regulations. Overall, while many countries have taken steps towards FF55 compliance, some are still in the process of aligning their energy plans with the EU's Fit for 55 objectives.

Country	Were the data you submitted for the ERAA 2023 compliant with FF55?	Please further explain the level of compliance with FF55.
AT	Partially compliant	The stated installed capacities for renewables are coordinated with the NECPs 2030 where the Austrian power supply is projected to be climate-neutral.
BE	Yes	The assumptions for Belgium are based on the latest official information available and on discussions or exchanges with the competent authorities and/or market players. The draft NECP is meant to reflect Europe’s strengthened ambitions, in line with the European Climate Law, ‘Fit for 55’ and ‘REPowerEU’. See latest National study ‘Adequacy & Flexibility study for Belgium 2024-2034’ https://www.elia.be/en/news/press-releases/2023/06/20230629_pressrelease_adeqflex

Country	Were the data you submitted for the ERAA 2023 compliant with FF55?	Please further explain the level of compliance with FF55.
BG	Partially compliant	The data submitted for the ERAA 2023 (NT scenario) are based on the BG NECP (2020 edition) and some modifications with the new BG TYNDP (2023 edition). At the time of data submission up until now there have been no new updates of the NECP to clarify whether the data are in compliance with the Fit For 55 deal. Hence the answer of 'Partially compliant'.
CY	Partially compliant	Data were based on the published NECP, which had not been updated to the latest EU targets at the time of data collection.
CZ	Yes	Fully compliant
DE	Yes	Compliance is ensured as the following changes are reflected in the data delivery: Coal phase out by 2030; High expansion of RES in line with EEG 2023 (German Renewable Energy Law); and Sector coupling through electrification of heat and mobility sector, as well as Electrolyser expansion. In addition, the national targets for 2030 are set at 65% emission reduction. The ERAA 2023 PEMMDB data collection is in line with the national targets.
DK	Not relevant to my country	The Project Assumptions of 2022, delivered by the Danish Energy Agency to Energinet, which has been utilized as the National Trend scenario reported to the PEMMDB 3.5, is evaluated as fully compliant with Fit for 55 by the Danish Energy Agency. The developments of the Project Assumptions for 2022 comply with Danish climate targets in 2030 (70% reduction of territorial GHG emissions compared to 1990 levels). They also internalise EU-requirements for transport regarding the prohibition of selling new internal combustion engine cars and vans, including plug-in-hybrids, from 2035 and beyond.
EE	Partially compliant	Estonia has successfully declared several renewable energy reverse auctions to accelerate renewable production, which has enabled a growth in PV power many times faster than that of the Fit for 55 targets. However, in the PEMMDB 3.5 a more conservative assumption has been taken on the commissioning of the first offshore windfarms. In Fit for 55, it is assumed that first offshore installations will be operational in 2030, but considering the current maturity of the project, issues with global supply lines and the risks related to taking an optimistic approach on the system adequacy, the timeline was postponed until 2033.
ES	Yes	The ERAA 2023 data are based on the most updated information available, pending the update of the NECP. The provided data meet the corresponding Fit for 55 targets.
FI	Yes	The scenario considers key policy decisions such as Fit for 55 and Finnish carbon neutrality target of 2035 and as such is estimated to be compliant with the decisions. The scenario has a high electrification of industries and RES development to support this, while most fossil fuel plants are phased out.

Country	Were the data you submitted for the ERAA 2023 compliant with FF55?	Please further explain the level of compliance with FF55.
FR	Yes	Net reduction of GHG emission of 55%. eRES capacity compatible with 40% share of the RES in the final energy demand. Electricity final demand in line with 30% decrease of final energy demand compared to 2012
GR	Yes	All provided data stem from the first draft of the revised NECP, which fulfils the Fit for 55 requirements.
HR	Partially compliant	The NECP and other energy strategies should analyse and define the fit to 55 scenarios in the near future.
HU	Partially compliant	Data provided are based on the forecasts created as part of the National Network Development Plan process. As part of this, TSO and DSOs make their assumptions on capacity and demand evolution based on NECP, National Energy Strategy, recent regulations, ongoing and planned state aids, investment plans, and network connection requests. As highly ambitious PV development is ongoing in Hungary, we consider this as a factor helping to achieve Fit for 55 aims.
IE	Yes	For the ERAA 2023, EirGrid has used the ambitious targets that are part of the latest government Climate Action Plan (CAP) 2023 – which amount to at least 80% RES-E by 2030, and which is aligned with Fit for 55. This formed the basis of EirGrid's submission for ENTSO-E studies.
IT	Yes	Exact targets have not been defined yet, nor updated NECP was available at the time of the data collection. Installed capacities are compliant with a scenario that reaches a RES share in electricity generation equal to 65% in 2030 in Italy and an emission reduction in line with FF55.
LT	Partially compliant	Litgrid is planning a significantly faster development of RES than provided in the current NECP. Based on connection requests, RES could cover ~136 % of electricity demand by 2030. The electrification of transport is also gaining momentum – the railway electrification project has already started, the development of electric vehicle infrastructure is underway, and support schemes for the purchase of EVs have been created.
LU	Yes	Compliant with updated NECP draft 2023
LV	Yes	The data are in line with the Latvian National energy and climate long term plan as well as Fit for 55 regulation.
MT	Partially compliant	Data submitted for PEMMDB 3.5 were compliant with projections developed for a national resource adequacy study, which moves Malta closer towards FF55 goals. It does not fully align with FF55 targets and objectives, as these would be reflected in the NECP update, which is still ongoing.
NL	Partially compliant	Expect to be largely compliant to the FF55 target. An analysis of the reduction of CO_2 emissions of the energy system has been carried out. Most recent data from national member state plans have been used.
PL	No	No final regulation referred to Fit for 55
PT	No	Data submitted are based on the Portuguese NECP and on the most recent national adequacy assessment report. No further information regarding the national Fit for 55 plan is available.

Country	Were the data you submitted for the ERAA 2023 compliant with FF55?	Please further explain the level of compliance with FF55.
RO	Partially compliant	The data were provided based on the national (TSO/Ministry) estimations for the new targets in line with the FF55 objectives as the NECP has not been updated yet and new official data are not available.
RS	Not relevant to my country	Serbia is not committed to Fit for 55 goals.
SE	Partially compliant	The data submitted are based on the best estimate of Svenska kraftnät and has not been adjusted to be exactly in line with the NECP.
SI	Partially compliant	Data provided for ERAA 2023 are primarily based on the NECP and on the study provided for ELES by an independent institute, which considers all available documents and policies, including documents such as NECP, to derive the future projections.
SK	No	The data provided are not compliant with Fit for 55. The national target regarding Fit for 55 has not yet been determined.
UA	Yes	In general, the data provided by Ukraine consider the goals of the FF-55. However, it should be remembered that such goals have not yet been implemented at the national level in Ukraine (work is currently underway). As of today, Ukraine has developed a draft NECP, but it has not been approved (this is expected later this year or early next year).

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:

The primary drivers for the data related to conventional generation were the NECP, permits, investment plans, connection requests, government decisions, power plant decommissioning assumptions, and information obtained from power plant owners and national studies.

8.1.2.2 RES data drivers:

The primary drivers for the data related to generation from RES were the NECP, Fit for 55 targets, TSO and DSO estimates, national studies, political targets and ambitions, connection requests, transmission grid development plans, and information gathered from independent research institutions, potential investors and government strategies.

These drivers played a significant role in shaping the data collection process and ensuring compliance with national plans, regulatory requirements and market trends for both conventional and RES generation.

Country	What were the primary drivers for conventional generation data?	Please further explain the primary drivers	What were the primary drivers for RES generation data?	Please further explain the primary drivers
AT	Other	In 2030, Austria will probably still depend on gas power to ensure security of supply (for transmission adequacy issues in Austria and neighbouring Member States).	NECP	The stated installed capacities for renewables are coordinated with the NECPs 2030 where the Austrian power supply is projected to be climate-neutral.
BE	Draft NECP + Official Nuclear closures and lifetime extension announcements.	Decision to extend the lifetime of two of Belgium's nuclear units beyond 2025 Commissioning of two new CCGT units from winter 2025 – 2026 as a result of the first CRM auction	Fit for 55	5.8GW offshore wind in 2030 and 8 GW offshore wind in 2040 (Development of the Princess Elisabeth Island+ +Esbjerg Declaration May 2022 + Ostend Meeting April 2023) Increased ambitions regarding onshore wind and Solar PV
BG	Other	Primarily NECP but there were some modifications based on the new BG TYNDP. Lack of officially stated policy in regards to the conventional generation has forced us to make some assumptions which are only estimations not backed up by official engagements.	Other	Considering that there are no updates of the NECP since 2020 and accounting for the rapid grow of mostly PV installations we made an expert estimation to increase the installed capacity from wind and solar on the basis of preliminary contracts and grid connection applications.
CY	NECP	Conventional generation data was based on the NECP plus the TSO's best estimates on new generation connection dates, based on connection applications and the latest information on the date of availability of natural gas.	NECP	Renewables data were based on the NECP plus the TSO's best estimates, considering connection applications and the latest DSO forecasts.
CZ	Other	CEPS conducted an annual data survey that included generation sources above the net installed capacity of 10 MWe (incl.). Submitted data respect strategies and plans of electricity	Other	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

Country	What were the primary drivers for conventional generation data?	Please further explain the primary drivers	What were the primary drivers for RES generation data?	Please further explain the primary drivers
		producers partially reflecting switching from coal to gas heat production.		Fund and other financial support tools that could increase the installed capacity of RES
DE	NECP	Data delivery is based on current power plant park including: decommissioning assumptions (age, technology, regulatory assumption e.g. coal phase out); information about decommissioning; commissioning of current power plant projects; and assumption of commissioning based on regulation (EEG). Installed capacity is based on our national studies (Netzentwicklungsplan & Systemanalyse). These studies must be compliant with NECP.	NECP	Installed capacity is based on our national studies (Netzentwicklungsplan & Systemanalyse). These studies must be compliant with NECP.
DK	NECP	The development of thermal capacity in the Project Assumptions for 2022 is evaluated by the Danish Energy Agency with point of departure in expectations for rentability of future thermal electricity and district heating production under consideration of current regulatory and political targets and ambitions. Among other things, it is assumed that the utilisation of gas, except for peak production, is phased out in district heating from 2030 and beyond.	NECP	The developments in renewables capacity in the Project Assumptions for 2022 are especially driven by political targets and ambitions. Among other things, it is the ambition that land-based renewable electricity production (solar photovoltaics and onshore wind) quadruples towards 2030 to accommodate an expected large increase in electricity consumption from for example electrolysis. The developments in offshore wind capacity is conditional on the realisation of two energy islands (Bornholm island with commissioning in 2030 and the North Sea island with first step commissioning in 2033), tenders of offshore wind farms before the end of 2030 and long term developments, that more or less corresponds to the ambition to fully utilise

Country	What were the primary drivers for conventional generation data?	Please further explain the primary drivers	What were the primary drivers for RES generation data?	Please further explain the primary drivers
				offshore wind resources in the North Sea, which is estimated to be around 35 GW.
EE	Other	The strategic plans of the conventional generation plant owners. Every year all of the owners of existing conventional generation power plants submit their plans for the next 15 years. New commissioning plans are discussed with the project owners and subsequently it is decided whether the plans are sufficiently mature to include in PEMMDB.	NECP	Combination of previously set political targets regarding renewable energy and accounting for actual projects under development are being analysed to give a value for each target year.
ES	Fit for 55	The conventional generation data have been based on the most updated information available, pending the update of the NECP. The provided data meet the corresponding Fit for 55 targets.	Fit for 55	The renewable generation data has been based on the most updated information available, pending the update of the NECP. The provided data meets the corresponding Fit for 55 targets.
FI	Fit for 55	In addition to the NECP and Fit for 55, specific policies such as coal phase-out and market-based drivers were considered in the conventional generation development.	Fit for 55	The RES development is primarily driven by market-based drivers, i.e. RES is developed on a merchant basis.
FR	NECP	New thermal generation capacity is forbidden based on the current NECP.	Other (please specify)	Mix between current NECP and stakeholder consultation
GR	Other	First draft of the revised NECP (Jan 2023). Conventional generation data are aligned with the first draft of the revised NECP and consider the most recent official information regarding the retirement of lignite units and new entries (CCGTs).	Fit for 55	RES generation data are aligned with the first draft of the revised NECP which complies with the Fit for 55 targets.

Country	What were the primary drivers for conventional generation data?	Please further explain the primary drivers	What were the primary drivers for RES generation data?	Please further explain the primary drivers
HR	National ten year transmission grid development plan (NDP)	Data about conventional generation were obtained from the power plants owners and NDP.	NDP and NECP.	In the NDP for the period 2023 – 2032, the following chapters were the source for the PEMMDB 3.5.: - Table 3.13. Projects with a signed connection agreement (period 2023 – 2025 and 2026 – 2032) Chapter 3.2.5. Existing and new network users who have expressed interest in connecting to the transmission network
HU	Other	Permits, investment plans, connection requests and consultation	NECP, National Energy Strategy, investment plans, connection requests.	The target values for PV capacity from NECP and National Energy Strategy have been exceeded by the sum of the built-in capacity and the planned capacity increase originating from connection requests. Therefore, the primary source for the capacity evolution of renewable energy sources are the connection requests, based on the network connection process for generators (due to this higher PV capacity, but lower biomass, geothermal capacity was provided than the values in NES and NECP).
IE	NECP	We are reporting ongoing issues for security of supply in Ireland, and so we see the need for this conventional generation.	NECP	Climate Action Plan 2023
IT	Fit for 55	Complete coal phase-out from December 2025 within the Italian mainland and from December 2028 in Sardinia (where the coal phase-out will be completed only after the 'Tyrrhenian Link' becomes operational); decommissioning of most of the oil units by 2028; and new thermal capacity additions according to national capacity market auctions for 2022, 2023 and 2024.	Fit for 55	Target to reach 65% of renewable generation within the electricity sector, driven by growth in solar and wind. Onshore wind assumed similar to the last available NECP at the time of the data collection, higher increase of offshore wind pushed by the number of requests received and general increase of solar in all the market zones

Country	What were the primary drivers for conventional generation data?	Please further explain the primary drivers	What were the primary drivers for RES generation data?	Please further explain the primary drivers
				(distributed solar mostly in the North and utility scale in the rest of the peninsula)
LT	Data for conventional generation obtained during the annual survey of major electricity producers, who provided their best knowledge about changes in status (development/mothballing/decommissioning) and technical parameters for the next 10-15 years.	Major electricity producers have planned decommissioning of old fossil fuel generating units before 2026 (~150 MW) and 510 MW of old generating capacity is approaching the end of its useful lifetime.	Lithuania seeks to achieve the situation whereby ~100% of the country's electricity demand is supplied by RES by 2030.	Considering the ongoing projects and the interest of investors in the development of RES energy in Lithuania even more ambitious RES targets, agreed upon with the Lithuanian Ministry of Energy, were submitted to PEMMDB. NECP is currently being updated.
LU	Fossil gas and fuel price - emission reductions targets for industry	/	NECP	/
LV	NECP	Base generation for Baltic States to provide balancing service and base power in wholesale electricity market.	Fit for 55	RES developments according to NECP and technical potential in Latvia.
MT	NECP	Projections for conventional generation submitted under PEMMDB 3.5 data collection are aligned with the projections developed for Malta's first NECP.	Other	NECP projections were used as the basis, but these were updated to consider the higher historical increase in years 2018-2022 as opposed to the NECP. The historical increase had a positive effect on the projected solar PV capacity.

Country	What were the primary drivers for conventional generation data?	Please further explain the primary drivers	What were the primary drivers for RES generation data?	Please further explain the primary drivers
NL	Government decisions on coal phase out, less methane usage, development of hydrogen usage. Data retrieved from generation companies.	Government decisions on coal phase out per 2030, less methane usage by stimulating renewables, development of hydrogen usage towards 2030 and beyond. Adaption of national climate agreement scenarios. Data retrieved from generation companies.	Fit for 55	Ambitions according to the National Energy Climate Agreement and increased ambition level of new Dutch coalition agreement regarding extending growth of renewables to meet FF55, solar PV and offshore wind growth 2024 – 2030 as well as beyond 2030 with use of PtX and batteries
PL	Input from the market participants which take after NECP	Ongoing transition	Current development trends	The forecasted values are higher than those from NECP and are aimed at achieving the fit for 55 preliminary targets
PT	NECP	Data submitted are 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 are based on the Portuguese NECP and on the most recent national adequacy assessment report. No further information regarding the national Fit for 55 plan is available.
RO	No official update of NECP data is available. Thus, the reference scenario was based on the recent information from the market participants, in line with the national commitments for coal phase-out of the market (decarbonisation plan)	The reference scenario was based on government decision on the sector's decarbonisation plan and the related trajectory for lignite and hard coal units phase-out of the market till 2026 , as well as on the most recent information submitted by the generators and other market participants	No new national RES targets are available, in line with FF55	No new national RES targets are available, in line with FF55. Thus, a further extension of RES growth compared to the NECP targets has been considered, based on the latest market data, development trends and Ministry /TSO best estimates. In addition, the offshore wind projection for 2030 was included.

Country	What were the primary drivers for conventional generation data?	Please further explain the primary drivers	What were the primary drivers for RES generation data?	Please further explain the primary drivers
RS	Information from public production utility.	Drivers are based on data used for national TYNDP 2023 – 2032	Information from TSO regarding connection requests and information gathered from DSO	Drivers are based on data used for national TYNDP 2023 – 2032
SE	Other	The generation capacities are mainly driven by the assessment of current national political plans/goals as well as market trends and assessment of the profitability of different generation technologies.	Other	The generation capacities are mainly driven by the assessment of current national political plans/goals in addition to market trends and the assessment of the profitability of different generation technologies.
SI	NECP, surveys	A survey has been done with all existing and other potential future owners of conventional power plants. The owners of these power plants provided excessive data and future development plans which were incorporated into the PEMMDB 3.5 databases.	NECP, surveys	Energy Sources submitted in the PEMMDB 3.5 RES capacity projections are based on projections developed by independent research institutions for ELES and are based also on NECP. Furthermore, an extensive survey and individual discussions were made with potential future investors. Finally, the Slovenian government has also presented a strategy of promoting the installation of new solar fields, connected to the transmission network, which is also considered.
SK	NECP; Up-to-date information on conventional sources of electricity was provided by their operators.	Up-to-date information on conventional sources of electricity was provided by their operators.	NECP	Except for the NECP, forecasts of the RES evolution for longer time horizons (after 2030) are based on the assumed RES realisable potential regarding to currently available information.

Country	What were the primary drivers for conventional generation data?	Please further explain the primary drivers	What were the primary drivers for RES generation data?	Please further explain the primary drivers
UA	Both the NECP and the FF55 are actually the main drivers of conventional generation, even though these plans have not yet been approved at the national level.	Among other things, the following approved documents should be considered as factors of conventional generation: National Plan for Reduction of Emissions from Large Combustion Plants, Energy Strategy of Ukraine until 2050, Second Nationally Determined Contribution of Ukraine	Economic Strategy of Ukraine until 2030, Energy Strategy of Ukraine until 2050, National Plan for Reducing Emissions from Large Combustion Plants, Second Nationally Determined Contribution of Ukraine, NECP project	The main factors also include the existing trends in the development of RES in Ukraine.

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. Primary drivers for demand forecasts and profiles in PEMMDB 3.5 included NECP, TSO/DSO studies, political targets, Fit for 55, national energy strategies, connection requests, and studies from independent research institutions. These drivers considered factors such as sector coupling, electrification, Power-to-X, line gas phase-out, GDP growth, and increasing electrification in various sectors. The data aligned with national resource adequacy assessments and reports.

Country	What were the primary drivers for the data related to demand forecasts and demand profiles?	Please further explain the primary drivers for the data related to demand forecasts and demand profiles submitted in the PEMMDB 3.5
AT	Other	For EVs and HPs, ad-hoc scientific work was produced which helped to identify drivers for demand growth for mobility and heating/cooling, in addition to refining the corresponding hourly profiles in the demand forecasts.
BE	Fit for 55	Industry electrification and associated flexibility. Recent policies regarding electrification of heating in buildings and transportation and associated flexibility. Incorporation of the impact of the recent energy crisis on the demand.
BG	Based on the NECP but adjusted to reflect the most recent trends.	The submitted demand data for the ERAA 2023 reflects an expertly estimated scenario about the development of EVs but does not consider HP as there are no reliable statistics for BG to base future projections on.
CY	NECP	The primary source was the NECP, with data for the next 10 years updated based on the latest TSO 10 year forecast.
CZ	Fit for 55	The demand forecast and demand profiles reflect significant growth in electricity demand, which is due to the 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 (HPs). The additional increase in consumption concerning hydrogen production is considered as well as energy savings.
DE	– based on national TSOs studies/NECP	Sector coupling and electrification of heating and transport sector lead to an increase in electricity consumption aligned with national targets (NECP).
DK	NECP	The developments in electricity consumption in the Project Assumptions for 2022 are driven by an assumption of the general direct electrification of Danish society, which assists in achieving Danish climate targets. In addition to direct electrification, the Project Assumptions for 2022 assumes a large-scale build-out of Power-to-X (PtX) technologies corresponding with the political ambition of commissioning 4-6 GW of electrolysis by 2030. In the long term, the Project Assumptions for 2022 assume that PtX contributes with the production of fuels for bunkering of international shipping- and aviation in Denmark alongside an expectation of direct export of hydrogen from Denmark to the EU. The developments in 'line gas' consumption is driven by the political ambition to phase out 'line gas' from the heating of households in 2035, which is why 'line gas' is expected to be utilized only in high-temperature processes in the industrial sector in the long term. The decreasing consumption of 'line gas' combined with the increasing production of green gasses does so that 'line gas' is expected to be 100% renewable by 2030 and beyond.
EE	Annual consumption comes from long-term demand forecast study.	Demand profiles are created with the Demand Forecasting Toolbox. The TSO has ordered a long-term demand forecast study, which sets targets based on relevant legislation, political targets, overall trends

Country	What were the primary drivers for the data related to demand forecasts and demand profiles?	Please further explain the primary drivers for the data related to demand forecasts and demand profiles submitted in the PEMMDB 3.5
		and outlooks. Demand profiles are generated by including relevant target energy consumptions and list of parameters into the Demand Forecasting Toolbox
ES	Fit for 55	The trajectory provided for the electricity demand and demand profiles have been based on the most updated information available, pending the update of the NECP. A moderate evolution of demand is considered. Demand growth affecting system adequacy could arise due to the installation of new data centres, additional industrial consumers linked to decarbonisation efforts, the evolution of electromobility, or extreme weather events.
FI	The Finnish climate target of carbon neutrality by 2035.	Electrification of industry, heating and transport sectors are the main drivers. The demand development has been based on the latest ambitious government/industry scenarios, which consider the carbon neutrality target of 2035. In addition, the demand development is adjusted according to the latest developments seen in the market, such as the development of power-to-X industry.
FR	Other (please specify)	Demand scenario derived from our 2050 outlook from 2022
GR	Fit for 55	Demand targets provided are aligned with the first draft of the revised NECP which complies with the Fit for 55 targets. The forecasts assume ambitious energy efficiency targets and high electrification, particularly of the transportation and heating sectors.
HR	Other	Strategy of the energy development of the Republic of Croatia until 2030, with a look at the year 2050.
HU	National Energy Strategy, connection requests of large industrial consumers and TSO – DSO assumptions on the evolution of e-mobility, heat pumps etc. These assumptions were based on recent regulations in addition to ongoing and planned state aids, including those based on Fit for 55.	Demand is based on the National Network Development Plan process. Input data considers the National Energy Strategy, connection requests of large industrial consumers and TSO-DSO assumptions on the evolution of e-mobility, HPs etc. These assumptions were based on recent regulations, ongoing and planned state aids, including those based on Fit for 55.
IE	NECP	The NECP assumes a certain growth in electricity demand from HPs and EVs; this, in turn, drives EirGrid demand forecast. Historical trends, economic growth, and the growth of large energy users are also considered.
IT	Fit for 55	Main drivers are: GDP growth and increasing share of electrification within the transport and civil sectors with the spread of electric vehicles and heat pumps
LT	Targets set in National Energy Independence Strategy; measures provided for in the plan for the implementation of the measures of the	The demand forecast is updated annually in light of the guidelines set out in the documents listed above (GDP, efficiency, EV, heat pumps, electrification, DSR etc.) and the latest available information.

Country	What were the primary drivers for the data related to demand forecasts and demand profiles?	Please further explain the primary drivers for the data related to demand forecasts and demand profiles submitted in the PEMMDB 3.5
	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	Demand forecasts and demand profiles are made by TSO/DSO Creos Luxembourg, and published in its Scenario Report. This Scenario Report is based on the targets of the NECP Lux.
LV	TSO best estimate forecast.	The data are a best-estimate TSO forecast which is based on the historical data of demand in Latvia and future demand needs.
MT	National resource adequacy assessment (Electricity Supply Study)	The demand forecasts/profiles submitted for PEMMDB 3.5 are in line with a national resource adequacy study (electricity supply study) undertaken following the development of Malta's NECP.
NL	Ambitions according to the National Climate Agreement and the increased ambition level of new the Dutch coalition agreement.	Ambitions according to the National Climate Agreement and increased ambition level of the new Dutch coalition agreement regarding the growth of EV and HP demand; adding electrolysers, datacenters, batteries and Power to Heat
PL	Higher than in NECP	The increase of the demand for electricity due to ongoing transition
PT	NECP	Data submitted are based on the Portuguese NECP and on the most recent national adequacy assessment report. No further information regarding the national Fit for 55 plan is available.
RO	Other	The expected moderate growth in demand is mainly driven by the expected economic growth and energy efficiency increase. Furthermore, the assumptions about electromobility are reflected in the electricity demand forecast and load profile.
RS	Demand energy forecast in the national TYNDP 2023 – 2032	Demand forecast in national TYNDP 2023-2032 was done by linear regression of historical demand and GDP growth data.
SE	Demand forecasts for electricity were mainly driven by load connection applications to Svk from industries wishing to connect load to the grid.	The scenarios on which we base the PEMMDB submission only include the electricity system and not the whole energy consumption. Since we had no information about the remaining energy consumption we took directly default values from REpowerEU, after checking that these seemed reasonably in line with what can be expected for the remaining energy system in our own scenarios. However, our own scenarios still have a significantly higher increase of electricity consumption compared to the RePowerEU/Fit for 55 scenarios.
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.

Country	What were the primary drivers for the data related to demand forecasts and demand profiles?	Please further explain the primary drivers for the data related to demand forecasts and demand profiles submitted in the PEMMDB 3.5
SK	NECP; A study of the forecast of electricity consumption to 2040 with a view to 2050.	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 the ERAA 2023 that could have a significant impact on the electricity demand evolution.
UA	Other	Neither one nor the other. Only existing and projected consumption trends (including other factors such as the development of electric transport, improved energy efficiency, etc.)

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	**12**
Partially compliant	**10**
Not compliant	**1**
Cannot be assessed	**3**
N/A	**3**

Country	All compliant borders	All non-compliant borders	All borders that cannot be assessed	EU Member States' assessment
AT	AT – DE, AT – CZ, AT – HU, AT – SI, AT – IT	-	-	Fully compliant

Country	All compliant borders	All non-compliant borders	All borders that cannot be assessed	EU Member States' assessment
BE	BE – FR, BE – DE, BE – NL, BE – LU, BE – UK			Fully compliant
BG	RO, GR	MK, RS, TR	-	Partially compliant
CY	N/A	N/A	N/A	N/A
CZ	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.			Fully compliant
DE			All of them	Cannot be assessed
DK	DE, NO, SE, UK, NL		BE (due to alignment with Elia whose input is that this cannot be evaluated this far into the future (2033)).	Partially compliant
EE	EE – FI, EE – LV			Fully compliant
ES	ES – FR and ES – PT		Spain-Morocco in not affected	Fully compliant
FI	SE1, SE3, EE			Fully compliant
FR			All because we (LACs) do not have information	Cannot be assessed
GR	IT		AL, BG, MK, TR, CY	Partially compliant
HR	SI, HR		RS, BA	Partially compliant
HU	AT, HR, RO, RS, SI, SK, UA			Fully compliant
IE	UK, FR			Fully compliant
IT	ITN1, ITCA, ITCN, ITCS, ITS1, ITSA, ITSI			Fully compliant
LT	LT – LV, LT – PL, LT – SE			Fully compliant
LU	DE, BE		FR	Partially compliant
LV	EE00 – LV00 and LV00 – LT00		LV00 – RU00	Partially compliant

Country	All compliant borders	All non-compliant borders	All borders that cannot be assessed	EU Member States' assessment
MT	MT00			N/A
NL	NL – NO, NL – DK, NL – BE, NL – DE, NL – UK			Fully compliant
PL	SE, technical profiles with DE, CZ, SK and LT in 2025	AC part of PL – LT beyond 2025	UA02 (radial connection with Dobrotvirska PP), UA00	Partially compliant
PT		PT – ES		Not compliant
RO	RO – HU, RO – BG	RO – RS, RO – MD, RO – UA		Partially compliant
RS			Serbia is not an EU country	N/A
SE	SE – LT, SE – DE, SE – PL		SE – FI, SE – NO, SE – DK	Partially compliant
SI	All			Fully compliant
SK		CZ, PL,HU	UA	Partially compliant
UA			UA00 – RO00, UA00 – HU00, UA00 – MD00, UA00 – PL00, UA00 – SK00	Cannot be assessed

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 the event it is not, the most conservative view is kept. 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.

NTC values were coordinated with neighbouring TSOs to ensure consistency, except for specific interconnections where coordination was not possible. Efforts were made to achieve compliance with the 70% target, and variations in NTC values were allowed within the ERAA methodology.

Country	What were the primary drivers for the data related to interconnection?	Please further explain the primary drivers for the data related to interconnection submitted in the PEMMDB 3.5 - In particular, please provide further detail on your country's 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.
AT	For Austria, there exists an action plan for fulfilling the 70% target.	Most of the borders are already subject to CORE flow based, which is represented in the ERAA	\

Country	What were the primary drivers for the data related to interconnection?	Please further explain the primary drivers for the data related to interconnection submitted in the PEMMDB 3.5 - In particular, please provide further detail on your country's 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.
	Compliance assessment will be performed annually, having started in 2022.	framework. The border AT-CH cannot be assessed (CH non-EU member state).	
BE	70% target	CORE CCM (incl 70% target in FB). All BE borders should be considered in FB according to the FBMC CORE CCM, which duly accounts for the 70% Target	NA - Elia no longer performs NTC simulations in its national studies
BG	70% target	For the purposes of providing CEP70 compliant values for the ERAA studies, a simple approach was followed. Nominal capacity in MVA of the interconnections on the GR-BG border were converted to MW (by a 0.93 factor) and the target NTC was obtained as 70% of the result. However, considering the network studies that were performed during the planning phase of the new interconnection and the increase of NTC that was calculated on each direction, it was commonly decided to limit the export NTC from Greece towards Bulgaria to 1400 MW. Please consider that NTCs between two countries are also highly affected by the networks of other countries as well. More specifically, the BG-GR border is affected and limited by the protection limits at the MEPSO side in the tie lines among North Macedonia and Greece; however, this is expected to be alleviated in the near future, allowing for the achievement of the expected benefits of the new BG-GR interconnection.	

Country	What were the primary drivers for the data related to interconnection?	Please further explain the primary drivers for the data related to interconnection submitted in the PEMMDB 3.5 - In particular, please provide further detail on your country's 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.
		SEE TSOs (IPTO, ESO, Transelectrica have amended the DA-ID CCM to be in line with the 70% principle. SEE TSOs have submitted the amended SEE CCM at their national NRAs in January 2023, a feedback is expected by autumn 2023. However even if it approved the implementation of the 70% compliance threshold is challenging, as not all neighbouring countries are bound by the same obligations. However, by Decision 2022/03/MC-EnC, the Ministerial Council of the Energy Community incorporated a package comprising the latest EU electricity regulations in the Energy Community. This Decision is binding not only on the Contracting Parties, but also on the neighbouring Member States. In this manner, reciprocity between Contracting Parties and EU Member States is established. This is especially relevant for the terms, conditions and methodologies (TCM) for specific regions which include both Member States and Contracting Parties. Such a region is SEE, where Greece and Bulgaria belong. The adapted Regulations and Codes by the Decision, require transposition by the Contracting Parties to their national legislation until 31 December 2023. This transposition will bind the Contracting Parties to the adopted Regulations. This is very important as it will facilitate discussions with	

Country	What were the primary drivers for the data related to interconnection?	Please further explain the primary drivers for the data related to interconnection submitted in the PEMMDB 3.5 - In particular, please provide further detail on your country's 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.
		EnC TSOs in the SEE area to come up with common methodologies. Such a methodology could be the Coordinated Capacity Calculation Methodology, which considers the minimum 70% target on the margin available for cross zonal trade.	
CY	Until international interconnections are constructed, local generation is needed for security of supply, because the electricity system of Cyprus is isolated.	Cyprus is currently an isolated island.	
CZ	Net imports limit of max 20 TWh/year		
DE	National Grid Development Plan and current TYNDP project state	NTC values are based on the current project state of interconnection projects and bilateral exchanges with neighbouring TSOs. For the NTC-values provided by the German LACs for the ERAA-process, it is not guaranteed that they are CEP-compliant as there is no consistent method to determine the NTC values which consider the 70% minRAM requirements.	Where possible, NTC values were coordinated with neighbouring TSOs beforehand and should be consistent. German TSOs do not submit maintenance-based NTC values, which is why there could be slight differences in some hours.
DK	NECP	For the ERAA 2023, interconnectors have been reported in compliance with the Project Assumptions for 2022 as the rest of the scenario.	NTC values have been coordinated with neighbouring TSOs and should be consistent.
EE	Specific project delays	Infrastructure projects from the network development plan are included in the PEMMDB. NTC calculations on all of the borders consider the 70% target.	All of the NTC values are coordinated with the neighbouring TSO-s

Country	What were the primary drivers for the data related to interconnection?	Please further explain the primary drivers for the data related to interconnection submitted in the PEMMDB 3.5 - In particular, please provide further detail on your country's 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.
ES	Both: Specific project delays and 70% target	Current interconnection data are based on the last two years of historical data. Those historical data are compliant with 70% percent Target. Additionally, for future interconnection data, a methodology that covers the 70% criteria is used, in addition to the commissioning dates of future interconnection projects.	SWE TSOs are coordinated when elaborating interconnection data for ERAA exercises. In addition, two new capacity calculation methodologies that cover the 70% criteria has been developed, that seem to be equivalent. Nevertheless, further investigations are currently ongoing on both methodologies to test and improve them.
FI	Fingrid's best estimate based on existing ICs and known IC projects	The primary drivers are known IC projects of Aurora Line (1 and 2) between FI-SE1 and Estlink 3 between FI-EE. The NTCs are set as such that over 70% of the transmission capacity is offered for cross-zonal trade.	
FR	Specific project delays	No particular explanation	Yes they are coordinated
GR	National and regional grid development plans	Data provided for interconnection is based on the national TYNDP, taking into account transmission projects in the SEE region. It should be noted that currently, the implementation of a methodology for assessing the 70% compliance threshold is challenging as not all neighbouring countries are bound by the same obligations. However, by Decision 2022/03/MC-EnC, the Ministerial Council of the Energy Community incorporated a package comprising the latest EU electricity regulations in the Energy Community. This Decision is binding not only on the Contracting Parties but also on the neighbouring Member States. In this manner, reciprocity between Contracting Parties	Yes

Country	What were the primary drivers for the data related to interconnection?	Please further explain the primary drivers for the data related to interconnection submitted in the PEMMDB 3.5 - In particular, please provide further detail on your country's 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.
		and EU Member States is established. This is especially relevant in the case of TCM for specific regions, which include both Member States and Contracting Parties. Such a region is SEE, where Greece and Bulgaria belong. The adapted Regulations and Codes by the Decision require transposition by the Contracting Parties to their national legislation until 31 December 2023. This transposition will bind the Contracting Parties to the adopted Regulations. This is very important as since it will facilitate discussions with EnC TSOs in the SEE area to come up with common methodologies. Such a methodology could be the Coordinated Capacity Calculation Methodology, which considers the minimum 70% target on the margin available for cross zonal trade.	
HR	Action plan in line with Article 16 of Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity.	NDP and Action plan in line with Article 16 of Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity.	Submitted NTC values are coordinated with all neighbouring countries.
HU	Best estimation based on existing NTCs and new interconnection projects (for the grid model: CEP70 Action Plan also).	The data are based on best estimation. Hungary has an Action Plan to achieve CEP70-compliance by the end of the derogation period (2025), which has been already fulfilled. This has an effect on flow-based compliance (through the grid model); other than that no effects on long-term NTCs can be estimated.	Yes

Country	What were the primary drivers for the data related to interconnection?	Please further explain the primary drivers for the data related to interconnection submitted in the PEMMDB 3.5 - In particular, please provide further detail on your country's 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	NECP	CAP 2023 calls for: Delivery of at least three new transmission grid connections or interconnectors; Explore further interconnection potential, including hybrid interconnector	Yes.
IT	FF55 and a subset of TYNDP scenarios (scenarios defined according to the National Development Plan)	The primary driver is improving electric market system efficiency indicators that the interconnection enables, such as the increase of the Social Economic Welfare (composed of consumer surplus, producer surplus, and congestion rent) and the reduction of Market Prices for consumers, considering the costs associated specified within the cost-benefit analysis. Moreover, to reach RES EU targets, the future grid needs to have an increasingly interconnected system to guarantee the stability, quality and safety of the electricity system itself.	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 the event a neighbouring TSO communicates lower NTC values). In the future, Italian NTC values could be further upgraded in light of upcoming energy scenarios.
LT	70% target	Regional grid development plans and synchronisation project with continental EU	All interconnection data provided are coordinated with neighbouring TSO.
LU	NECP	/	/
LV	Fit for 55	Fit for 55 is very important and crucial regulations for power system development in Latvia.	Not always; sometimes we submit separate NTC values and then the lowest value among two TSOs is considered.
MT	National resource adequacy assessment (Electricity supply study)	The national resource adequacy assessment identified the need for a second electricity link between Malta and Italy. This was therefore submitted as a projected new interconnection capacity by 2026 as part of the PEMMDB 3.5 data collection.	NTC values are as per Regolamento di Esercizio between Terna (Italian TSO) and Enemalta. If there is a reduction in the NTC values, Terna informs Enemalta and projected values are updated accordingly.

Country	What were the primary drivers for the data related to interconnection?	Please further explain the primary drivers for the data related to interconnection submitted in the PEMMDB 3.5 - In particular, please provide further detail on your country's 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.
NL	National Investment Plan (IP)	70% included in FB calculations	Not consistent with BE and DE since there is no consistent methodology to determine 70% compliant NTC values.
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 since 2026. The level of transmission capacities in 2025 resulting from the CNEC list provided for FB purpose in PEMMDB 3.4 (ERAA 2022) is consistent with the Polish Action Plan. 2024 and 2025 NTC values do not consider the 70% minRAM criteria for technical profiles with DE, CZ, SK, due to the inclusion in the calculations of unscheduled flows through Poland, which limits the NTC level.	SE and LT NTC is consistent. NTC with DE, CZ, SK is not coordinated as PSE provides NTC for common border with DE, CZ, SK (technical profile).
PT	Data submitted are based on most recent REN's Grid Investment Plan.	Data submitted are based on the most recent REN 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.
RO	70% target	For the 2023–2025 period, the NTCs values provided for the EU borders are in line with the Action Plan developed by the Romanian TSO in accordance with the provisions of Art. 15 of	The NTC values provided are not coordinated with the neighbouring TSOs and represent the capacity of the electricity grid of Romania.

Country	What were the primary drivers for the data related to interconnection?	Please further explain the primary drivers for the data related to interconnection submitted in the PEMMDB 3.5 - In particular, please provide further detail on your country's 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.
		Regulation (UE) 2019/943 and the Derogation for 2023.	
RS	Historical NTC values and planned NTC increases reported in ENTSO-E TYNDP	The national TYNDP considers internal bottlenecks for NTC and proposes new projects to overcome these issues.	Yes.
SE	Historical availability data	Currently SE does not fulfil the 70% rule on borders with FI, DK and possibly NO. However, it is assumed that in the long-term after grid reinforcements, and with the transition to the flow-based market model all connections with fulfil the 70% rule.	Only NTC on connections SE-FI were explicitly coordinated in the submission. Remaining NTCs were not coordinated, but it was assumed that other TSOs would submit similar values.
SI	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).	Consistent
SK	The primary drivers for the data related to interconnection are specified in the National TYNDP (which is based on the 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). Currently, derogation on borders marked as 'non-compliant borders' in the previous able for the 70% target is granted.	The data related to interconnection are specified in the National TYNDP (which is based on the National Development Plan) while these ones related to the interconnections were aligned with the values of the neighbouring TSOs within process of data quality checks.

Country	What were the primary drivers for the data related to interconnection?	Please further explain the primary drivers for the data related to interconnection submitted in the PEMMDB 3.5 - In particular, please provide further detail on your country's 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.
UA	Other	The assessment for compliance with the 70% target has not yet been carried out, as Ukraine has not yet made such commitments. A number of EU Directives and Regulations are currently being implemented in Ukraine, so such assessments will be carried out later and such targets will be introduced accordingly.	So far, NTCs for all interconnectors have not been agreed upon as these are estimates and will change depending on the implementation of certain interconnector development projects (all interconnectors are currently being modernised). The impact of the war should not be forgotten either

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 and reducing temperature dependent load).

8.1.5.1 Efficiency increase by converting/upgrading heating technologies

The large majority of TSOs (28 of 29) anticipate a reduction of emissions through an increase in efficiency. Many countries have plans to reduce emissions by converting/upgrading heating technologies, such as promoting the use of HPs, transitioning from fossil fuels to renewables, providing subsidies and improving energy efficiency in buildings. These efforts aim to achieve more sustainable heating systems and decrease reliance on high-emission heating sources.

Country	Does your country intend to reduce emissions through an increase in efficiency by converting/upgrading heating technologies?	Please further explain how your country intends to reduce emissions through an increase in efficiency by converting/upgrading heating technologies?
AT	Yes	Austria invests in climate-friendly technologies for heating (e.g. HPs, biomass) by financially supporting the switch from fossil fuels and will continue to do so in the future.
BE	Yes	See Assumptions provided in relation to HPs (See latest National study 'Adequacy & Flexibility study for Belgium 2024-2034' https://www.elia.be/en/news/press-releases/2023/06/20230629_pressrelease_adeqflex)

Country	Does your country intend to reduce emissions through an increase in efficiency by converting/upgrading heating technologies?	Please further explain how your country intends to reduce emissions through an increase in efficiency by converting/upgrading heating technologies?
BG	Yes	According to the NECP significant increase of biomass technologies and only a slight increase of HPs for heating purposes is to be expected in BG for the period 2020 – 2030.
CY	Yes	Government subsidy schemes for upgrading the energy efficiency of buildings cover the installation of HPs, as well as the replacement of old air-conditioning units with newer more efficient ones.
CZ	Yes	Financial support within Modernisation Fund (based on EU ETS income according to the EC Regulation)
DE	Yes	The revision of the Climate Protection Law is currently finalized by the government and likely to enter into force in 2023. It targets a reduction in CO2 emissions by a switch from oil and gas heating towards HPs and renewable heat sources. The plan is to base all new heating on at least 65% renewable energy sources after 2024. Through subsidies, the exchange of existing heating installations is encouraged. After 2045, heating with fossil energy sources such as gas and oil is forbidden.
DK	Yes	The political ambition is to phase out the utilisation of 'line gas' in individual heating in households towards 2035. The heating demand is expected to be covered by district heating and individual electricity-driven solutions, where district heating is not a possibility. District heating pro-duction is also expected to be increasingly driven by electricity due to the roll-out of heat pumps in the district heating mix.
EE	Yes	Several district heating utilities have communicated plans to electrify their production. Subsidies are offered households to replace non-efficient heating supplies with new and efficient ones.
ES	Yes	The data provided include measures in the residential sector for installations of heating and air conditioning. The measures contemplate the incorporation of RES to cover demand in accordance with the final renewable energy consumption Spanish objectives. These measures include the hybridisation of renewable technologies in converting/upgrading heating technologies.
FI	Yes	HP technology develops and replaces not only fossil-fuel based heating and direct electric heating, but also older HP technologies.
FR	Yes	Acceleration of heat pump deployment and renovation policy
GR	Yes	Several relevant measures are envisaged, such as: Incentives for installing heat pumps and replacing air-conditioning units, and replacing oil-fired heating systems with gas-fired heating systems. Already, the current NECP (2019 edition) 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, HPs, 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. The revised NECP is expected to contain even more ambitious targets.

Country	Does your country intend to reduce emissions through an increase in efficiency by converting/upgrading heating technologies?	Please further explain how your country intends to reduce emissions through an increase in efficiency by converting/upgrading heating technologies?
HR	Yes	Some highly efficient cogenerations are in the process of revitalising and increasing efficiency. Converting/upgrading heating technologies is encouraged at the state and local level by various measures.
HU	Yes	Help households switch from wood-based heating to e.g. heat pumps combined with PV panels (state aids, development programmes).
IE	Yes	We have targets for the installation of HPs in 700,000 dwellings by 2030
IT	Yes	Replacement of traditional boilers with HPs
LT	Yes	The main goal of the strategy is still valid - to achieve consistent and balanced modernisation (optimisation) of district heating systems; ensure efficient heat consumption as well as reliable, economically attractive (competitive) supply and manufacturing; enabling the introduction of modern and environmentally friendly technologies; use indigenous and RES to secure systems' flexibility; and create a favourable environment for investment.
LU	Yes	Improvement of building insulations / switching from fossil energies to HPs / Use of electricity for generating heat in industrial processes (where applicable and useful)
LV	Yes	Promoting the switching from gas boilers to electrical HPs - introducing the subsidy scheme.
MT	Yes	Malta does not have any district heating networks or gas heating technologies. Malta intends to reduce emissions in the heating sector primarily through continued efforts in the electrification of heating, primarily through the installation of HPs in end-use sectors.
NL	Yes	Through ETS, regulations and subsidies, and also governmental stimulation to reform gas firing processes towards electrifying processes
PL	Yes	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 data provided for any type of HPs.
RS	Yes	Through incentives that will increase the usage of HPs.
SE	Yes	The direct emissions from heating are very low but increased energy efficiency in buildings and more HPs instead of direct electricity heating will cause emission reduction in other sectors.
SI	Yes	The NECP includes the necessary measures. Slovenia invests in the renovation of old houses and the use of climate-friendly technologies (e.g. HPs, 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 the NECP and Slovakia's recovery and resilience plan.

Country	Does your country intend to reduce emissions through an increase in efficiency by converting/upgrading heating technologies?	Please further explain how your country intends to reduce emissions through an increase in efficiency by converting/upgrading heating technologies?
UA	Yes	Yes, but the effect is not expected to be too significant.

8.1.5.2 Efficiency increase by electrifying transport

Countries are taking various measures to reduce emissions by electrifying transport, including implementing subsidy schemes for EVs, investing in charging infrastructure, promoting the use of electric and low-emission vehicles in public transport, and introducing policies to replace fossil fuel-powered cars with EVs. These efforts aim to transition to cleaner and more energy-efficient modes of transportation and reduce GHG emissions in the transport sector.

Country	Does your country intend to reduce emissions through an increase in efficiency by electrifying transport?	Please further explain how you country intends to reduce emissions through an increase in efficiency by electrifying transport?
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.
BE	Yes	See Assumptions provided in relation to EVs (See latest National study ‘Adequacy & Flexibility study for Belgium 2024-2034’ https://www.elia.be/en/news/press-releases/2023/06/20230629_pressrelease_adeqflex)
BG	Yes	
CY	Yes	Subsidy schemes for EVs.
CZ	Yes	Financial support within the Modernisation Fund (based on EU ETS income according to the EC Regulation)
DE	Yes	Based on subsidies. There are several initiatives to support the roll-out of EV and the related infrastructure. This includes subsidies to support the electrification of public transport. High investments are also planned in the state-owned railway system.
DK	Yes	Fossil cars are assumed to be replaced by EVs, among other things due to EU-requirements.
DE	Yes	Based on subsidies. There are several initiatives to support the roll-out of EV and the related infrastructure. This includes subsidies to support the electrification of public transport. High investments are also planned in the state-owned railway system.

Country	Does your country intend to reduce emissions through an increase in efficiency by electrifying transport?	Please further explain how you country intends to reduce emissions through an increase in efficiency by electrifying transport?
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	By 2030, Finland will reduce emissions from domestic transport by at least 50% compared to the 2005 level. The aim is to achieve an entirely fossil-free transport sector by 2045.
FR	Yes	Deployment of EV
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 current NECP (2019 edition), according to which the 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. The revised NECP is expected to contain even more ambitious targets.
HR	Yes	New charging stations for EVs are constantly being built. There are state subsidises for the purchase of EVs.
HU	Yes	Reducing transport emissions by improving rail transport, operating zero emission buses and providing state aids for buying EVs.
IE	Yes	We have targets for up to 1 million EVs by 2030
IT	Yes	By the replacement of old polluting vehicles with less polluting, electric and biofuels options; the gradual reduction of the use of cars increasing smart and flexible working; and improving local public transport; as well as increasing the use of railways for both passengers and goods.
LT	Yes	The railway electrification project has already started, the development of EV infrastructure is underway, and support schemes for the purchase of EVs have been created.
LU	Yes	Public charging infrastructure is deployed. Fast and supercharging infrastructure are currently projected and being built. The aim is to convert the entire bus fleet to electric buses (or low-emission vehicles). Public transport is free of charge and the goal is to extend the train and railcar/tram network infrastructure. Subsidies and tax benefits are in place to encourage e-mobility for personal and goods transport.
LV	Yes	Via the advantages for owners of electrical cars - free parking, subsidy, can use public transport lines etc.
MT	Yes	As per the Low-Carbon Development Strategy (LCDS) Malta intends to have 65,000 EVs by 2030.
NL	Yes	By a focus on emission levels, making fossil fuels expensive and subsidising EVs
PL	Yes	E.g. support schemes for EVs

Country	Does your country intend to reduce emissions through an increase in efficiency by electrifying transport?	Please further explain how you country intends to reduce emissions through an increase in efficiency by electrifying transport?
PT	Yes	Regarding electric mobility, estimates based on NECP consider 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	By the assumptions provided regarding the expected growth of EVs, given the incentives granted and the development of the charging infrastructure (some projects funded by the Recovery and resilience plan)
RS	Yes	By building a subway system in Belgrade.
SE	Yes	By high taxes on petrol and building out charging infrastructure which provides incentives for consumers to switch to EVs.
SI	Yes	Slovenia is investing into electrifying transport by providing subsidies. New charging stations for EVs are constantly being built, in particular considerable effort is being made in building fast charging stations near the highways, especially for preparing for the introduction of e-trucks. Slovenia also promotes the use of public transport.
SK	Yes	Information about reducing emissions through an increase in efficiency by electrifying transport in detail are specified in the NECP and Slovakia's recovery and resilience plan
UA	Yes	The electrification of all modes of transport is envisaged, but most of all in the private transport sector

8.1.5.3 Efficiency increase by improving building insulation

Most TSOs mention that an improvement in building insulation is foreseen. Countries are implementing various measures to reduce emissions by improving building insulation, such as implementing stricter building codes with higher insulation requirements for new buildings, providing government subsidies for upgrading the energy efficiency of existing buildings, promoting he comprehensive renovation of residential and public buildings, and incentivising the population to improve building insulation. These efforts aim to enhance energy efficiency, reduce heat loss and decrease energy consumption in buildings, leading to lower GHG emissions.

Country	Does your market node intend to reduce emissions through an increase in efficiency by improving building insulation?	Please further explain how your country intends to reduce emissions through an increase in efficiency by improving building insulation?

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.
BE	Yes	See Assumptions provided in relation to buildings (See latest National study 'Adequacy & Flexibility study for Belgium 2024-2034' https://www.elia.be/en/news/press-releases/2023/06/20230629_pressrelease_adeqflex)
BG	Yes	
CY	Yes	By building codes with stricter insulation requirements for new buildings, and government subsidy schemes for upgrading the energy efficiency of existing buildings.
CZ	Yes	Financial support within Modernisation Fund (based on EU ETS income according to the EC Regulation)
DE	Yes	Based on subsidies, policy: The legislation regarding energy efficient buildings has been revised and consolidated in 2023. The insulation standard for new buildings has been raised. The allowed amount of primary energy demand has been lowered. Certain categories of old buildings have to be further insulated.
DK	Yes	Renovation of buildings and efficiency gains are internalized in the modelling of the consumption side of the Project Assumptions for 2022.
EE	Yes	Subsidies are offered to renovate buildings to achieve a higher energy class. New buildings have a mandatory energy class that needs to be reached.
ES	Yes	The impact of the installation of thermal insulation improving the energy efficiency in existing buildings in the residential sector has been considered in the demand values considered.
FI	Yes	Finland is committed to EU targets in energy efficiency improvements.
FR	Yes	No explanation
GR	Yes	Incentives for buildings renovations
HR	Yes	Every year, the state significantly co-finances the energy renovation of buildings.
HU	Yes	There are state aid programmes for improving energy efficiency of buildings; further development programmes for buildings are under consideration.
IE	Yes	We have retrofit programmes for 500,000 dwellings to have BER B2 rating; and a target to have all new dwellings at ZERO-EMISSION Building standard by 2030
IT	Yes	Keep in place measures already introduced in the past such as building insulation of houses and possibly incentivise the change windows/glasses for more performing ones.
LT	Yes	By promoting the comprehensive renovation of multi-apartment residential and public buildings.
LU	Yes	Ambitious renovation targets for existing buildings; high standards must be fulfilled for new constructions
LV	Yes	They have a support scheme from the government.

MT	No information available.	No information available.
NL	Yes	By making fossil fuels expensive and subsidising insulation and electrification as well as adapting the laws regulating how to build properly
PL	Yes	E.g. 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	Assumptions provided in relation to the expected energy efficiency improvements in buildings
RS	Yes	Through incentives that will aid the population in improving building insulation.
SE	Yes	Yes, through incentives to building owners to improve energy efficiency
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 the NECP and Slovakia's recovery and resilience plan
UA	Yes	This is considered in consumption forecasts.

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 whereas 6 see no such plans by their country. Countries are taking measures to reduce emissions by reducing the temperature dependent load, primarily through improving the efficiency of heating and cooling systems, increasing building renovations and promoting the usage of HPs. Stricter building codes for insulation, subsidies for insulation and upgrading air-conditioning units, and the installation of efficient HPs contribute to reducing the energy required for temperature control in buildings, leading to lower emissions. However, it is worth noting that in some cases, the shift from combustion heating to electrification may increase the electrical heat demand, which can have implications for emissions depending on the electricity generation mix.

Country	Does your county intend to reduce emissions through an increase in efficiency by reducing temperature dependent load?	Please further explain how your country intends to reduce emissions through an increase in efficiency by reducing temperature dependent load?
AT	Yes	Yes, by an increase of HPs and their availability to shift the load.
BE	Yes	See Assumptions provided in relation to Demand (See latest National study 'Adequacy & Flexibility study for Belgium 2024-2034' https://www.elia.be/en/news/press-releases/2023/06/20230629_pressrelease_adeqflex)
BG	Yes	
CY	Yes	By building codes with stricter insulation requirements for new buildings and by subsidy schemes for insulating old buildings and replacing old air-conditioning units with newer, more efficient ones.
CZ	No	
DE	No	In general, the emissions will be reduced through an increase in efficiency, but the shift of the temperature dependent load from combustion heating to electrification will increase out electrical heat demand
DK	Other (please specify)	This has not been specifically evaluated for the Project Assumptions for 2022.
EE	Yes	Several district heating utilities have communicated plans to electrify their production. Subsidies are offered to households to replace non-efficient heating supplies with new and efficient ones.
ES	Yes	Efficiency is the basis of all national policies and has been considered in the demand values.
FI	Other (please specify)	The main method to reduce temperature-dependent load is to replace direct electric heating and old HPs with more efficient HPs. Overall, however, temperature-dependent load might increase as heating is electrified both in households and district heating. In district heating, many electric boilers and large-scale HPs are planned to be commissioned, but at the same time there are plans to increase heat storages, which add flexibility to the load. Flexibility is assumed to also increase in households' heating, with smart solutions optimising the load according to the electricity price. Increased flexibility is considered in the inputs.
FR	Yes	Temperature dependent electricity load will increase due to HP deployment, but it will result in emission decrease as HP replaces less efficient fossil boilers.
GR	Yes	Mainly by increasing efficiency and building renovations
HR	Yes	Mainly by increasing the efficiency of heating/cooling and building renovations.
HU	No	N/A
IE	Yes	Overall emission will reduce with the electrification of heating and an increase in home insulation
IT	Yes	Improving building insulation reduces its temperature dependency

Country	Does your county intend to reduce emissions through an increase in efficiency by reducing temperature dependent load?	Please further explain how your country intends to reduce emissions through an increase in efficiency by reducing temperature dependent load?
LT	No	No such intention yet.
LU	Other (please specify)	\
LV	No	N/A
MT	Other (please specify)	As per the NECP, Malta's population is expected to continue to increase. As a result, the expected (temperature-dependent) load in the households and tertiary sectors is also expected to increase. Nevertheless, Malta will continue to focus on efforts to improve the efficiency of HP technologies in the residential and tertiary sectors.
NL	No	
PL	Other (please specify)	No information
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	Other (please specify)	Lack of specific measures/data.
RS	Yes	Through incentives that will increase the usage of HPs.
SE	Unknown	By the elimination of direct heating by electricity and reduce temperature dependent load. In addition, by the installation of HPs in properties which were previously connected to the district heating system and increase the temperature dependent load. Therefore, there are opposing trends and we do not know which one will dominate.
SI	Yes	By the renovation of buildings and installation of efficient HPs, which decreases the temperature dependent load.
SK	Yes	By the introduction of low carbon alternatives such as HPs. Information about reduced emissions through an increase in efficiency by reducing temperature dependent load in detail are specified in the NECP and Slovakia's recovery and resilience plan
UA	No	The approved documents do not provide for this.

8.1.6 Consideration of 'Recovery and Resilience Facility' programme

This 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.

Country	Did your country consider the Recovery and Resiliency Facility in the completion of these data?	If 'Other (please specify)', explain
AT	No	
BE	Other (please specify)	NA
BG	Other (please specify)	Not sure
CY	Other (please specify)	Data were based on the available NECP, which was published before the RRF. However, responses in this survey do account for relevant funding through the RRF.
CZ	No	
DE	Other (please specify)	uncertain
DK	No	
EE	Yes	
ES	Yes	
FI	Yes	
FR	Yes	
GR	Yes	
HR	Yes	
HU	Yes	
IE	Other (please specify)	N/A
IT	No	
LT	No	
LU	No	
LV	Yes	
MT	No	
NL	No	
PL	Other (please specify)	No information
PT	No	
RO	Yes	
RS	No	
SE	No	

Country	Did your country consider the Recovery and Resiliency Facility in the completion of these data?	If 'Other (please specify)', explain
SI	Other (please specify)	Recovery and Resiliency is a priority topic and strategic goals of ELES. There are ongoing activities in this field. However, for now no concrete measures are considered.
SK	Yes	
UA	Other (please specify)	Similar goals to the Recovery and Resilience Facility are envisaged as the war in Ukraine is ongoing, and therefore this issue is even more acute than in Europe.

8.1.7 Drivers of evolution

The next question aims to understand whether the data provided would still be valid in November 2023 in the opinion of each TSO, and what factors would influence the eventual evolutions.

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 2023?	Other (please specify)	Describe the key capacity and energy mix evolution drivers (policy or not) for all the data provided.
AT	Other (please specify)	Dependent on the outcome of the new NECP / FF55 / ÖNIP (Austrian NIP) data in the autumn	NECP
BE	Other (please specify)	Data provided are the best possible forecast. Changes are always possible.	Nuclear Phase out and extension, RES development, Electrification and Flexibility, Interconnection capacity, Nuclear availability in Belgium and France, Coal Phase out in Germany
BG	Other (please specify)		BG has not had a regularly elected government and a firm policy in the energy sector for the last two years and now the newly formed government is

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 2023?	Other (please specify)	Describe the key capacity and energy mix evolution drivers (policy or not) for all the data provided.
			attempting to catch up on delayed reforms which could lead to changes in the expected evolution of the energy mix and capacity.
CY	Other (please specify)	Switching of existing generators from oil to gas, and commissioning of new gas generation, might be delayed.	The Green Transition, as mandated in EU legislation
CZ	Other (please specify)	Changes related to alignment NECP are expected at the end of the year (Actualisation of the State Energy Policy of the Czech Republic))	Renewables expansion, Coal phase-out, New nuclear power plants commissioning including SMR, Hydrogen technologies deployment
DE	Yes		Policy, subsidies. Based on the German laws regarding renewable generation (EEG for instance)
DK	Yes		This should be covered by previous answers to this survey.
EE	Yes		Electricity price is one key driver. Synchronisation with the Central European Synchronous Area is another driver. National energy targets are key drivers of renewable energy.
ES	Other (please specify)	The drivers of Spain's ERAA 2023 data are based on the best information available; however, an update of the NECP is expected in the coming months.	The ERAA 2023 dataset reflects the rapidly evolving energy and considers the best data right now (roadmaps, stakeholders information…). We can 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 as high fossil fuel and CO2 prices drive the development of RES and storages. There are also government policies including phase-out of coal in energy use and many energy companies have published their plans to phase-out coal. There are

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 2023?	Other (please specify)	Describe the key capacity and energy mix evolution drivers (policy or not) for all the data provided.
			many confirmed and expected investments on RES that are done on a merchant basis. These developments have been considered in the capacity and energy mix evolution
FR	Other (please specify)	The drivers will be the same but with a higher climatic ambition through further electrification	Maximising the production of the existing nuclear fleet acceleration of RES deployment
GR	Other (please specify)	The final version of the revised NECP is expected by the end of the year. It is possible that RES capacities may vary from the data provided for the ERAA 2023.	The main drivers for all the data provided are the country's first draft (Jan 2023) revised NECP, which incorporates the Fit for 55 targets, including energy security, GHG emissions reduction, low cost, and reduction of energy dependence.
HR	Other (please specify)	Minor changes are possible; the NECP is under revision.	National transmission grid development plan, Strategy of energy development of the Republic of Croatia until 2030 with a look at the year 2050, NECP.
HU	Other (please specify)	Basically yes, but the National Network Development Plan process can overwrite part of the capacity and energy mix evolution. In addition, the NECP is currently under review by the Ministry of Energy. The result of this review may affect the assumptions.	The yearly process of gathering input data and assumptions for the National Network Development Plan (every year a period which begins in autumn and ends in winter) can overwrite the provided data as this process is designed to consider changing policy drivers, investment plans and all the other factors that can be relevant. Furthermore, the network connection process for generators is organised in half-year-long cycles. The next cycle will start in September 2023, which will affect the foreseen capacity and energy mix evolution.
IE	Yes		Climate Action Plan 2023

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 2023?	Other (please specify)	Describe the key capacity and energy mix evolution drivers (policy or not) for all the data provided.
IT	Other (please specify)	Possible changes due to the publication of the new NECP	General drivers for collected data: - 2030 RES capacity: new policy targets - 2030 demand: updated to reflect the increase in GDP growth and further electrification of transport and heat, and green H2 production - New storage capacity assessed to support the renewables deployment to reach the targets and including qualified units in the 2023/2024 capacity market auctions. DSR is in line with the actual capacity qualified for participating in the ancillary services market for the mid-term; - Complete coal phase-out by December 2025 for the mainland; and by December 2028 in Sardinia, where the coal plants will be phased out by 2028 after the Tyrrhenian Link enters into operation; and - New thermal capacity in line with capacity market results with delivery year 2022/2023/2024.
LT	Yes		The majority of fossil generation capacity (mainly gas) is quite old and gradually reaches the end of its useful lifetime. In addition, an ambitious goal is to derive 100% of electricity consumed from RES by 2030. Given the interest of investors, it is likely that this goal can be achieved.
LU	Yes		Updated NECP
LV	Yes		N/A
MT	No		The capacity and energy mix evolution drivers are based primarily on the NECP (conventional generation), as well as an updated national resource adequacy study (interconnection capacity). Solar PV projections are based on NECP drivers, which have been updated to take into account a higher historical increase compared to the NECP.
NL	Other (please specify)	Yes, but at every time stamp for data collection new insights	The national climate and energy outlook and policies towards an sustainable future targeting CO2 reductions 2030, coal phase out 2030 and stimulating hydrogen above methane fuel usage, towards zero CO2 emissions at 2050;

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 2023?	Other (please specify)	Describe the key capacity and energy mix evolution drivers (policy or not) for all the data provided.
		and policy can be incorporated in new data sets	also with massive growth in solar PV and strong development of offshore wind energy to hubs for flexible and dedicated electrolysers with connections to other countries; and usage of batteries.
PL	Other (please specify)	It is not forecasted	Changing policies
PT	Other (please specify)	A revision of NECP as well as a new National Adequacy Assessment Report with updated data is expected to be delivered before the end of 2023.	- New large hydro power plant (160 MW) by 2024 - Decommissioning of old CCGT (1 GW) in 2029 - 14 GW of new RES between 2022–2030 (of which 10 GW are solar)
RO	Other (please specify)	The new NECP, FF55-compliant, may introduce different targets than the best estimated data provided. Also, due to different investment plans or changes in some economical, political and social drivers, the data may deviate from the current scenario.	The current scenario dataset reflects the policy measures and the information available from the different market participants on the date of collection, elaborated in the light of the more ambitious national targets expected to be adjusted in response to FF55 and become available later this year to replace the current NECP trajectory data (related to the evolution of RES capacity and the penetration of Electrolyser/DSR/Batteries in the market etc) .
RS	Yes		Interest of private investors in RES.Alongside that tendency of Serbia is to go towards the full decarbonisation of the energy sector.
SE	Yes		Electrification increases demand in industry and transport sectors. Increasing buildout of renewable increases the share of renewables in the generation mix. The biggest uncertainty is the future role of nuclear in the generation mix, if existing nuclear reactors can be operated beyond their projected technical lifetime and if new nuclear reactors will be constructed.

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 2023?	Other (please specify)	Describe the key capacity and energy mix evolution drivers (policy or not) for all the data provided.
SI	Yes		The main driver is the 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 2023. However, they may be updated with the release of a new NECP.	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 the ERAA 2023 that could have a significant impact on the electricity demand evolution 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. However, they may be updated with the release of a new NECP.
UA	Other (please specify)	In the context of the ongoing war, the mix of power and energy may change significantly.	In the context of the ongoing war, the main factor is to maintain a balance in the energy system, and therefore the relevant policy is being implemented.

8.1.8 Market reforms

The question aimed to understand whether national market reforms were initiated in the different Member States, and which reforms and to what extend they were considered in the data provided. Market reforms considered in the PEMMDB 3.5 data include the introduction of a fully competitive electricity market model, stakeholder discussions for developing a climate-neutral electricity system, and various reforms such as participation of demand-side and storage facilities, modification of price caps, and interconnection reinforcement. However, some countries have not implemented specific market reforms and rely on existing market structures. Overall, the extent and nature of market reforms vary among countries based on their energy policies and goals. Detailed answers can be found below.

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	Which market reforms (e.g. price cap rules, scarcity pricing) were considered when providing data for PEMMDB 3.5? Please list the reforms	How were the reforms listed above considered when providing data for PEMMDB 3.5?
AT	There are no future plans for market reforms.	none	-
BE	Automatic increase of price cap (HMMCP ACER decision January 2023)	(HMMCP ACER decision January 2023) relates to the modelling rather than to the data provided	\
BG	The government put forward a gradual plan to completely liberalize the energy market in BG by 2026 which was met with considerable backlash from stakeholders but reforms are taking place.	No specific reforms were considered.	\
CY	The Market Management Software (MMS) and the fully competitive electricity market will be operational soon. Furthermore, a framework for storage is being introduced in the interim market arrangements.	The MMS and the fully competitive electricity market model.	NECP
CZ	Flexibility support, Energy storage support, PPA contracts	Nothing	N/A
DE	In 2023, Germany began a stakeholder discussion ‘Climate-Neutral Electricity System Platform’ to develop market design options for a climate neutral energy system. The developed proposals and options for the development of the electricity market design within the Climate-Neutral Electricity System Platform are an important basis for the drafting of specific adjustments to the regulatory framework for the electricity market. No specific interventions have been announced yet.	-	-
DK	The Project Assumptions for 2022 does not internalise market reforms. Modelling of the electricity system is based on current market structures. The Project Assumptions for 2022 is developed by the Danish Energy Agency based on a so-called ‘Frozen policy approach’, which means that the Danish Energy Agency does not internalise new actions, which is supposed to ensure power adequacy in Denmark. It is the task of Energinet to, subsequently, develop physical and market-based solutions, which are to accommodate	\	\

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	Which market reforms (e.g. price cap rules, scarcity pricing) were considered when providing data for PEMMDB 3.5? Please list the reforms	How were the reforms listed above considered when providing data for PEMMDB 3.5?
	challenges regarding security of supply based on the implementation of the Project Assumptions for 2022 and the analysis and conclusions that the utilisation of these lead to. Consequently, such measures have not been implemented in the PEMMDB 3.5 reporting as the analysis outcome of the utilisation of this scenario is, amongst other things, supposed to identify such measures and the need for them.		
EE	According to the ERAA2022 and national resource adequacy assessment Estonia is expected to exceed its reliability standard in 2027 and has initiated the implementation of the capacity mechanism.	No market reforms were considered.	No market reforms were considered.
ES	Input data are provided in line with market arrangements expected from 2023 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 +4000 €/MWh and -500 €/MWh in the day-ahead market and to +/-9999 €/MWh in intraday market; - Connection to the European RR platform (March, 2020).; and - Integration into Imbalance Netting process through the 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 (may 2022); and - Participation of demand-side and storage facilities in the redispatch market (foreseen Q4 2023).	All Market reforms mentioned have been considered when providing data for the ERAA 2023.	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.

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	Which market reforms (e.g. price cap rules, scarcity pricing) were considered when providing data for PEMMDB 3.5? Please list the reforms	How were the reforms listed above considered when providing data for PEMMDB 3.5?
	- Participation of independent aggregators in the markets (foreseen in Q3 2024). - Market for voltage control (pilot project developed in Q1-Q2 2022; final implementation foreseen in Q4 2024); - National project approaching the aFRR standard product (foreseen in Q1 2024); - Connection to mFRR European platform (MARI) in Q2 2024 and aFRR European platform in Q3 2024; and - Implementation of 15' Imbalance Settlement Period in April 2024.		
FI	Significant market reforms include an EU-wide harmonised balancing market, imbalance settlement and requirements for the procurement of reactive power. The new government programme also states that a study will be conducted to create a cost-effective capacity mechanism (e.g. an auction or similar) that will ensure a sufficient amount of available electricity at all times.	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.	The market reforms were considered to the extent possible when providing data. The impact of a possible CM was not considered.
FR	Yes, but no specific details at this stage	Not available now	No explicit link between reforms and provided data
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	A new law on the electricity market was adopted in October 2021.	All market reforms are in line with European legislation.	Data provided for PEMMDB 3.5 are in line with the NDP and Energy strategy.
HU	No information on any plans related to national market reforms.	N/A	N/A
IE	The SEM (our Single Electricity Market) 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 significant systems service changes. RAs are leading a review of network tariffs.	-	-

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	Which market reforms (e.g. price cap rules, scarcity pricing) were considered when providing data for PEMMDB 3.5? Please list the reforms	How were the reforms listed above considered when providing data for PEMMDB 3.5?
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.
LT	No plans to initiate market reforms. Peak shaving products might be introduced.	No market reforms considered. Peak shaving products might increase demand response capacities.	No market reforms considered. A higher amount of DSR capacities is expected.
LU	/	/	/
LV	N/A	N/A	N/A
MT	Malta is currently not considering any market reforms.	Not applicable.	Not applicable.
NL	Currently not foreseen	Currently not foreseen	n/a
PL	To be developed on MS level	Not considered	Not considered
PT	No market reforms were considered.	No market reforms were considered.	No market reforms were considered.
RO	No specific plans were considered.	-	-
RS	Implementation is in the consideration phase.	None.	These reforms were not considered in the PEMMDB3.5.
SE	SE will be investigating the possibility of introducing a capacity market after contract for the current strategic reserve runs out in 2025. Most likely, some interim solution will be required to bridge the time until a capacity market can be implemented.	None	N/A
SI	No specific market reforms are considered when providing the data.	-	-
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	The application of market reforms is mainly perceived in the INECP (NECP of Slovakia), which corresponds in its	For example, increasing NTC on the SK–HU interconnection profile

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	Which market reforms (e.g. price cap rules, scarcity pricing) were considered when providing data for PEMMDB 3.5? Please list the reforms	How were the reforms listed above considered when providing data for PEMMDB 3.5?
	necessary to apply the principles (market reforms) of Article 20(3) of Regulation (EU) 2019/943 to eliminate possible regulatory distortions.	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 has a positive impact on the release of capacity for the connection of new RES.	

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	Which market reforms (e.g. price cap rules, scarcity pricing) were considered when providing data for PEMMDB 3.5? Please list the reforms	How were the reforms listed above considered when providing data for PEMMDB 3.5?
UA	Regulations and directives of the EU Energy Package 4 are only being implemented in Ukraine (in particular, Article 23(5)(e) and Article 20(3) of the Electricity Regulation), and therefore, it is not yet possible to say	It was assumed that the level of price restrictions is higher than currently, because the existing level of restrictions does not always provide an opportunity to import electric energy (primarily during periods of maximum demand for electric energy).	Currently, in fact, such reforms do not affect the indicators that are given in PEMMDB 3.5

8.1.9 Out-of-market measures

This 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. Some countries are highlighted in the text. Detailed answers can be found in the table below.

Germany has a capacity reserve, grid reserve, demand-side response, lignite units in standby, frequency restoration reserves, and special network equipment. The capacity reserve contributes 1056 MW, and lignite units in standby require a lead time of 240 hours. However, some measures primarily support system operation rather than directly addressing supply shortages.

Denmark utilises FRRs and FCRs. The total reserve requirement for DKE1 is 712 MW from 2022 onwards, while for DKW1, it is 394 MW. Italy lacks a strategic reserve, while Malta has 215 MW of gasoil-fired back-up generation plants for emergencies. Portugal does not specify out-of-market measures.

These measures, including strategic reserves, demand-side response, FRRs, and voltage reduction, contribute to system adequacy by providing additional capacity, supporting grid stability and managing supply – demand imbalances.

Country	What out-of-market measures (e.g. capacity market strategic reserves, voltage reduction, eco gestures, FRR, FCR, etc.) do you have at your disposal to address potential shortfalls in supply?	Please provide a 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
AT	none	-	-
BE	0MW* ‘Out of market’ measures for BE where the Strategic Reserves’. The SR mechanism is no longer relevant for BE as it is no longer approved by EC.	\	\
BG	Currently BG does not deploy out-of-market measures (that may change in the future). We are mostly relying on 750 MW of mFRR provided mostly from hydro.	650 - 750 MW of mFRR provided mostly by hydro resources.	The total amount of reserve on BG (FCR, aFRR and mFRR) is around 1 GW which is sufficient to cover the largest generator FO for several hours and 99% percentile of peak loads in BG. Again BG is well interconnected with its neighbouring countries and can rely on emergency assistance in tight situations.
CY	N/A	N/A	N/A

Country	What out-of-market measures (e.g. capacity market strategic reserves, voltage reduction, eco gestures, FRR, FCR, etc.) do you have at your disposal to address potential shortfalls in supply?	Please provide a 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	Voltage reduction + ancillary services + PV curtailment	Load shortage in emergency security situations	Classic power production increase/decrease to ensure matching demand
DE	The out-of-market resources for Germany include: - Capacity reserve: Reserve for unforeseeable events, which are activated in the event 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: The German National Regulatory Agency (BNetzA) is preparing a regulation to withhold a demand-side response out of the market from 2023/24 onwards with the primary purpose of supporting system stability. - Lignite units in standby (Versorgungsreserve). These reserves can only be activated by the government until March 2024. - FRRs. - Special network equipment: used only for redispatch	- Capacity reserve: Since 1 October 2022 and until 30 September 2024, a total capacity of 1056 MW of gas-fired power plants outside the market is available. These power plants have to be available within maximum 12 hours. The German Capacity reserve has been approved by the European Commission until 30 September 2025. The dimensioning from 1 October 2024 onwards is still pending. - Out-of-market demand-side response: Up to 750 MW are under discussion. - Lignite units in standby (Versorgungsreserve): Lignite-fired power plant blocks with a total capacity of 1.9 GW are available as reserves. They have been allowed to operate on the market until June 2023. In the event of a gas supply crisis, the government may allow them to operate on the market again. The lead time in which the power plants are completely available is 240 hours. After 31 March 2024, this reserve will be completely dissolved. - Grid reserve: Currently, it comprises a total capacity of 3.9GW. The target capacity for the winter 2023/24 is 4.6 GW. - Special Network Equipment: a total of 1200 MW are available for curative redispatch.	The capacity reserve contributes 1056 MW to national adequacy. Lignite units in standby contribute with a lead time of 240 hours (limited until March 2024). No other reserves should be considered for adequacy studies, as their primary purpose is the support of system operation.

Country	What out-of-market measures (e.g. capacity market strategic reserves, voltage reduction, eco gestures, FRR, FCR, etc.) do you have at your disposal to address potential shortfalls in supply?	Please provide a 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	Besides FRR and FCR, 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 requirement in the ERAA 2023 for DKE1 is 712 MW from 2022 onwards. For DKW1, the requirement is 394 MW for the entire 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	The TSO has an emergency powerplant which can be activated if all of the ancillary service providers have exhausted their resources. It can offer mFRR.	A maximum of 250 MW	It does not contribute to long-term system adequacy; it is used if all of the ancillary service providers have exhausted their resources.
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 are available for out-of-market measures.
FI	Finland has a strategic reserve measure in place until 2032; 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.	No capacity is contracted to the strategic reserve currently and due to the annual procurement, reserve capacity for the upcoming years is unknown. The expected development of mFRR capacity is given in the reserve inputs.	The strategic reserve does not currently contribute to system adequacy as no capacity is contracted to the reserve. The mFRR are mainly used for frequency restoration but can also be used for system adequacy for short periods of time.
FR	Voltage reduction, eco gesture, FCR, aFRR, mFRR and RR and interruptible contracts	Between 5% and 15%, not to be published	Reserved capacities to activate when they are needed
GR	None	\	\
HR	DSR, FRR, FCR	Between 200 - 250 MW	The out-of-market measures contribute positively to system adequacy.

Country	What out-of-market measures (e.g. capacity market strategic reserves, voltage reduction, eco gestures, FRR, FCR, etc.) do you have at your disposal to address potential shortfalls in supply?	Please provide a 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
HU	Balancing market products (FRR, FCR) are available; however, these are used for frequency containment and restoration, not for addressing potential shortfalls in supply. There is a process in place for rotational load shedding, based on national regulation. This can be activated as a last resort, after all market-based methods are deemed insufficient to solve the shortfall in supply.	The capacity available for rotational load shedding is ~230 MW without the key consumers (based on their role in providing indispensable services for the residential sector). An additional ~100 MW is available with the key consumers mentioned before, but the requirement is that the electricity supply of these key consumers needs to be maintained as long as possible, even during a crisis situation.	Rotational load shedding is available as a last resort when all market-based mechanisms fail to solve the adequacy problem.
IE	Voltage reduction	-	The out-of-market measures contribute positively to system adequacy.
IT	At present, there is no strategic reserve in Italy.	-	-
LT	None	-	-
LU	/	/	/
LV	None - we are not expecting shortages in the Latvian power system	0 MW, 0%	N/A
MT	Malta has strategic reserves in the form of gasoil-fired back-up generation plants, which are available for dispatch in case of emergencies.	Malta has 215 MW of gasoil-fired back-up capacity.	Emergency back-up plants are available for dispatch at any time in case of any shortfalls in supply (such as disruptions in gas-fired capacity or the interconnector with Italy) and hence contribute to system adequacy.
NL	none	n/a	n/a
PL	1. DSR contracted for the period 2023-2027 as a part of the already concluded Capacity Market auctions. 2. Voluntary DSR contracted with consumers for the period from April 2023 till March 2024. 3. Additional must-run understood as the increase of the contracted infeed of CHPs.	1. Average values: - 2023: 1032-1151 MW a), b) - 2024: 1610 MW c) - 2025: 959 MW c) - 2026: 1509 MW c) - 2027: 1539 MW c) a) level dependent on season; b) values from main and additional CM auctions; c) reduction	These out-of-market measures are operational ones, their role is to restore reserves in the system and therefore they do not contribute to the system adequacy in medium- and long-term perspective. The exception is DSR withing CM, which can be applied in sc. with CM during the post process of ERAA preparation.

Country	What out-of-market measures (e.g. capacity market strategic reserves, voltage reduction, eco gestures, FRR, FCR, etc.) do you have at your disposal to address potential shortfalls in supply?	Please provide a 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
	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 Risk-preparedness plan (draft is not publicly available). 5. Agreements on emergency energy exchange with neighbouring TSOs / Agreement on assistance for active power delivery with CEPS.	tests did not proceed yet, effective level may be lower; 2. Up to 100 MW (based on a recent PSE 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 for the above-mentioned consumers, for which load curtailment cannot be used. 5. Level depends on availability of interconnections and power in neighbouring TSOs	
PT	For ERAA 2023 purposes, there were no out-of market measures indicated by REN, according to the PT national adequacy assessment report.	For ERAA 2023 purposes, there were no out-of market measures indicated by REN, according to the PT national adequacy assessment report.	For the ERAA 2023 purposes, there were no out-of market measures indicated by REN, according to the PT national adequacy assessment report.
RO	No out-of-market measures considered for the ERAA2023. Data for both FCR and FRR have been provided. In crisis situations in the operation of the national power system, the Romanian TSO may apply the safeguard regulation issued by the NRA.	N/A	N/A
RS	Voltage reduction	Voltage reduction 5% in winter period.	Voltage reduction reduces peak demand in critical regimes.
SE	Strategic reserve, and disturbance reserve	Strategic reserve: 562 MW	The strategic reserve ensures that a power plant which would otherwise probably have been closed down is ready for operation in case the spot-market does not clear or if it is otherwise

Country	What out-of-market measures (e.g. capacity market strategic reserves, voltage reduction, eco gestures, FRR, FCR, etc.) do you have at your disposal to address potential shortfalls in supply?	Please provide a 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
			forecast that there will be a lack of generation capacity in the system.
SI	Measures to address decreases and increases in frequency; measures to address voltage drops and surges; measures to prevent overloading of elements (DSR, FRR, FCR, DTR etc.). This also includes the batteries the primary goal of which is FRR etc.	With regard to FCR+/-, aFRR+/- and mFRR+/-, the total market node requirement can vary in the future for FCR from 15 to 24 MW. Regarding aFRR, it totals +/- 60 MW. The development of the capacity is included in the data inputs.	The out-of-market measures contribute positively to system adequacy.
SK	Measures to address decreases and increases in frequency; measures to address voltage drops and surges; measures to prevent overloading of elements; measures to prevent imbalance	Regarding FCR+/-, aFRR+/- and mFRR+/-, the total market node requirement in 2023 is as follows: - total market node requirement (positive): 665 MW - total market node requirement (negative): 315MW	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.
UA	Emergency assistance (if for a short period of time); consumer restrictions (as a longer term tool); use of reserves (FRR, RR) for the purposes of reducing the deficit of electric energy	Emergency assistance - up to 1500 MW consumer restrictions - up to 75% of total load use of reserves - up to 50% of the regulated value	In the period from 24 February, 2022, all of the above were applied in Ukraine.

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