Polskie Sieci Elektroenergetyczne

Response to ACER's Opinion on the differences between the national resource adequacy assessment of Poland and the 2023 European resource adequacy assessment

Appendix to

National resource adequacy assessment 2025 - 2040

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1 Introduction

Articles 20, 23 and 24 of Regulation (EU) 2019/943 (Electricity Regulation) set out that a Member State may conduct a national resource adequacy assessment (NRAA) to complement the European resource adequacy assessment (ERAA) when monitoring resource adequacy within its territory. NRAA shall have a regional scope and shall be based on the methodology referred in article 23 (3) of Electricity Regulation, in particular in points (b) to (m) of Article 23(5).

Where the NRAA, as defined in Article 24 of the Electricity Regulation, identifies an adequacy concern that was not identified in the ERAA, the NRAA must include reasons for the divergence between the two assessments, including details of the sensitivities used and the underlying assumptions. The NRAA must be published and submitted to ACER for an opinion. ACER's opinion assesses, on a case-by-case basis, whether the differences between the two assessments are justified. ACER primarily considers the differences identified and reasoned by the Member State in the submission, but may also identify further differences, if they also have a material impact on the results.

The most recent ERAA (ERAA 2023) was approved on 2 May 2024[1]. Poland carried out its own resource adequacy assessment (the Polish NRAA) which was published on 15 November 2024[2] together with the explanations on the divergence between national and European assessment. On the basis of the national law, the TSO (i.e. PSE) is the entity responsible for the preparation of the NRAA. Polish authorities submitted the Polish NRAA to ACER and the Agency's Opinion (No 1/2025) was published on 3 February 2025[3]. This Opinion concerns the differences between the Polish NRAA and ERAA 2023 and evaluates whether these differences are justified.

The main results of the resource adequacy assessment are the LOLE and EENS indicators. The values of these indicators for the respective target years for both ERAA 2023 and NRAA are presented in Table 1 and Table 2 with the red color indicating results exceeding the reliability standard for Poland, i.e. 3 h/year.

Table 1 The results of the LOLE indicator for the base scenario of the Polish NRAA, as well as Scenario A and Scenario B of ERAA 2023 report

Study				**2025**	**2028**	**2030**	**2033**
-	Polish reliability standard	LOLE	h/a	3.0	3.0	3.0	3.0
NRAA	base scenario	LOLE	h/a	**7.6**	**33.3**	**9.6**	**15.0**
ERAA 2023	scenario A	LOLE	h/a	0.1	1.7	2.5	**8.5**
ERAA 2023	scenario B	LOLE	h/a	0.3	**4.7**	**4.4**	**12.3**

Table 2 The results of the EENS indicator for the base scenario in the Polish NRAA, as well as Scenario A and Scenario B of ERAA 2023 report

Study				**2025**	**2028**	**2030**	**2033**
NRAA	base scenario	EENS	GWh/a	5.8	52.1	13.8	24.3
ERAA 2023	scenario A	EENS	GWh/a	0.0	1.2	0.9	6.1
ERAA 2023	scenario B	EENS	GWh/a	0.0	3.0	2.6	13.5

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

[2] https://www.pse.pl/-/publikacja-raportu-zgodnie-z-art-15-i-ustawy-prawo-energetyczne

[3] https://www.acer.europa.eu/sites/default/files/documents/Official_documents/Acts_of_the_Agency/Opinions/Opinions/ACER_Opinion_01-2025_Polish_National_Resource_Adequacy_Assessment.pdf

2 Response to ACER's evaluation and recommendations

ACER's assessment analyzes twelve changes implemented in the Polish NRAA compared to ERAA 2023. ACER found that they are interlinked and give rise to three main differences:

1. assumptions towards cross-zonal exchanges,
2. capacity resources,
3. the modelling choices made.

For each group of main differences between the Polish NRAA and ERAA 2023, ACER prepared an evaluation regarding their reasons and merits, as presented in Table 3 below.

Table 3 Summary of the differences between the Polish NRAA and ERAA 2023

No	Difference	Reason for difference	ACER's evaluation
1	Assumptions regarding cross-zonal exchanges	Constrained contribution of foreign units and no possibility for export for domestic units.	Not justified
2	Assumptions on capacity resources	Updates due to new information available.	Justified
3	Modelling of capacity resources	Different modelling of the economics of power plants.	ACER cannot conclude whether the difference

PSE response to ACER's evaluation:

1. Assumptions regarding cross-zonal exchanges - ACER points out that the Polish NRAA does not take into account the full benefits of the internal electricity market for the security of supply.

The Polish NRAA only models the Polish market zone while other bidding zones are not explicitly modelled. The neighbouring bidding zones are however not neglected, as these are modelled as direct contribution to adequacy based on the ERAA 2023 results[4]. This contribution is calculated based on the methodology used for determining the volumes of foreign capacity participating in capacity mechanisms i.e. maximum entry capacity (MEC). The MEC calculation takes into account the expected availability of interconnection and the likely concurrence of system stress in the system where the resources are contributing and the system in which the foreign capacity is located thus it represents the forecasted expected contribution of foreign resources to domestic bidding zone (here PL00). The method is consistent with the ACER's Decision, which is presented in the annex to decision titled: "ACER Decision on technical specifications for cross-border participation in capacity mechanisms: Annex I". Essentially, in this method, the contribution of foreign capacities to the adequacy of the zone where the capacity market is located is determined based on the analysis of cross-border flows during hours when there is unserved energy in that zone, i.e., during scarcity periods.

The chosen approach allowed for significantly more detailed analysis in NRAA as compared to ERAA 2023, as it allowed for analyzing all years from 2025 to 2040 with unit by unit revenue based EVA where fully performed, for two scenarios: scenario with and without CM. Indeed, the possibility to conduct detailed calculations and adequacy assessments was the main goal of preparing a national NRAA. At the same time, consideration of direct contribution of generation capacity from neighboring bidding zones to Polish adequacy does meet the requirement of a regional scope of the analysis.

Having on mind that there are a lot of changes expected in Polish energy system in upcoming years, expanding number of analyzed years in comparison to ERAA 2023 was crucial. In particular, inclusion of all years of

[4]In detail it is modelled as "expensive generator" that is activated after all available domestic units are activated. It results in activation in scarcity moments so there is not much annual energy from this resource. This "generator" reduces number of scarcity hours thus reducing revenues of domestic resources and improves adequacy metrics

2025 – 2040 horizon, allowed to capture the all changes in the power system that impact the economic viability of resources (like increasing share of RES and decreasing capacity factors of fossil-fired units) while ERAA study focuses only on 4 target years. However, year by year data necessary to build a full-fledged European/regional model for the purpose of NRAA was not available. Hence, the only way of keeping consistency with ERAA 2023 while ensuring a regional scope of NRAA was to find a way of including cross-zonal exchanges as an aggregated flows. Due to the complexity of the model and the required computation time, the calculation problem had to be reduced by omitting elements which do not influence the results. That is why the interaction between the Polish bidding zone and the foreign bidding zones are modelled as the contribution of generation capacity to security of supply based on the forecasts presented in the ERAA 2023.

It is worthwhile to point out, that according to ERAA 2023, forecasted security of supply decreases in all bidding zones in Europe. The ERAA 2023 results clearly indicate that during potential energy crises (regional scarcity situations), there is no guarantee that resources available in foreign bidding zones will be available for import to Poland i.e. be equal to or exceed the cross-border capacities toward Poland. Thus, the comparison of import flows from real-life data of 2023 (where there were in fact no regional scarcity moments) with the future energy system during a forecasted regional crisis scenario is not justified. Such comparison does not show cross-border power flows during scarcity situations experienced in one or more bidding zones at the same time, but rather presents cross-border flows in normal situations. It is also worth mentioning that, in the case of Poland, scarcity situations will occur particularly during hours when there is little to no PV or wind generation. Such conditions ("dunkelflaute") will almost certainly cause scarcity or near-scarcity situations in the neighboring countries, especially in Germany. This will lead to economic-only driven power flows (commercial exchange) between two or more bidding zones experiencing scarcity, where the stronger economy will be able to pay higher price and thereby secure imports of energy, causing even deeper scarcity in other bidding zones. Such a situation occurred on November 6, 2024, when low RES generation led to exceptionally high electricity prices in Germany, exceeding 800 €/MWh—compared to the November average of approximately 114 €/MWh. As Germany imported energy from other countries experiencing scarcity, prices in some of these exporting countries rose above 500 €/MWh.

ACER also points that scarcity events in ERAA 2023 generally occur during winter months and thus due to different patterns it cannot be applied to Polish NRAA. Figure 1 and

Figure 2 present scarcity moment distribution in the NRAA base scenario for Poland, separately in the market module and adequacy module. For the same of comparison, only the Target Years matching the ERAA 2023 ones are presented. As shown in the below figures, majority of scarcity moments experiences in Polish NRAA also appear in winter, thus identically to ERAA 2023 study. The only exception is TY2025 in the market module (Figure 1), which shows a significant number of scarcity hours in Q3. This was primarily due to the fact, that in the market module there is only 1 randomly selected forced outage schedule that is being used in all 3 analyzed climate scenarios . In contrast, in the adequacy module there are 10 forced outage schedules considered for each of the 38 climate scenarios. This is why Q3 (summer period) in the adequacy module does not show significant number of scarcity hours, aligning more closely with the results presented in the ERAA 2023.

Figure 1. Scarcity moment distribution in the Polish NRAA base scenario - market module

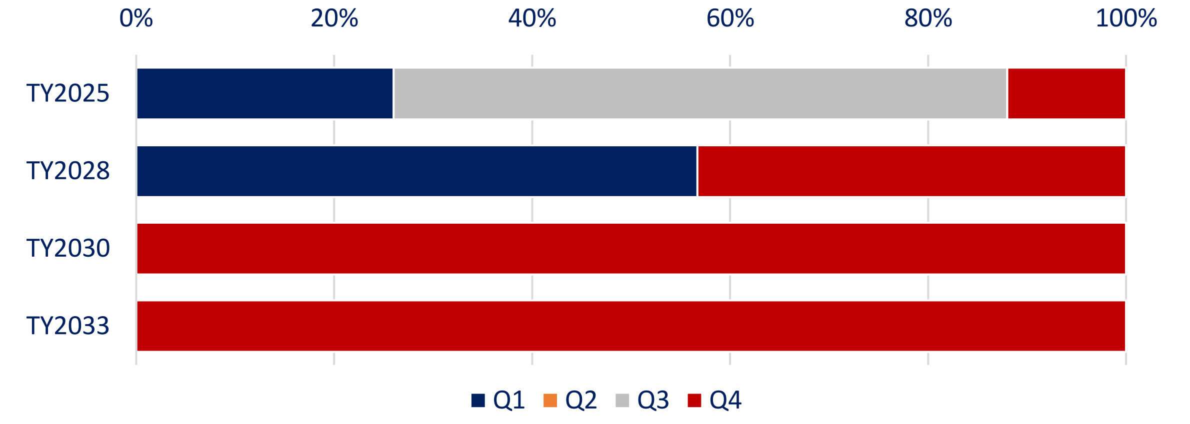
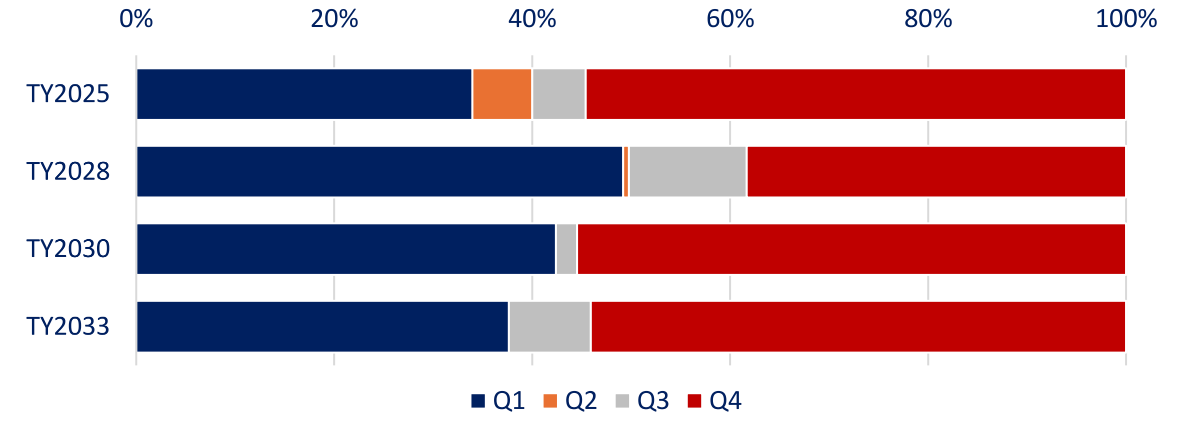


Figure 2. Scarcity moment distribution in the Polish NRAA base scenario - adequacy module



The simplified approach to assessing regional contribution to Polish adequacy was elaborated with full understating of its limitations, while ensuring that the chosen simplification have as limited as possible impact on the NRAA results. For example, the availability of foreign resources is reflected in the Polish NRAA as values of available foreign capacity that reliably can be imported during system stress events. This leads to a reduction of over 50% in the number of scarcity events - meaning that more than half of the potential scarcity situations are avoided thanks to the contribution of resources from neighboring bidding zones. This clearly demonstrates that cross-border contribution significantly improves adequacy in the Polish bidding zone, and it was reflected in the Polish NRAA.

<u>Consideration of the value provided by import an exports with regards to adequacy and economics</u>

ACER in its opinion states that lack of consideration of exports in the Polish NRAA strongly impacts the results of economic viability assessment, thereby impacting the final adequacy results. In opinion of PSE, this is not the case for the following reasons.

The latest ERAA and TYNDYP reports show that Polish bidding zone is globally a net importer in the upcoming years (at least 10 TWh of import per year). Hence, the statement that export from Poland would significantly impact the generation of fossil-fired units in Poland is not justified by the data coming from ERAA and TYNDYP.

With regards to the instances of time when Poland would export energy to neighboring bidding zones, it needs to be highlighted that significant majority of such hours occur when energy prices in Polish bidding zone are low due to abundance of RES (especially PV). Only TY2025 in the ERAA 2023 is quite different, due to not high RES share, Poland is importer even when prices are low. According to forecast in ERAA 2023 in TY2025 Poland imports for c.a.98% of time (Figure 3).

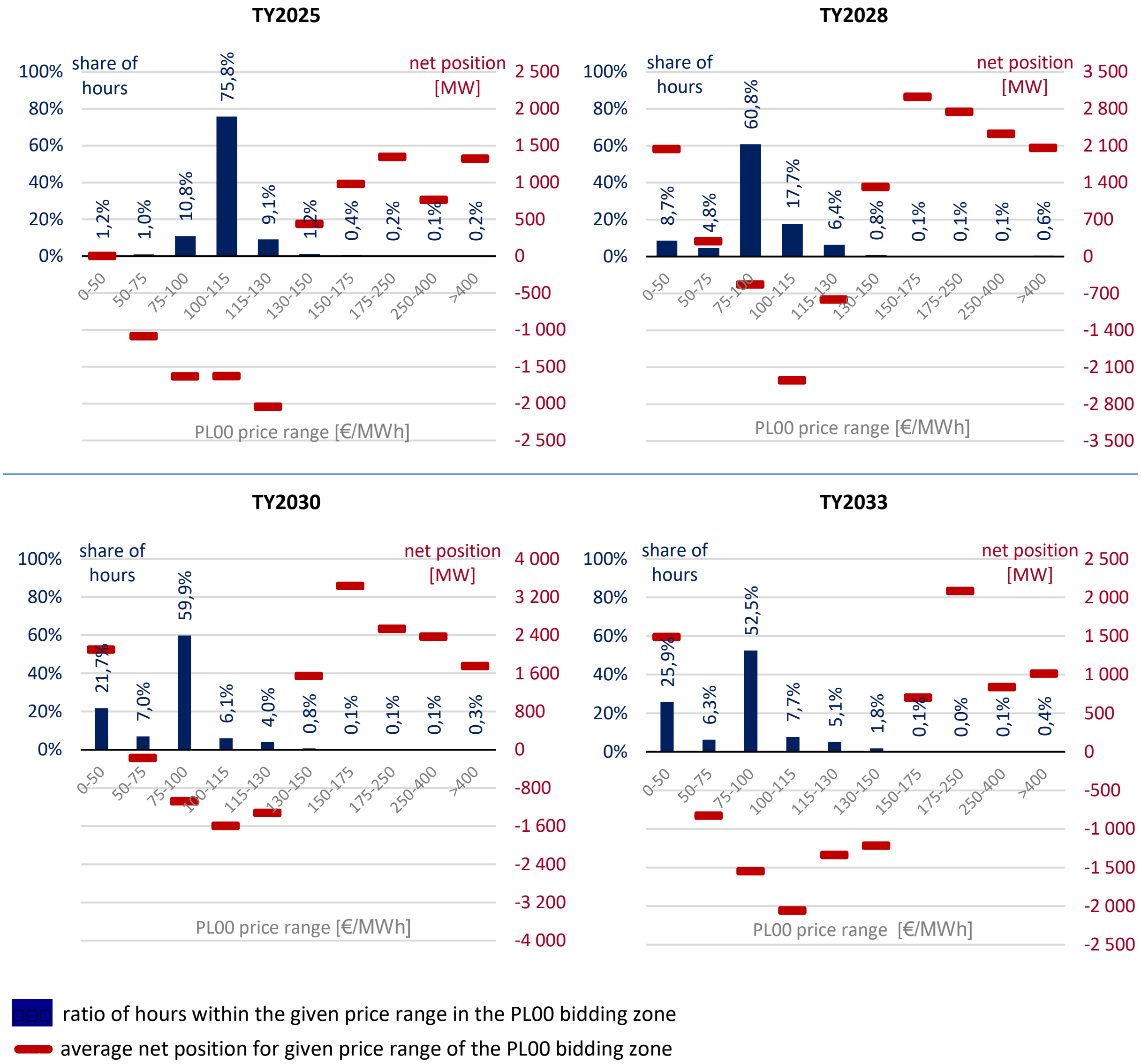
Figure 3 illustrates the price distribution and average net position of the Polish bidding zone, based on the ERAA 2023 results for each target year. Negative net position means that the Polish bidding zone is globally importing, while positive net position means that bidding zone is globally exporting. Additionally, exports and imports are divided into time periods based on market prices. This was done in order to allow for better illustrating the economic opportunities, or lack thereof, for exports. In ERAA 2023, the short-run marginal cost (SRMC) of existing coal and lignite units, i.e. units considered in the optimization process selecting whether they should be decommissioned or continue operation, ranges from 100 €/MWh to 123 €/MWh for target year 2025, and increases to 123 €/MWh to 150 €/MWh for target year 2033[5]. Therefore, in order to improve economic viability of fossil-fired units by means of additional generation that could be exported, this export would need to take place during hours when wholesale prices reach at least the aforementioned SRMC. This does not seem to be the case in ERAA 2023. On the contrary, it can be seen from the figure, that Poland is indeed a predominantly importing bidding zone, as significant majority of time stamps are characterized by imports. The hours with exports are rare – starting from 2% of total hours in TY2025 to 26,5% in TY2030. Moreover, the hours with exports and simultaneously sufficiently high market prices exceeding the SRMC range are extremely rare – ranging from 0,6% to 2,0% of total time, depending on the target year. As a result, electricity generated by fossil-fired units, meaning the units that are subject to potential decommissioning decisions in the optimization process, can only be exported in fraction of the time, so that the potential impact on their profitability is negligible. Real life experience shows exports from Poland takes place generally during low-price periods, characterized by high RES generation. This is however not a profit making activity for fossil-fired units, but rather a means of economic loss-reduction for such units, which are often inflexible and cannot be switched on and off easily. Therefore, modeling exports in the NRAA would in practice only allow for lower RES curtailments rather than improving economic viability of existing fossil-fired units. The data from ERAA 2023 shows that consideration of exports will not impact the capacity mix and consequently will neither significantly increase nor significantly decrease the adequacy risks seen by the adequacy model.

The situation looks very differently for imports, which is quite obvious when looks at the relation between Polish net position and energy prices in the ERAA 2023 figures. Significant import into Poland considered in the ERAA 2023 and TYNDYP does significantly impact the profitability of fossil-fired units (see Chapter 5.1.1: Base scenario with energy import). Import of around 10 TWh per annum will decrease the profitability of existing and new units (delaying or cancelling their commissioning), decreasing long-term security of supply in the Polish bidding zone.

The aim of the NRAA is particularly to assess the level of operational security of the national power system. Therefore, the lack of full modelling of cross-border exchange during periods not characterized by a tight balance situation does not affect the adequacy analysis result. In our opinion all benefits of the internal electricity market for the security of supply are sufficiently taken into account in the Polish NRAA.

[5]Data refers to Lignite/old 1, Lignite/old 2, Hard coal/old 2 and Hard coal/old 1 unit's categories located in PL00 bidding zone

Figure 3. Price distribution and average net position of the Polish bidding zone, ERAA 2023



NOTES:

- Negative net position means that the bidding zone is globally importing, while positive net position means that bidding zone is globally exporting.
- Data is based on: ERAA 2023 adequacy runs pre curtailment sharing (CS)[6], for 4 climate years (1985, 1995, 2005, 2015), all samples, all MTUs.

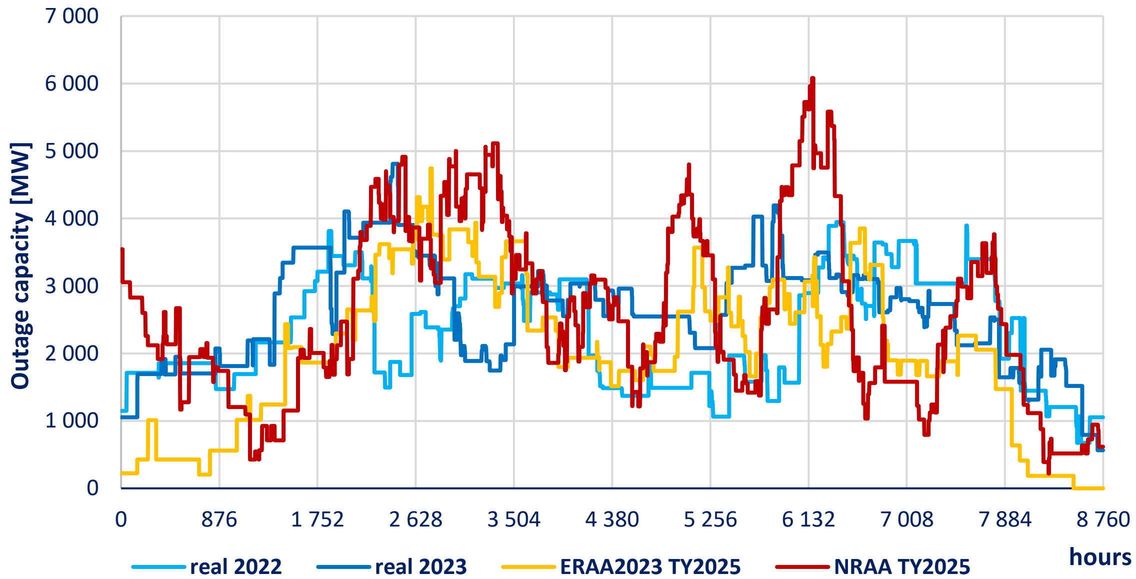
<u>Consideration of the differences in the planned and forced outage patterns</u>

ACER in its opinion on the Polish NRAA discusses also the differences in the planned and forced outage patterns. In opinion of PSE, such differences are quite natural. As the NRAA is strongly focused to represent the Polish power system with the highest care, the planned outage patterns used in the Polish NRAA are more accurate when comparing to real life outage patters, certainly more than the ones considered in the ERAA 2023 study. Figure 4 presents the comparison of real life and modeled outage patterns for ERAA 2023 and Polish NRAA. In general both outage patterns are quite similar, but the ERAA 2023 pattern assumes almost no outages during the winter season. This is not in line with real-life observations (indicated in blue in the below figure). Hence, the

[6] models after CS do not include price information, and thus models pre curtailment sharing were used for presentation purposes.

outage patters in the Polish NRAA differs slightly in order to better reflect operating conditions in the Polish power system.

Figure 4. Comparison of planned outages patters in real life, NRAA and ERAA2023 for Polish bidding zone



It is also to be highlighted, that when monitoring resource adequacy within Member State, NRAA is of fundamental importance for modelling country-specific constrains, which cannot be modelled in ERAA due to very high complexity of the model used in ERAA and its modelling limitations. Hence, the solutions applied in the Polish NRAA were necessary in order to obtain as realistic as possible view of Polish adequacy, thereby effectively complementing the ERAA calculations as intended in the legal framework.

2. Assumptions on capacity resources - ACER points out inconsistency in inputs and recommends that the same national-specific costs used in the NRAA are also used in ERAA.

All data that is not strictly confidential is delivered to ENTSO-E. Unfortunately, due to the model complexity, as well as software and hardware constrains, there are limitations when applying country-specific parameters in ERAA, whereas NRAA allows for more detailed considerations.

Additionally, the timing of input collection for both studies is not identical. The Polish NRAA was conducted already after ERAA 2023 was approved and published (ERAA 2023 was approved in May of 2024). Inputs for NRAA were thus built and collected in first half of 2024, while input collection for ERAA 2023 commenced end 2022. CONE study[7] was thus not available at the moment of data collection for ERAA 2023. Same applies to all other inputs used to build models of ERAA and NRAA studies.

Despite the highest level of care, discrepancies in data may still occur, primarily due to the timing of data collection and the modeling approach used.

[7] published by Polish NRA: https://bip.ure.gov.pl/bip/rynek-mocy/4416,Koszt-wejscia-na-rynek-nowych-mocy.html

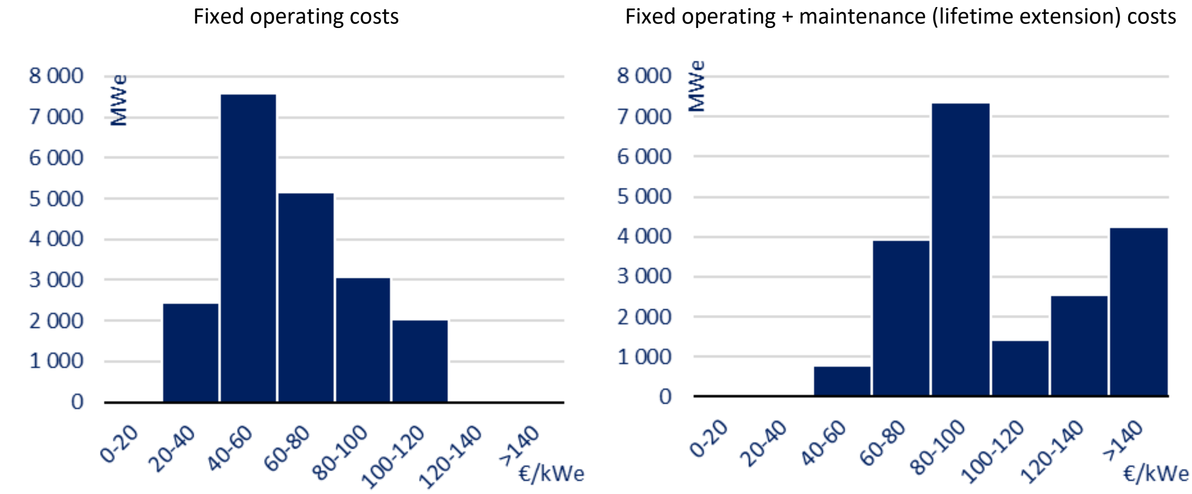
3. Modelling of capacity resources

In the ACER opinion regarding the Polish NRAA, the Agency points out that economic viability assessment (EVA) shall consider future revenues and costs, and that further clarity is provided as to the economic outcomes of the economic viability assessment.

The two-step EVA approach implemented in the Polish NRAA incorporates both a long-term model and multiple short-term models (with an iterative process). The use of the two-step approach is linked to the limitations of the calculation tool used i.e. Plexos software (same as for ERAA studies). This tool cannot perform accurate EVA in a single step, so an additional step using an iterative approach is required. The long-term model is a projection covering the period from 2025 to 2050 (year-by-year, covering 26 target years). This model is only minimizing the total system cost and does not analyze revenues of the generation resources (new and existing). In PSE opinion, the model performs quite well in estimating entry and exit decisions. Second step of the EVA in Polish NRAA are short-term models, where each single calendar year is calculated. For each year, market and adequacy models until 2040 are developed (i.e. covering 16 target years). These market models provide a more detailed and accurate information about the forecasted revenues and costs of each generation resource. The resulting cash flows are taken into account when defining entry and exit decisions. Experience has shown that the EVA based only on cost minimization (i.e. only the first step, without considering market models) tends to underestimate decommissioning and presents an overly optimistic outlook. The addition of a second step helps to overcome limitations of the modeling tool and ensures a more comprehensive EVA. This is why the Polish NRAA utilizes two-step EVA process covering both cost minimization and market models, in contrast to ERAA which due to the complexity and modelling limitations includes only the cost minimization model in the EVA process. In view of PSE, two-step IVA as applied in the Polish NRAA is the more correct approach.

Regarding the differences in data used in ERAA and NRAA it is to be underlined, that PSE collected detailed cost data of generating units through a survey conducted in Q3 2024. However, all unit owners classified the provided information as highly confidential, restricting its use solely for the Polish NRAA and prohibiting its sharing even within PSE. Despite the critical role of these costs in the EVA, it was not possible to disclose detailed data during the ACER screening process, limiting the ability to provide greater transparency. It is also worth mentioning that due to the modeling limitations, ERAA study uses cross-country average cost for generating units and does not model generating units "unit by unit". Example of this are fixed costs of different generators. Figure 5 presents the aggregated fixed costs of coal units in the Polish NRAA. In contrasts with these figures, ERAA 2023 uses fixed costs of category 'Hard Coal old 1 and 2', set at 25,6 €/kWe for all units falling under that category, and for category 'Lignite old 1 and 2' these fixed costs amount to 32,5 €/kWe. This is yet another reason for differences between ERAA and NRAA, although the NRAA approach is yet again more accurate and more representative.

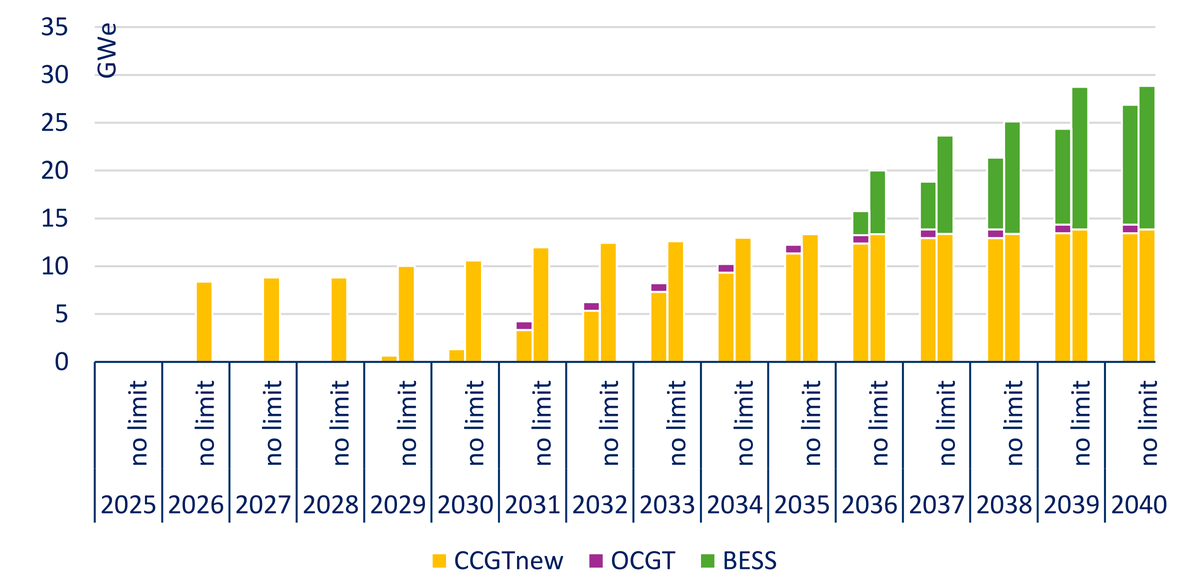
*Figure 5. Existing coal units operating costs included in the Polish NRAA**



Another recommendation included in ACER opinion on the Polish NRAA is that no additional DSR or storage will enter the Polish system beyond the capacity contracted in the capacity mechanism.

In the Polish NRAA, the expansion optimization horizon begins in 2029, as capacity market auctions for previous years have already been conducted, and new units have been determined and included. NRAA calculations assume thus that until that time only decommissioning is possible. From 2029 onwards, the storage is indeed an expansion candidate, but the calculations coming out the model do not indicate positive economic result. Consequently, no investment decisions for storage are made. First new entrants in storage technology appear only from 2036, based on the energy market and ancillary services profits. The expansion with no limits for storage and CCGTs was also tested[8], it results being presented in Figure 6.

Figure 6. Results of expansion optimization without constrains – Polish NRAA, based on test model



[8]Presented results are interim results. Therefore the 'base' results may slightly differ from the final results of the EVA in NRAA

PSE analysis carried out in the frame of NRAA indicates, that inclusion of storage as an expansion candidate from 2025 will not change the results – new storage will still be commissioned only around 2036, as in the base scenario. It happens even in spite of the negative market prices being modeled in the Polish NRAA, while these are not modelled in the ERAA.

Even though the DSR is not an expansion candidate in the Polish NRAA, it is highly present as a determined component of the study. The NRAA includes a significantly greater, comparing to ERAA 2023, potential for demand response through changes in power and energy demand by both individual and industrial consumers. The Polish NRAA includes implicit and explicit DSR, i.e. both the demand-side capabilities where consumers voluntarily adjust their energy consumption in response to market price signals (implicit DSR), as well as DSR resulting from contracts to reduce consumption based on TSO requests (explicit DSR) were considered. Demand flexibility includes loads such as electrode boilers, industrial heat pumps, green hydrogen production installations, and electric vehicles. This way, greater flexibility of the power system was modelled by shifting part of the demand to more favorable moments, allowing cost minimization and reducing peak power demand. The results of ERAA included explicit DSR resulting from contracts to reduce consumption, which depended on ENS, its value, the time of occurrence, and duration. The ERAA 2023 did not consider implicit DSR.

3 Conclusion

In conclusion and summarizing the explanations provided in this document, PSE maintains that all elements indicated by the Agency in its Opinion on the Polish NRAA as differences between ERAA 2023 and NRAA were implemented in the Polish NRAA to enhance the approach used in the ERAA 2023 study and to better reflect national specificities. Moreover, modeling of cross-border contribution to adequacy based on the outputs from ERAA allowed to improve the resolution of the Polish NRAA without affecting the quality of key results, i.e. determination of economic viability of resources and resource adequacy.