ACER Decision on ERAA 2023: Annex I.d

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

European Resource Adequacy Assessment

2023 Edition

Annex 3: Detailed Results

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Table of Contents

1 Introduction

In this Annex, detailed tables and graphs aim to provide insights on the results for all the scenarios. These results cannot be dissociated from the assumptions (cf. Annex 1) and the overall methodology followed in the European Resource Adequacy Assessment (ERAA) 2023 (cf. Annex 2). The presentation of results includes results from the single reference tool.

The results of each simulation include values of loss of load duration (LLD) and energy not served (ENS), which are aggregated in sets of LLDs and ENSs per study zone and modelling tool. LLDs are expressed as the number of hours of the simulation's time horizon during which supply could not meet demand in a given study zone, whereas ENSs are expressed in GWh of unserved energy during the LLD hours. For each set of LLDs and ENSs, the mathematical expectation/average, the median/50th percentile and the 95th percentile value were derived. These values are defined as loss of load expectation (LOLE), expected energy not served (EENS), P50 LLD, P50 ENS, P95 LLD and P95 ENS, respectively[1]. In addition, the ratios between EENS and the annual demand by study zone were also calculated. Readers should refer to Annex 2 for more details on the calculation methodology and for mathematical descriptions of the above.

In addition, the results of some study zones are aggregated to the country level, namely:

- Danish study zones DKE1 and DKW1 are aggregated in DK00;
- Irish study zones IE00 and UKNI are aggregated in I-SEM;
- Italian study zones ITCA, ITCN, ITCS, ITN1, ITS1, ITSA and ITSI are aggregated in IT00;
- Norwegian study zones NOS0, NOM1 and NON1 are aggregated in NO00; and
- Swedish study zones SE01, SE02, SE03 and SE04 are aggregated in SE00.

For a geographical area with multiple nodes, ENS is calculated as the total ENS of all its nodes. Moreover, EENS is the mathematical average of the ENS calculated over the total number of Monte Carlo (MC) sample/simulation years. Similarly, for a geographical area with multiple nodes, LLD is the number of hours during which at least one node in the area experiences ENS during a single MC sample/simulation year, whereas LOLE is the mathematical average of the LLD over the total number of MC sample/simulation years.

2 Calculated inputs/Intermediary Inputs

2.1 Flow-based domains

The clustering process (from the ERAA 2022) resulted in 4 typical flow-based (FB) domains for Target Year (TY) 2025. Two clusters were identified for each of the summer and winter seasons. A clustering model also determined when each of the typical domains should be opted in Economic Dispatch simulations according to the operational conditions (demand, RES generation, etc.) in each climate year (CY) of the ERAA model. As described in Annex 2, the 4 timestamps for which the representative FB domains were calculated are the following. The year refers to the CY used for the reference calculation.

[1]For a set of 100 calculated values, the 95th percentile (often abbreviated as P95) represents the value that is greater than or equal to 95% and lower than or equal to 5% of all values contained in the set. The 50th percentile is calculated accordingly.

Table 1: Initial market model timestamps.

Timestamp #	Timestamp	Label
1	1988-09-14 23:00	Summer 1
2	2014-06-14 19:00	Summer 2
3	2014-10-27 04:00	Winter 1
4	2014-11-09 13:00	Winter 2

In the ERAA 2023, all borders between Core and non-Core study zones are modelled as advanced hybrid coupling (AHC), and there is one single evolved flow-based (EFB) element, namely the Alegro DC link between Belgium and Germany. With 12 Core study zones, one EFB link and 29 AHC links, the FB domain holds a total of 42 PTDF columns. As this means that the FB domain has 42 dimensions, it is computationally impossible to compute full 2D projections of the FB domain. Instead, for visualisation purposes, dimensions were chosen, along which the exchange possibilities show in a 2-dimensional projection. For the projections shown here, the impact of the AHC borders was fixed to the relevant border flows over these links from the reference case, so these are projections of the standard hybrid coupling FB model. This reduction is only applied for illustrational purposes and, in the adequacy simulation, all dimensions are considered in full and not fixed to any pre-determined value. Two examples of 2D projections of the FB domains for combinations of areas are shown in Figure 1.

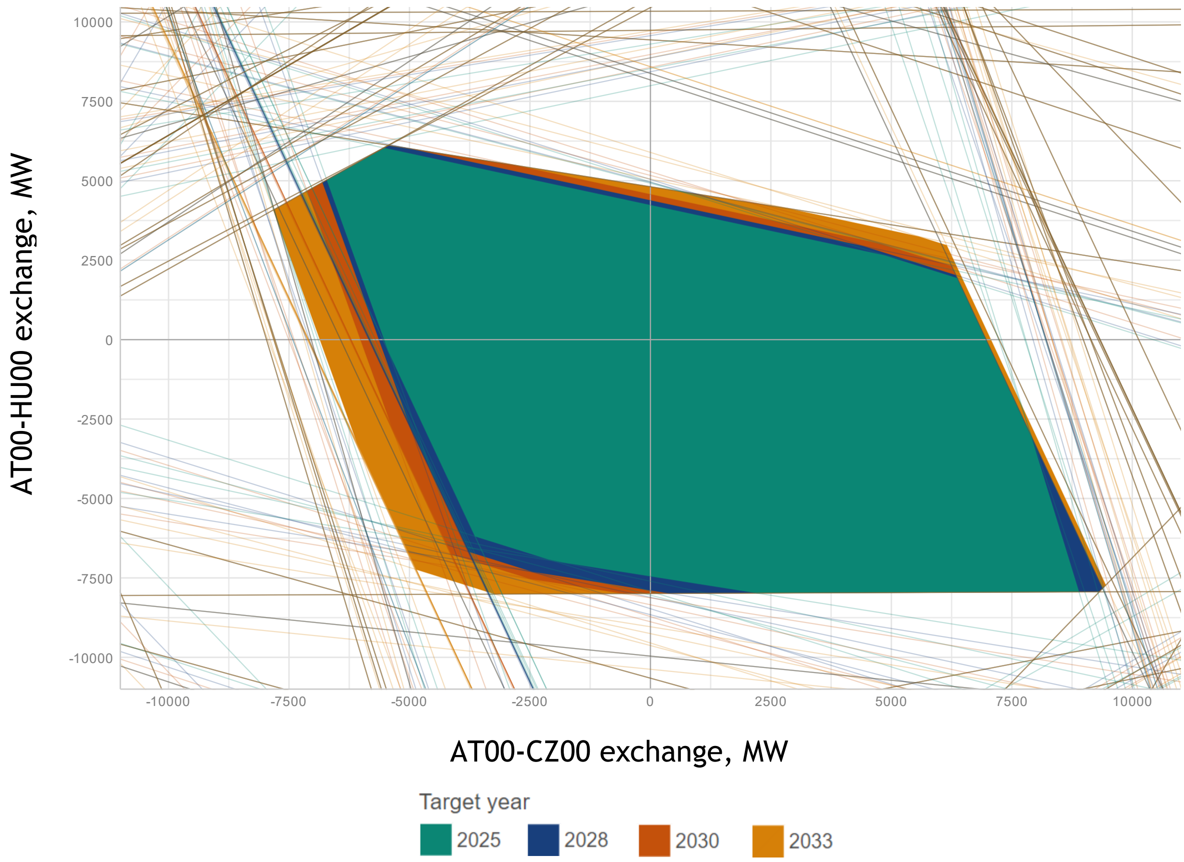

Figure 1: FB domain (Winter 1) projection on AT00-CZ00 and AT00-HU00 exchange profiles

From the plots in Figure 1, it can be observed that the possible levels of exchanges within Core increase with the TYs. The increases are a result of planned grid investments that allow for greater levels of cross-zonal exchanges.

A second indicator to quantify how much more exchanges are enabled by FB domains is the maximum theoretical import and export net position of study zones as shown in Figure 2. These values are calculated by finding the maximum Core net position per study zone in both import and export direction, respectively, subject to the FB constraints. It should be noted that these values are of a theoretical nature as for the calculation, the only target is to maximise social welfare across the entire Capacity Calculation Region (CRR) (and cover all load). A second point is that for these calculations, the AHC borders were fixed to 0, so these maximum import and export capacities and do not take into account the additional capacity that the optimisation of these elements could add. These minimum and maximum net positions enable an easy comparison between different FB domains but cannot be used as metric to draw any conclusions on what could be actually feasible for specific power systems to import or export.
For example, stark increases in the minimum and maximum net position for Belgium can be observed between 2028 and 2030. Similarly, the Austrian minimum and maximum net position increases when going from 2030 to 2033.

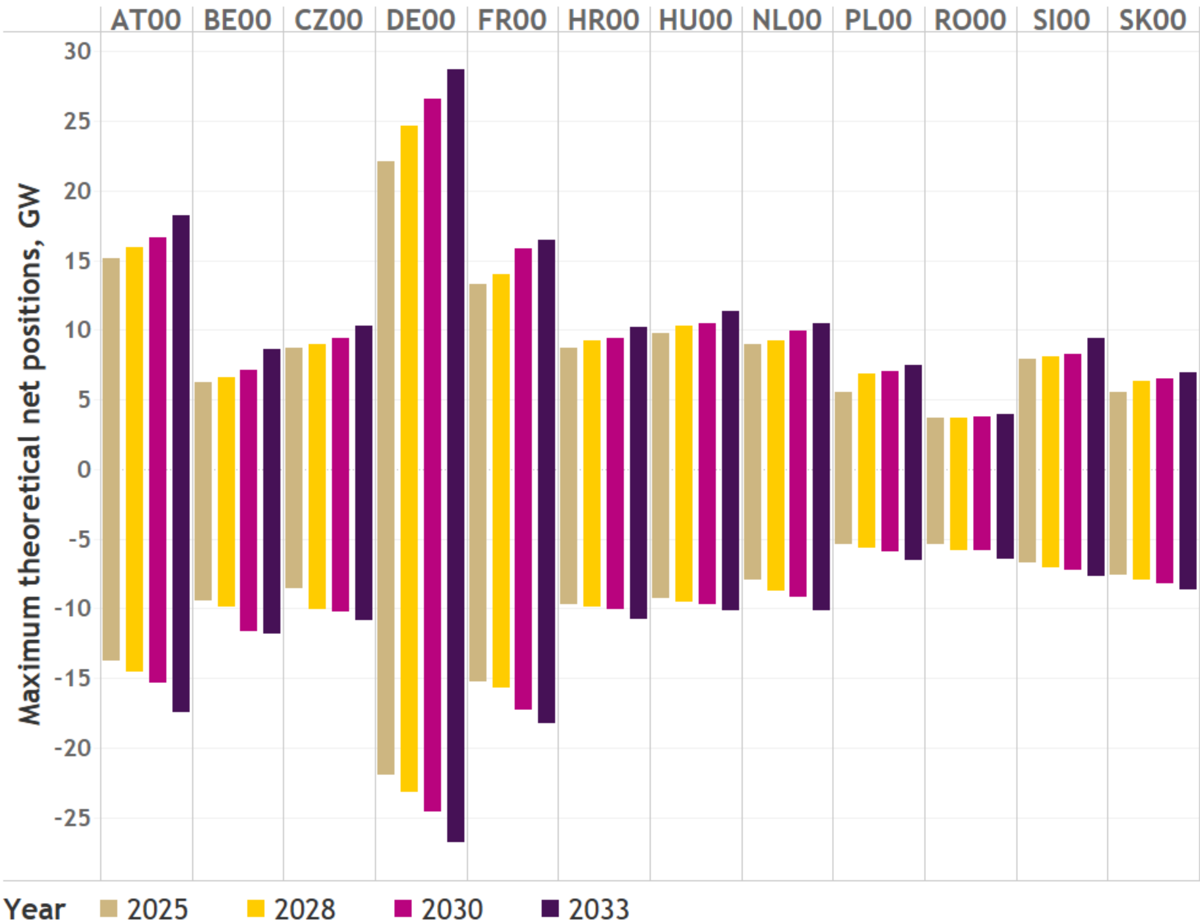

Figure 2: Illustrative theoretical maximum export and import capacities for all TYs – Summer 2 FB domain[2]

2.2 Limits on Maximum Import and Export

For the Economic Viability Assessment (EVA), limits on the maximum import and export per study zone were defined to enhance its consistency (using Net Transfer Capacity [NTC] MC) and ED (using FB MC) models. These additional limits constrain the exchanges in the EVA model using NTC MC to exchange levels

[2] Positive value shows maximum export value, negative value shows maximum import value.

in line with typical exchange levels identified in ED model using FB MC. Typical exchanges in the preliminary ERAA 2023 ED model (with FB MC) where exchange levels are considered to be trustworthy were identified and used as a limiting factor in the ERAA 2023 EVA models to ensure that exchanges in NTC models would not reach unrealistic levels.
The magnitude of these maximum import and export limits are shown in Figure 3 below.

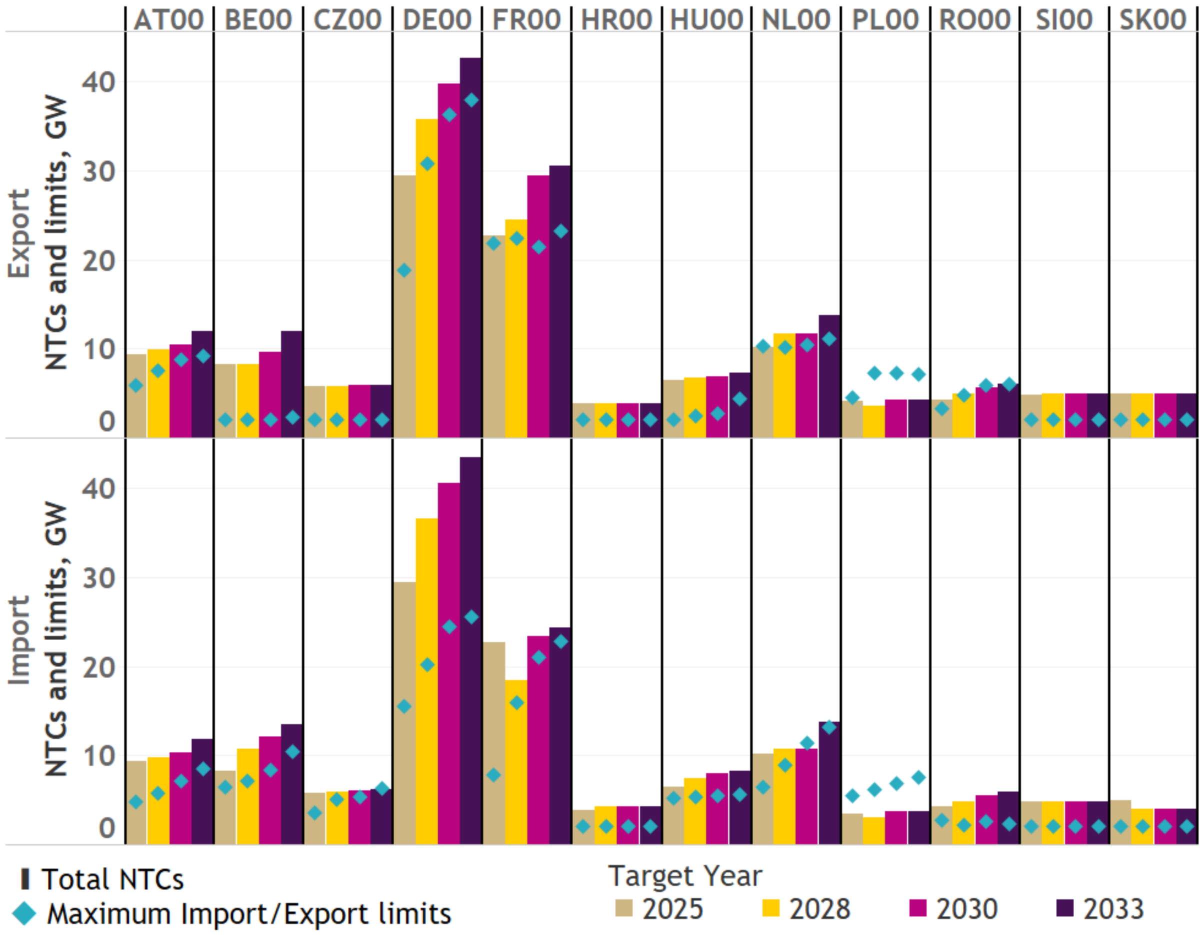

Figure 3[3]: Maximum import and export limits, per Core bidding zone

2.3 Maintenance Profiles

As described in Annex 2, only thermal assets are subject to planned maintenance. The capacities are taken out of the market for maintenance during times of low risk of scarcity.

[3] These maximum import and export limits represent constraints on the global net position of a study zone - on CORE and AHC borders.

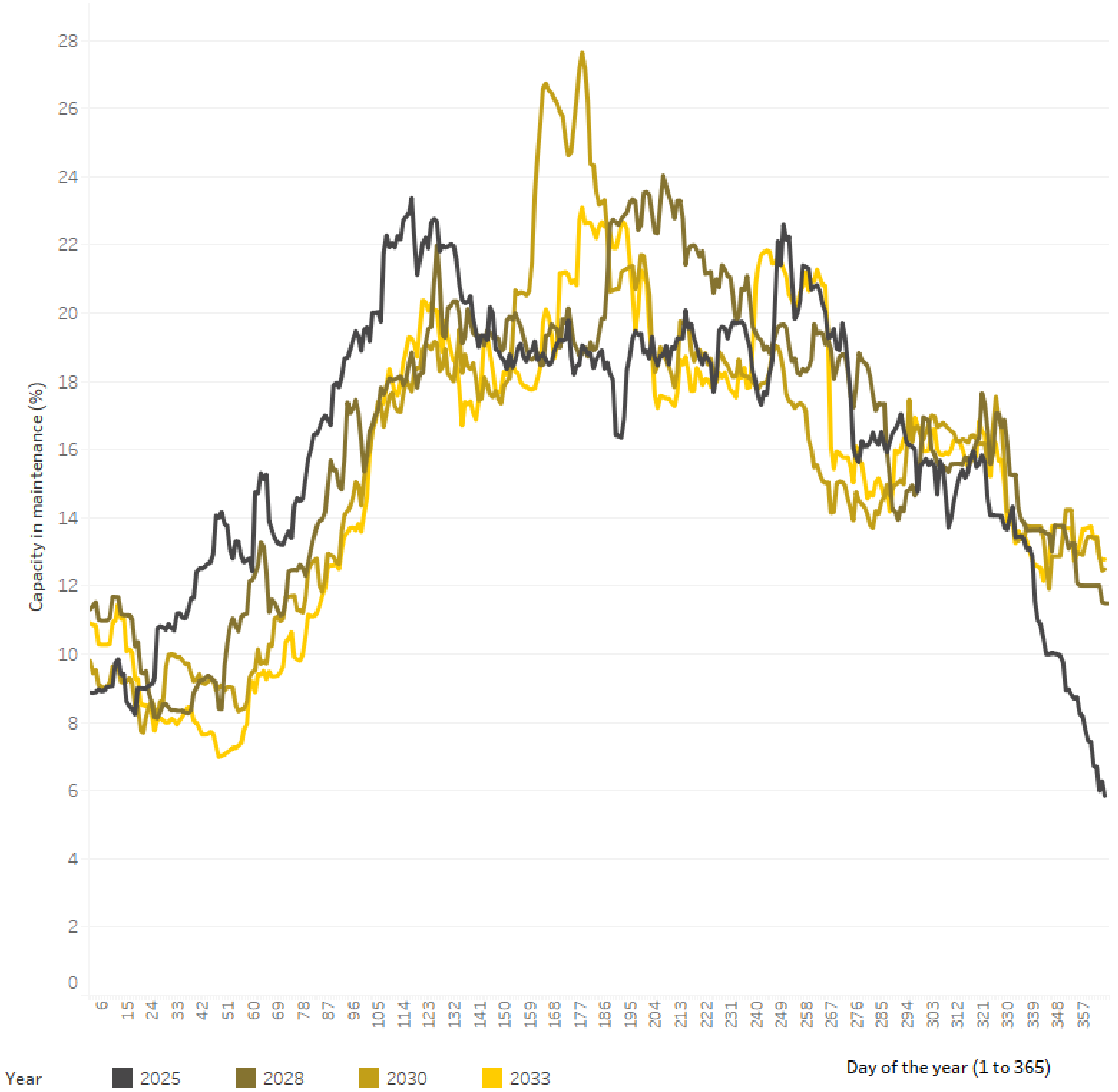

Figure 4 shows the daily maintenance ratio profiles aggregated for thermal technologies in the ERAA explicit region for each of the TYs. For all TYs, the maintenance window is mainly during the European summer season.

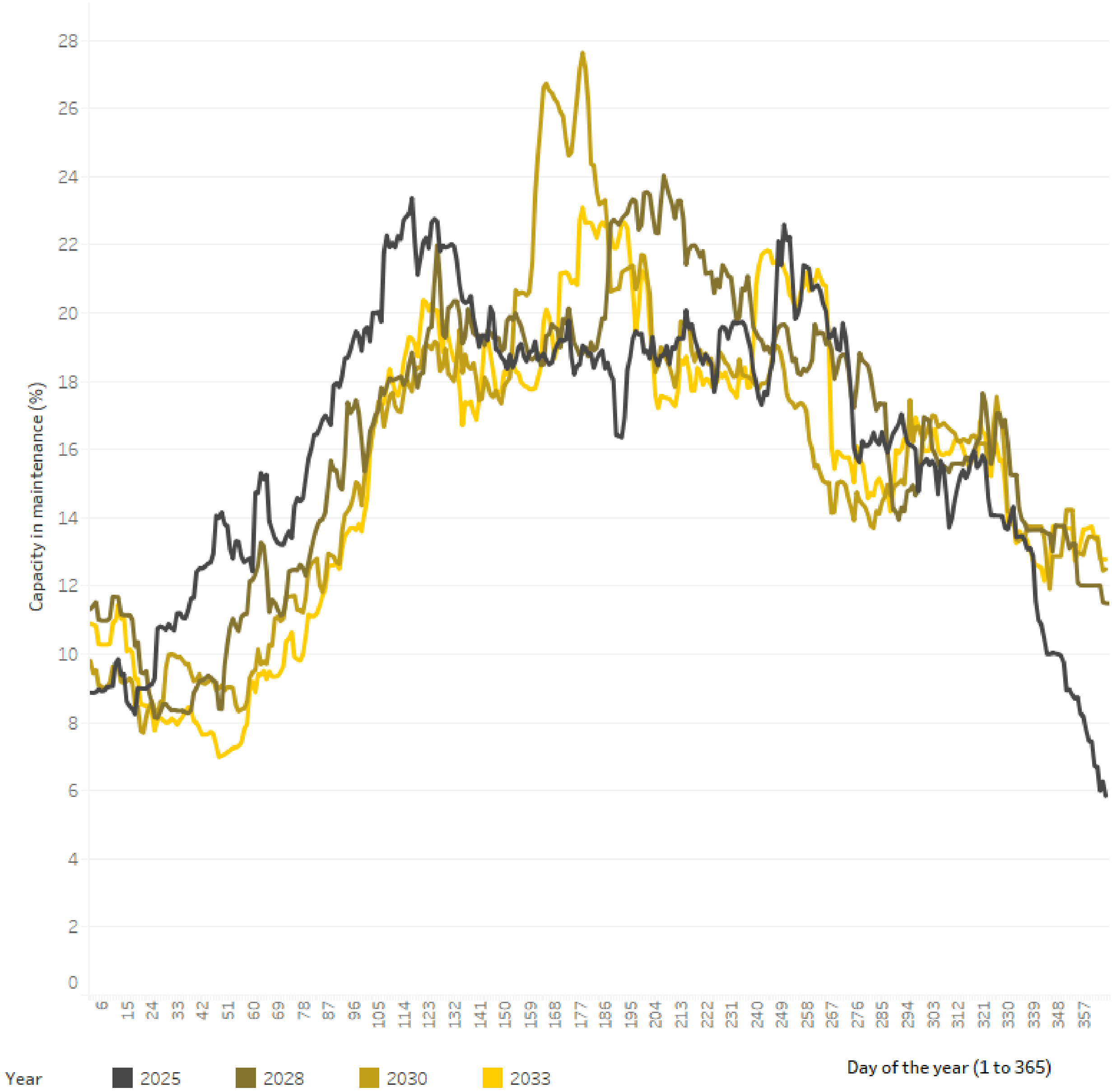

Figure 4: Thermal capacity maintenance ratio

2.4 Price caps

As a reminder from Annex 1 section 6.6, Table 2 below shows the price cap evolution over all the TYs used in the ERAA 2023.

Table 2: Price cap [€/MWh] per TY

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

2.5 Representative climatic scenarios for the EVA

As introduced in section 10.7 of Annex 2, the methodology included the development of two scenarios:

- Scenario A: weights based on the LOLE of the ERAA 2022 adequacy results; and
- Scenario B: weights according to the ERAA 2022 methodology.

For each scenario, the CYs 1985, 1988 and 2003 were assigned in the EVA with the following weights shown in Table 3.

Table 3: CY weights for Scenarios A and B

Set of CY weights	Scenario A	Scenario B
1985	0.085	0.028
1988	0.058	0.057
2003	0.858	0.915

Given the two sets of weights considered above, the two sets of results are presented. Section 3 presents both sets of results, namely 1) Results – Scenario A, and 2) Results – Scenario B.

3 Results per scenario

3.1 Results – Scenario A

In this section we are presenting results for Scenario A. As a reminder, in Scenario A the CY representation in the EVA is calibrated based on the LOLE of the ERAA 2022 adequacy results aiming at the consistency of this indicator throughout the economic viability and adequacy analyses. In Scenario B, the CY representation in the EVA is calculated according to the ERAA 2022 methodology, aiming at the consistency of the total system costs throughout the EVA.

3.1.1 EVA results

Table 4 presents the capacity change per decision variable, for each technology and TY, as well as for the most affected study zones. The values in the table represent capacity differences with respect to the 'National Trends' assumptions for each TY, i.e. if a certain capacity deemed non-viable reaches its expected decommissioning date, the non-viable capacity reported leaves out this capacity as from the TY of the expected decommissioning date[4]. Detailed results per study zone are given in Table 5.

The trend shows significant amounts of decommissioned thermal capacity in Europe, with a peak of ca. 47 GW in 2028. In 2033 the retired thermal capacity regarding the "National Trends" scenario amounts to ca.

[4] For example, if a region indicates that Unit A (100 MW) is available until 2029 but EVA analysis shows that the unit is not viable in 2025 and 2028 then the Net EVA effect will show:
2025: -100 MW
2028: -100 MW
2030: 0 MW
2033: 0 MW

33 GW. Among thermal capacities, gas technologies show higher decommissioning in EVA compared to lignite and hard coal. Reasons for this are two-folded: on the one hand, Figure 17 of Annex 1 clearly depicts a "coal before gas" scenario in the merit order, up to 2028 for the most efficient CCGT technologies and prolonged further for less efficient CCGTs and OCGTs due the underlying fuel and CO_2 price trajectories. On the other hand, hard coal and lignite capacity is heavily subject to exogenous phase-out trajectories due to policy targets in many Member States which are already reflected in the original PEMMDB data and as such do not show up as additional capacity change in the EVA results. In addition, ca. 10 GW in 2025 and 2 GW in 2028 are deemed not viable in the respective TYs but return to market at a later TY (Mothballing). On the other side, the EVA suggests investments in batteries, DSR and gas units in all TYs (expansion in gas units not allowed in 2025 due to construction period constraints - see Annex 1, chapter 6.4.1.1). Investments in 2025 and 2028 remain below 1 GW and 4 GW respectively, while ca. 21 GW of capacity is built in 2030 and 37 GW in 2033. Most investments in 2030 and 2033 are allocated to gas technologies (84%). DSR investments amount to up to 5 GW in 2033. In addition, life extension keeps up to 2 GW of gas-fired capacity in the system.

Table 4: Capacity change proposed by the EVA compared to the National Trends scenario [MW] – Non-cumulative (Scenario A)

Decision Variable	Technology	2025	2028	2030	2033	Most affected study zones
New Entry	Battery	110	110	110	1310	GR00, MT00
	DSR	510	1980	3450	4750	AT00, CZ00, DE00, DKE1, DKW1, FI00, HR00, HU00, NL00, PT00, SI00, SK00
	Gas CCGT	0	1710	16970	27280	DE00, HU00, PL00, UK00
	Gas OCGT	0	0	470	3700	BE00
Life Extension	Gas CCGT	300	1620	1800	1800	BE00, DKE1, HU00
	Gas OCGT	50	160	350	360	BE00, DKW1, HU00
Mothballed	Gas CCGT	-6840	-1990	-760	0	AT00, DE00, DKE1, ES00, NL00
	Gas OCGT	-1480	0	0	0	AT00, DE00, DKW1
	Oil	-1410	0	0	0	DE00
	Hard Coal	-240	0	0	0	FI00
Decommissioning	Gas CCGT	-15210	-21330	-21370	-23980	ES00, FI00, GR00, IE00, ITCA, ITCN, ITCS, ITN1, ITS1, UK00
	Gas OCGT	-6130	-3140	-3190	-2730	BG00, HR00, ITCS, ITN1, ITS1, UK00
	Oil	-3150	-1840	-1560	-580	EE00, GR03, HR00, IE00, UK00, UKNI
	Lignite	-8460	-12810	-11260	-5250	BA00, BG00, CZ00, GR00, ME00, PL00, RO00, RS00
	Hard Coal	-4460	-7550	-4170	-910	CZ00, ES00, FI00, HR00, NL00, PL00, RO00
Total		-46410	-43080	-19160	5750	CZ00, ITCS, ITN1, UK00

Table 5: Capacity change proposed by EVA per study zone, PEMMDB technology, and decision variable [MW] – Non-cumulative (Scenario A)

Study Zone	PEMMDB Technology	Decision Variable	2025	2028	2030	2033
AL00	Gas CCGT	Decommissioning	-100	-100	-100	-300
AT00	DSR	New Entry	0	0	150	150
	Gas CCGT	Mothballed	-300	0	0	0
	Gas OCGT	Mothballed	-480	0	0	0
	Gas OCGT	Decommissioning	-80	0	0	0
BA00	Lignite	Decommissioning	-1520	-1470	-1470	-1470
BE00	Gas CCGT	Life Extension	300	1480	1480	1480
	Gas CCGT	Decommissioning	-380	0	0	0
	Gas OCGT	New Entry	0	0	470	3700
	Gas OCGT	Life Extension	50	50	50	50
BG00	Gas OCGT	Decommissioning	-110	-480	-480	-480
	Hard Coal	Decommissioning	-90	0	0	0
	Lignite	Decommissioning	-790	-2840	-2500	-1900
CY00	Gas OCGT	Decommissioning	0	-100	-100	-100
CZ00	DSR	New Entry	0	0	180	180
	Hard Coal	Decommissioning	-600	-40	-40	0
	Lignite	Decommissioning	-3030	-3910	-3680	0
DE00	DSR	New Entry	0	820	820	820
	Gas CCGT	New Entry	0	0	12440	22380
	Gas CCGT	Mothballed	-3480	-850	0	0
	Gas OCGT	Mothballed	-890	0	0	0
	Oil	Decommissioning	-90	0	0	0
	Oil	Mothballed	-1410	0	0	0
DKE1	DSR	New Entry	0	120	120	120
	Gas CCGT	Mothballed	-40	0	0	0
	Gas CCGT	Life Extension	0	140	140	140
DKW1	DSR	New Entry	0	0	200	200
	Gas OCGT	Mothballed	-110	0	0	0
	Gas OCGT	Life Extension	0	110	190	200
	Gas OCGT	Decommissioning	-360	0	0	0
	Oil	Decommissioning	-60	-30	0	0
EE00	Oil	Decommissioning	-420	0	0	0
ES00	Gas CCGT	Decommissioning	-1090	-1090	-2190	-2190
	Gas CCGT	Mothballed	-430	0	-760	0
	Hard Coal	Decommissioning	-560	0	0	0
FI00	DSR	New Entry	120	120	120	120
	Gas CCGT	Decommissioning	0	0	0	-870
	Gas OCGT	Decommissioning	0	0	0	-90
	Hard Coal	Decommissioning	0	0	0	-620
	Hard Coal	Mothballed	-240	0	0	0
GR00	Battery	New Entry	0	0	0	1200
	Gas CCGT	Decommissioning	-1310	-1310	-3580	-3410
	Gas OCGT	Decommissioning	-150	-150	-150	0
	Lignite	Decommissioning	0	-660	0	0
GR03	Oil	Decommissioning	-410	-410	-410	0
HR00	DSR	New Entry	0	0	80	80
	Gas OCGT	Decommissioning	-680	-680	-680	0

Study Zone	PEMMDB Technology	Decision Variable	2025	2028	2030	2033
	Hard Coal	Decommissioning	0	-290	-290	-290
	Oil	Decommissioning	-300	-300	-300	0
HU00	DSR	New Entry	60	60	60	60
HU00	Gas CCGT	New Entry	0	0	40	40
HU00	Gas CCGT	Life Extension	0	0	180	180
HU00	Gas OCGT	Life Extension	0	0	110	110
HU00	Lignite	Decommissioning	-190	0	0	0
IE00	Gas CCGT	Decommissioning	-300	-550	-660	-660
IE00	Gas OCGT	Decommissioning	0	-120	-120	-120
IE00	Oil	Decommissioning	-290	-190	-190	-190
IE00	Lignite	Decommissioning	0	-110	-110	0
ITCA	Gas CCGT	Decommissioning	0	-2340	-3210	-3270
ITCA	Gas OCGT	Decommissioning	0	-220	-220	-220
ITCN	Gas CCGT	Decommissioning	-390	-390	-390	-390
ITCS	Gas CCGT	Decommissioning	-480	-4010	-4010	-4370
ITCS	Gas OCGT	Decommissioning	-120	-600	-600	-600
ITN1	Gas CCGT	Decommissioning	-4130	-5250	-5250	-5300
ITN1	Gas OCGT	Decommissioning	-240	-240	-240	-240
ITS1	Gas CCGT	Decommissioning	0	-1510	-2000	-2000
ITS1	Gas OCGT	Decommissioning	-250	-250	-250	-250
ITSI	Gas OCGT	Decommissioning	0	-210	-210	-210
LT00	Gas OCGT	Decommissioning	-90	0	0	0
LV00	Gas CCGT	Decommissioning	0	0	0	-270
ME00	Lignite	Decommissioning	0	-440	-440	-220
MK00	Gas OCGT	Decommissioning	-60	-60	-60	-60
MT00	Battery	New Entry	110	110	110	110
NL00	DSR	New Entry	290	420	960	2080
NL00	Gas CCGT	Mothballed	-2590	-1140	0	0
NL00	Hard Coal	Decommissioning	0	-3380	0	0
PL00	Gas CCGT	New Entry	0	1710	4490	4490
PL00	Hard Coal	Decommissioning	-3210	-3710	-3710	0
PL00	Lignite	Decommissioning	-1060	-2740	-2420	-1020
PT00	DSR	New Entry	0	400	400	580
PT00	Gas CCGT	Decommissioning	-170	-170	0	0
RO00	Gas CCGT	Decommissioning	0	0	0	-400
RO00	Gas OCGT	Decommissioning	0	-20	-70	-250
RO00	Hard Coal	Decommissioning	0	-130	-130	0
RO00	Lignite	Decommissioning	-1570	0	0	0
RS00	Lignite	Decommissioning	0	-620	-620	-620
SE01	Gas OCGT	Decommissioning	0	0	0	-100
SI00	DSR	New Entry	40	40	40	40
SI00	Lignite	Decommissioning	-300	0	0	0
SK00	DSR	New Entry	0	0	320	320
UK00	Gas CCGT	New Entry	0	0	0	370
UK00	Gas CCGT	Decommissioning	-6860	-4610	20	-10
UK00	Gas OCGT	Decommissioning	-3480	0	0	0
UK00	Oil	Decommissioning	-1190	-520	-270	0
UKNI	Gas CCGT	Decommissioning	0	0	0	-540
UKNI	Gas OCGT	Decommissioning	-510	-10	-10	-10

Study Zone	PEMMDB Technology	Decision Variable	2025	2028	2030	2033
	Oil	Decommissioning	-390	-390	-390	-390
	Lignite	Decommissioning	0	-20	-20	-20

Country specific results show that investments in new gas capacities are located in Belgium, Germany, Hungary, Poland and the UK from 2028 onwards, with a maximum of 22.4 GW in Germany in 2033. New investments in explicit DSR bands occur in multiple countries throughout the whole horizon, according to the specific available DSR potential, while grid-scale battery expansion is limited to Greece and Malta only. The net effect of the EVA on the European mix is displayed in Figure 5 and Figure 6 for the four TYs. There is an overall net reduction of ca. 46 GW in 2025 and 43 GW in 2028 with respect to the 'National Trends'. Most of the reduction comes from gas and hard coal capacity being decommissioned or mothballed. In 2030, the net effect is lessened to a reduction of around 19 GW of capacity as the effect is softened by the commissioning of around 20 GW of new capacity. In 2033, the net effect turns into an increase in total system capacity, as decommissioning slows down to roughly 30 GW while ca. 36 GW of new gas, DSR and battery capacity is invested. In total, the post-EVA capacity of the assessed technologies increases from around 350 GW in 2025 to 430 GW in 2033. However, the share of these technologies of total installed capacity decreases by time, as the assessed technologies are roughly 25% of total installed capacity in 2025 down to 20% in 2030 as reported in Figure 6 (cf. Annex 1 on input assumptions).

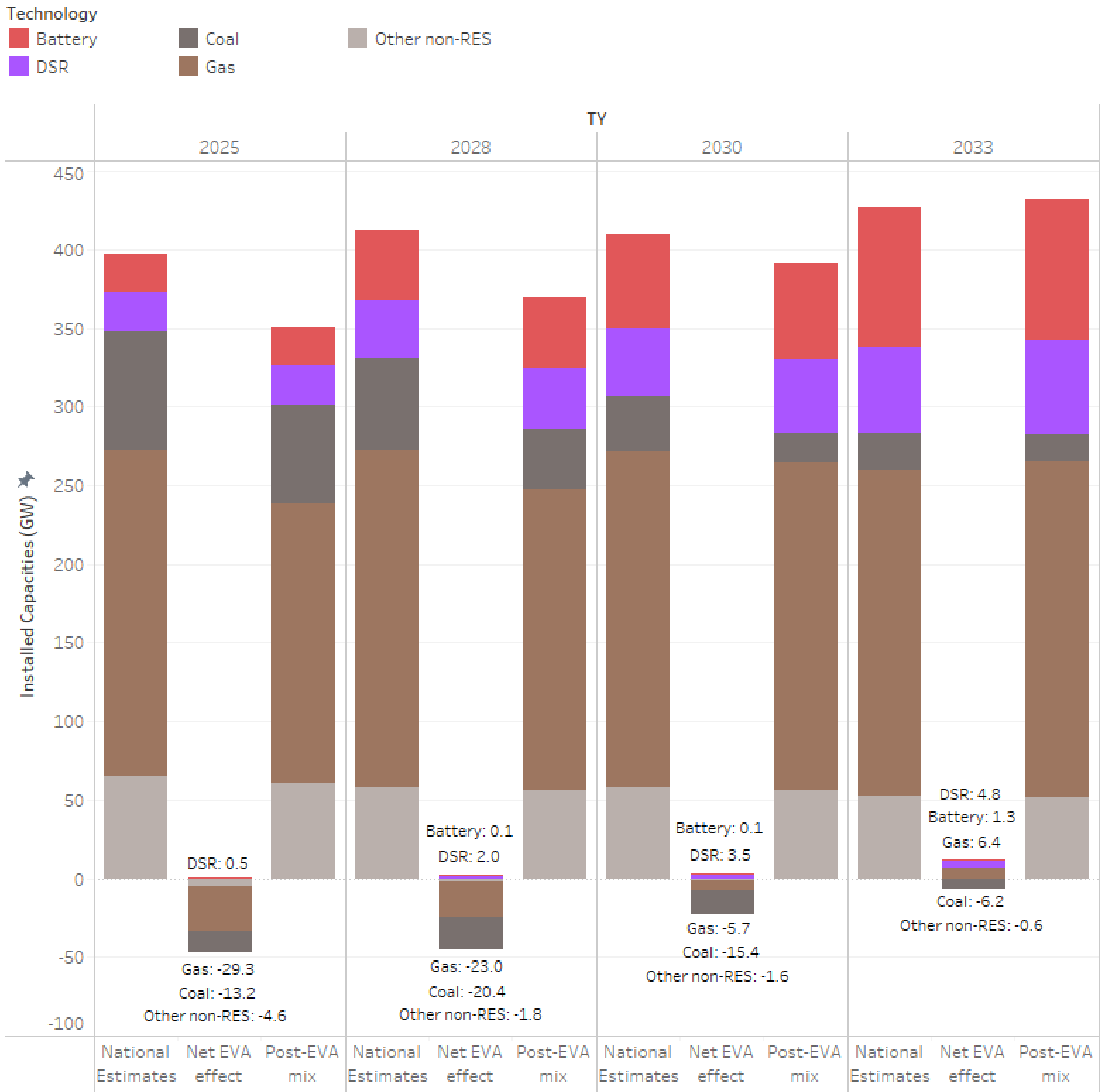

Figure 5: Net effect of the EVA on the European mix – focus on the technologies assessed (Scenario A)

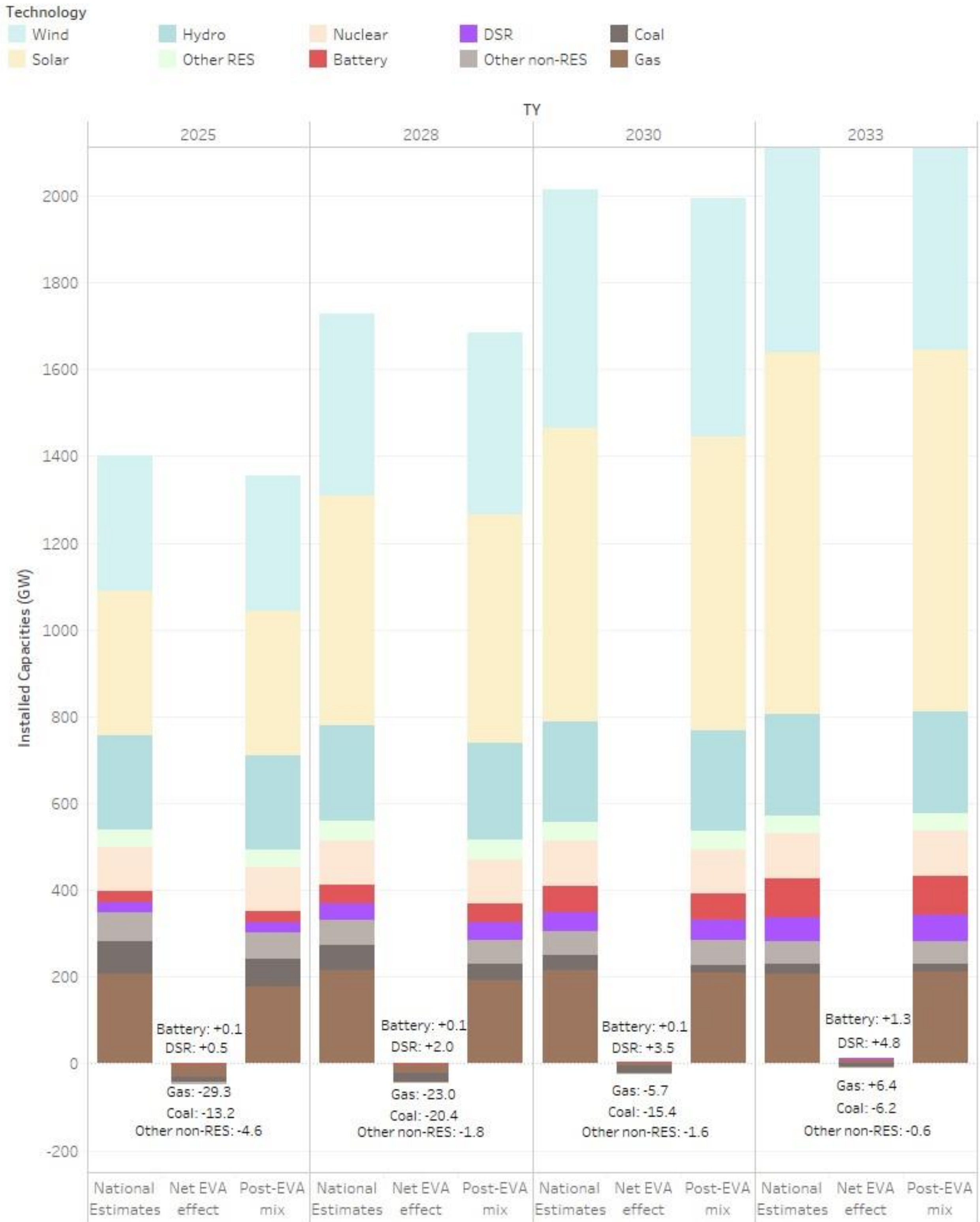

Figure 6: Net effect of the EVA on the European mix (Scenario A)

3.1.1.1 Revenues and profitability analysis for thermal expansion units

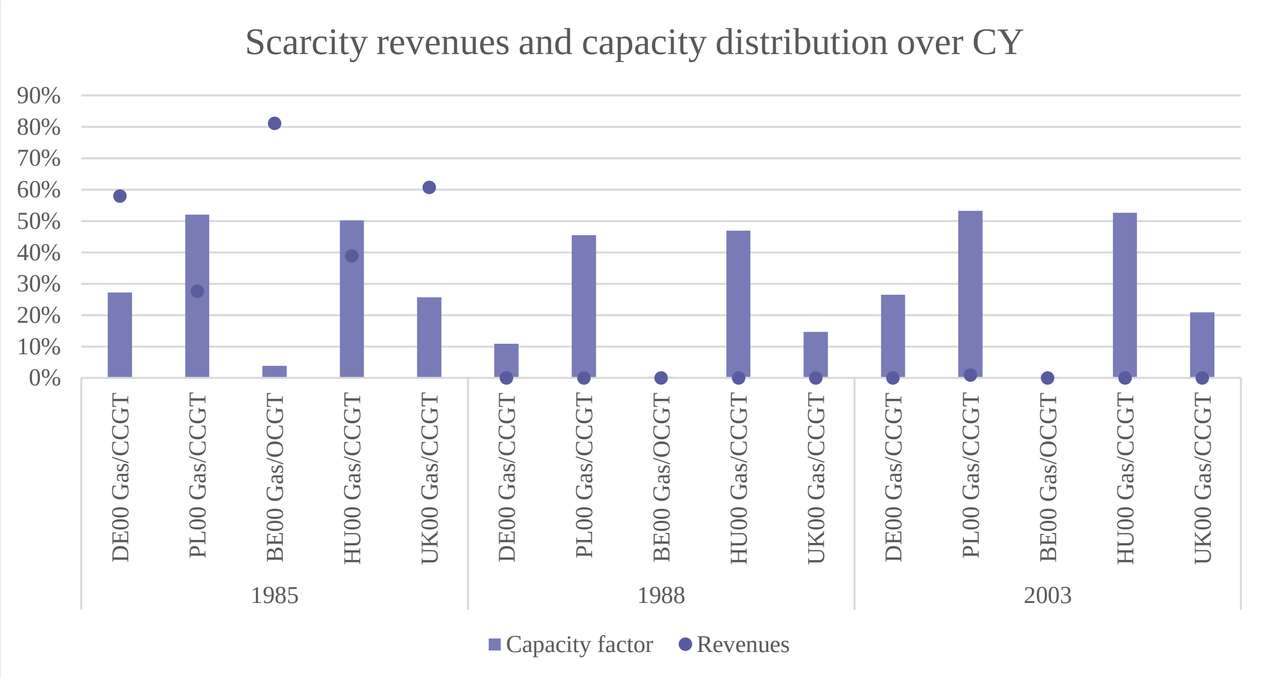

Figure 7: Scarcity revenues and average capacity factor (%) for new gas capacity (Scenario A)

The graph above (Figure 7) shows the percentage of revenues that the new gas capacity receives during near-scarcity hours (dots) and the average capacity factor (bars) over the researched horizon and depending on the year of commissioning. The capacity factor represents the average ratio (over the horizon) of its yearly generation and its theoretical maximum energy output[5]. As the new gas-fired capacity enters the market in 2028, 2030 and 2033, the results include these TYs, according to the specific entry-date in each bidding zone. Near-scarcity hours are defined as hours where the marginal price of electricity reaches more than 50% of the price cap (e.g. in 2030 the market price cap is 7000 €/MWh: a near-scarcity hour is here defined as an hour in which the marginal price is higher or equal to 3500 €/MWh). It follows that scarcity hours (hours at market price cap) are included in the count of near-scarcity hours. As CYs 1988 and 2003 show no near-scarcity events, there are no scarcity-based revenues. In combination with the capacity factor shown as bars it can be concluded that higher capacity factors lead to lower scarcity-based revenues in 1985. It can be observed that new gas open cycle gas turbine (OCGT) revenue in Belgium is driven by instances of (near) scarcity situations in the 1985 CY. In fact, its average capacity factor is 4% in 1985 and 0% for the other CYs, meaning that such new capacity is never called in the merit order and does not generate revenues aside from 1985 where 80% of such revenues are captured during near-scarcity hours. In the case of gas CCGTs in Germany and UK with ~60% of the revenues in 1985 during scarcity situations, it is seen that these units also provide energy with 20 – 30 % average capacity factor in CY 2003 which has the highest weight in EVA simulations. Among the expanded units, gas CCGT in Poland and Hungary are the units which rely the lowest on revenues in scarcity situations. To assess the overall profitability also including non-scarcity revenues and costs, the results in Figure 8 are relevant.

[5] Capacity factor = yearly generation [GWh] / (Pnom [GW] x 8760 h)

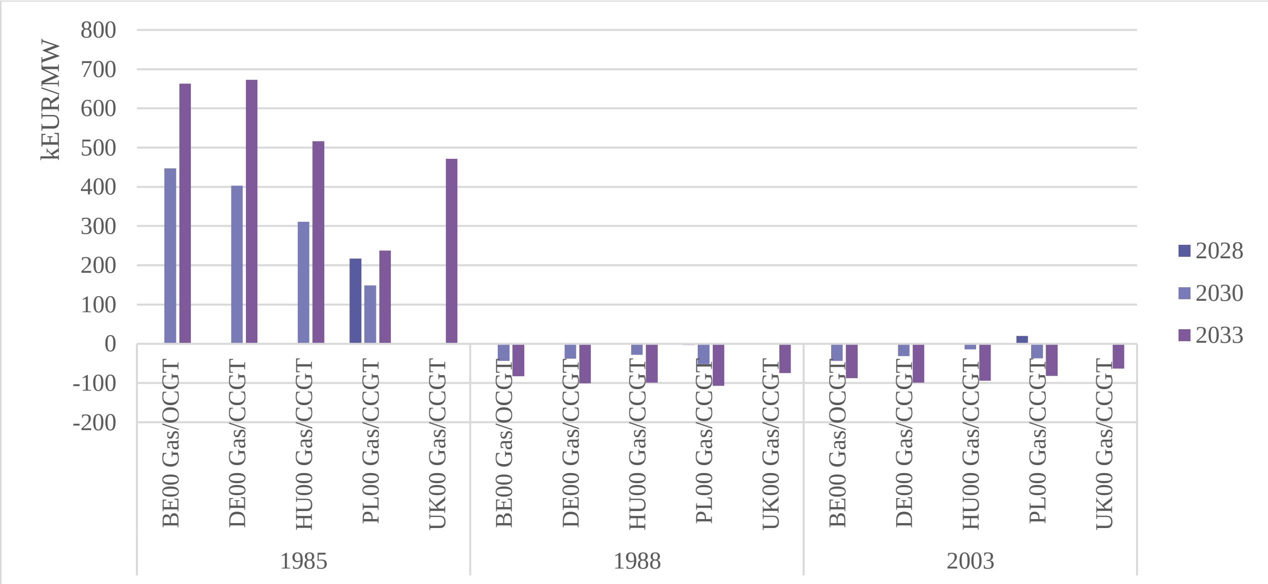

Figure 8: Yearly net profit per installed MW of new gas capacity (Scenario A)

Figure 8 shows annualised net profits by subtracting the components of capex and fixed operating costs from the net revenues generated by the new capacity[6]. It can be observed that in all the areas where new entry of gas capacity takes place, only the net profits for CY 1985 are positive (with the exception of CCGTs in Poland for the CY 2003 and TY 2033), while the net cash flows in the other CYs are negative, thus resulting in a net loss for the capacity. Profits in CY 1985 are highly driven by scarcity events which do not occur in 1988 and 2003. The high profits in 1985, that are the only driver for gas expansion, are offset by the relative low weight assigned (8.5%): the EVA model seeks the long-term equilibrium over the modelled horizon, meaning that the CY weighted (according to Table 3) and discounted sum of net profits (and losses) over the horizon (i.e. Net Present Value) converges to zero. The distribution in Figure 8 shows the relevance of including multiple CYs in EVA, especially to assess the viability of new build peaking units.

3.1.2 Adequacy results

The following chapters give insights into the detailed results per study zone, in addition to the quantifications of the convergence of the model.

3.1.2.1 LOLE and EENS

The following tables include EENS and LOLE results per study zone for all scenarios in addition to the 50th and 95th percentiles of ENS and LLD occurrences. 95th percentile occurrences can be interpreted as a '1-time-in-20 years' occurrence and thus covers events with a lower likelihood but higher impact on adequacy. Results consider the activation of already approved out-of-market measures for Poland[7]. For scenario A, TY 2025, Table 6 lists each study zone average LOLE and LLD percentiles, and Table 7 the country average LOLE and LLD percentiles for countries with multiple study zones.

[6] Figure 8 contains cost components that are not discounted.
[7] The Scenarios account 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, including strategic reserves, which are relevant for Poland in TY 2025.

Table 6: Study zone LOLE (average) and LLD percentiles for scenario A, for TY 2025

Study zone	Scenario A – TY 2025		
	Average [h/year]	P50 [h/year]	P95 [h/year]
AL00	0.26	0	1
AT00	0.39	0	1
BA00	1.64	0	6.8
BE00	1.87	0	9
BG00	0.06	0	0
CH00	0.10	0	0
CY00	0	0	0
CZ00	2.01	0	9
DE00	2.16	0	9
DKE1	1.88	0	9
DKW1	1.6	0	7
EE00	4.50	0	30.8
ES00	4.99	3	16
FI00	4.07	0	29.8
FR00	1.45	0	8
GR00	0.13	0	0
GR03	0.74	0	4
HR00	0.07	0	0
HU00	2.97	1	12
IE00	372.06	359	547.6
ITCA	0.01	0	0
ITCN	1.39	0	6
ITCS	0.08	0	0
ITN1	1.64	0	7
ITS1	0.01	0	0
ITSA	0.06	0	0
ITSI	0.004	0	0
LT00	1.30	0	7.8
LUG1	2.16	0	9
LV00	0.04	0	0
ME00	0.06	0	0
MK00	0.57	0	3.8
MT00	511.6	462	841.2
NL00	0.05	0	0
NOM1	0.05	0	0
NON1	0.004	0	0
NOS0	0.01	0	0

Study zone	Scenario A – TY 2025		
	Average [h/year]	P50 [h/year]	P95 [h/year]
PL00[8]	0.12	0	1
PT00	0.06	0	1
RO00	0.98	0	4
RS00	1.59	0	6
SE01	0	0	0
SE02	0	0	0
SE03	1.42	0	6.8
SE04	1.59	0	7
SI00	0.03	0	0
SK00	0.38	0	2
UK00	19.74	15	56
UKNI	182.94	177	299

Table 7: Country LOLE (average) and LLD percentiles for scenario A, for TY 2025

Country	Scenario A – TY 2025		
	Average [h/year]	P50 [h/year]	P95 [h/year]
DK00	1.91	0	9
ISEM	383.73	372	564.8
IT00	1.96	1	8
LU00	2.16	0	9
NO00	0.13	0	0
SE00	1.59	0	7

[8] Poland has contracted DSR out of market for year 2025. Therefore, LOLE / EENS results for Poland in 2025 for both scenarios are lowered by the activation of DSR contracted for the corresponding TY.

For scenario A, TY 2025, Table 8 lists each study zone average EENS and ENS percentiles, and Table 9 the country average EENS and ENS percentiles for countries with multiple study zones.

Table 8: Study zone EENS (average) and ENS percentiles for scenario A for TY 2025

Study Zone	Scenario A – TY 2025		
	Average [GWh]	P50 [GWh]	P95[GWh]
AL00	0.001	0	0.002
AT00	0.03	0	0.02
BA00	0.08	0	0.28
BE00	0.35	0	2.09
BG00	0	0	0
CH00	0.003	0	0
CY00	0	0	0
CZ00	0.17	0	1.27
DE00	1.91	0	13.29
DKE1	0.89	0	4.71
DKW1	2.15	0	11.52
EE00	0.29	0	2.09
ES00	5.08	1.07	23.61
FI00	1.28	0	9.06
FR00	0.84	0	5.47
GR00	0.006	0	0
GR03	0.08	0	0.13
HR00	0	0	0
HU00	0.64	0	4.40
IE00	93.36	87.84	161.78
ITCA	0	0	0
ITCN	1.03	0	5.96
ITCS	0.003	0	0
ITN1	1.24	0	7.60
ITS1	0	0	0
ITSA	0.002	0	0
ITSI	0	0	0
LT00	0.05	0	0.33
LUG1	0.02	0	0.16
LV00	0	0	0
ME00	0	0	0
MK00	0.03	0	0.05
MT00	36.35	31.82	69.51
NL00	0	0	0
NOM1	0	0	0
NON1	0	0	0
NOS0	0.01	0	0

Study Zone	Scenario A – TY 2025		
	Average [GWh]	P50 [GWh]	P95[GWh]
PL00[9]	0.009	0	0
PT00	0	0	0
RO00	0.05	0	0.10
RS00	0.14	0	0.39
SE01	0	0	0
SE02	0	0	0
SE03	1.77	0	6.32
SE04	1.31	0	4.12
SI00	0	0	0
SK00	0.01	0	0.02
UK00	39.13	19.03	146.39
UKNI	30.99	28.54	54.35

Table 9: Country EENS (average) and ENS percentiles for scenario A, for TY 2025

Country	Scenario A – TY 2025		
	Average [GWh]	P50 [GWh]	P95 [GWh]
DK00	3.04	0	15.40
ISEM	124.35	116.59	209.95
IT00	2.28	0	12.48
LU00	0.02	0	0.17
NO00	0.01	0	0
SE00	3.07	0	10.48

[9]Poland has contracted DSR out of market for year 2025. Therefore, LOLE / EENS results for Poland in 2025 for both scenarios are lowered by the use of DSR contracted for this year.

For scenario A, TY 2028, Table 10 lists each study zone average LOLE and LLD percentiles, and Table 11 the country average LOLE and LLD percentiles for countries with multiple study zones.

Table 10: Study Zone LOLE (average) and LLD percentiles for scenario A, for TY 2028

Study Zone	Scenario A – TY 2028		
	Average [h/year]	P50 [h/year]	P95 [h/year]
AL00	0.004	0	0
AT00	0.47	0	1
BA00	2.30	0	7.8
BE00	3.86	0	14.8
BG00	0.87	0	2
CH00	0	0	0
CY00	0.006	0	0
CZ00	3.06	0	12
DE00	3.55	0	15.8
DKE1	3.80	0	18
DKW1	2.37	0	10.8
EE00	4.08	0	22.8
ES00	4.46	3	16
FI00	2.06	0	14
FR00	3.14	0	12
GR00	0.006	0	0
GR03	0.13	0	0
HR00	0	0	0
HU00	3.81	0	15
IE00	8.51	0	30.8
ITCA	0	0	0
ITCN	1.46	0	5
ITCS	0.25	0	0
ITN1	1.46	0	5
ITS1	0	0	0
ITSA	0.006	0	0
ITSI	0	0	0
LT00	4.85	0	30
LUG1	3.55	0	15.8
LV00	0.07	0	0
ME00	0	0	0
MK00	0.50	0	0
MT00	121.42	105	279.4
NL00	0.59	0	1.8
NOM1	0.58	0	1.8
NON1	0.10	0	0
NOS0	0.17	0	0

Study Zone	Scenario A – TY 2028		
	Average [h/year]	P50 [h/year]	P95 [h/year]
PL00	1.89	0	10
PT00	0	0	0
RO00	0.01	0	0
RS00	2.87	0	11.8
SE01	0.35	0	3
SE02	0	0	0
SE03	3.14	0	16.8
SE04	3.73	0	18
SI00	0.09	0	0
SK00	0.83	0	2.8
UK00	3.98	0	19
UKNI	0.89	0	8

Table 11: Country LOLE (average) and LLD percentiles for scenario A, for TY 2028

Country	Scenario A – TY 2028		
	Average [h/year]	P50 [h/year]	P95 [h/year]
DK00	3.83	0	18.8
ISEM	8.52	0	30.8
IT00	1.52	0	5
LU00	3.55	0	15.8
NO00	0.72	0	3.8
SE00	3.38	0	18

For scenario A, TY 2028, Table 12 lists each study zone average EENS and ENS percentiles, and Table 13 the country average EENS and ENS percentiles for countries with multiple study zones.

Table 12: Study Zone EENS (average) and ENS percentiles for scenario A, for TY 2028

Study Zone	Scenario A – TY 2028		
	Average [GWh]	P50 [GWh]	P95 [GWh]
AL00	0	0	0
AT00	0.14	0	0.03
BA00	0.27	0	0.37
BE00	3.51	0	9.72
BG00	0.17	0	0.08
CH00	0	0	0
CY00	0	0	0
CZ00	1.73	0	8.72
DE00	9.52	0	57.36
DKE1	2.27	0	9.02
DKW1	4.68	0	18.98
EE00	0.32	0	1.69
ES00	4.45	0.28	25.2
FI00	0.28	0	1.47
FR00	8.57	0	31.29
GR00	0	0	0
GR03	0.01	0	0
HR00	0	0	0
HU00	4.62	0	25.44
IE00	2.49	0	9.34
ITCA	0	0	0
ITCN	1.35	0	6.21
ITCS	0.16	0	0
ITN1	2.70	0	10.80
ITS1	0	0	0
ITSA	0.00	0	0
ITSI	0	0	0
LT00	0.45	0	2.37
LUG1	0.12	0	0.75
LV00	0.002	0	0
ME00	0	0	0
MK00	0.04	0	0
MT00	8.53	5.45	26.11
NL00	0.17	0	0.92
NOM1	0.18	0	0.06
NON1	0.01	0	0
NOS0	0.04	0	0

Study Zone	Scenario A – TY 2028		
	Average [GWh]	P50 [GWh]	P95 [GWh]
PL00	1.10	0	9.12
PT00	0	0	0
RO00	0.	0	0
RS00	1.30	0	3.57
SE01	0.02	0	0.04
SE02	0	0	0
SE03	5.46	0	26.93
SE04	3.59	0	14.82
SI00	0.003	0	0
SK00	0.08	0	0.18
UK00	8.13	0	53.33
UKNI	0.08	0	0.69

Table 13: Country EENS (average) and ENS percentiles for scenario A, for TY 2028

Country	Scenario A – TY 2028		
	Average [GWh]	P50 [GWh]	P95 [GWh]
DK00	6.95	0	24.84
ISEM	2.57	0	9.57
IT00	4.22	0	16.06
LU00	0.12	0	0.75
NO00	0.24	0	0.16
SE00	9.07	0	43.01

For scenario A, TY 2030, Table 14 lists each study zone average LOLE and LLD percentiles, and Table 15 the country average LOLE and LLD percentiles for countries with multiple study zones.

Table 14: Study zone LOLE (average) and LLD percentiles for scenario A, for TY 2030

Study zone	Scenario A – TY 2030		
	Average [h/year]	P50 [h/year]	P95 [h/year]
AL00	0.01	0	0
AT00	0.36	0	1
BA00	1.92	0	6.8
BE00	3.13	0	14
BG00	0.65	0	1
CH00	0.08	0	1
CY00	1.36	1	4
CZ00	2.90	0	14
DE00	4.28	1	17
DKE1	4.73	0	29.8
DKW1	1.46	0	8
EE00	3.2	0	23
ES00	0.66	0	3
FI00	1.66	0	18
FR00	3.27	0	13.6
GR00	0.05	0	0
GR03	0.18	0	1
HR00	0.01	0	0
HU00	3.04	1	15.8
IE00	0.67	0	4
ITCA	0.01	0	0
ITCN	0.80	0	5
ITCS	0.64	0	4
ITN1	1.35	1	5
ITS1	0	0	0
ITSA	0.03	0	0
ITSI	0.004	0	0
LT00	2.73	0	20.8
LUG1	4.28	1	17
LV00	0.08	0	1
ME00	0.02	0	0
MK00	0.41	0	1
MT00	27.86	17	100.6
NL00	0.85	0	5
NOM1	0.60	0	2.8
NON1	0.13	0	1
NOS0	0.25	0	1

Study zone	Scenario A – TY 2030		
	Average [h/year]	P50 [h/year]	P95 [h/year]
PL00	2.81	2	11
PT00	0.06	0	1
RO00	0.01	0	0
RS00	2.97	1	8
SE01	1.65	0	13.8
SE02	0	0	0
SE03	3.54	0	25.8
SE04	3.61	0	26
SI00	0.04	0	0
SK00	0.43	0	1
UK00	2.13	0	14
UKNI	0.08	0	0

Table 15: Country LOLE (average) and LLD percentiles for scenario A, for TY 2030

Country	Scenario A – TY 2030		
	Average [h/year]	P50 [h/year]	P95 [h/year]
DK00	4.74	0	29.8
ISEM	0.73	0	4.8
IT00	1.57	1	5
LU00	4.28	1	17
NO00	0.96	0	4
SE00	3.65	0	26.8

For scenario A, TY 2030, Table 16 lists each study zone average EENS and ENS percentiles, and Table 17 the country average EENS and ENS percentiles for countries with multiple study zones.

Table 16: Study zone EENS (average) and ENS percentiles for scenario A, for TY 2030

Study zone	Scenario A – TY 2030		
	Average [GWh]	P50 [GWh]	P95 [GWh]
AL00	0	0	0
AT00	0.09	0	0.009
BA00	0.23	0	0.33
BE00	2.39	0	7.49
BG00	0.15	0	0
CH00	0	0	0
CY00	0.008	0	0.006
CZ00	1.41	0	7.72
DE00	15.16	0	125.15
DKE1	4.06	0	23.28
DKW1	3.02	0	17.95
EE00	0.18	0	1.29
ES00	0.67	0	1.58
FI00	0.22	0	1.12
FR00	11.35	0	35.41
GR00	0	0	0
GR03	0	0	0
HR00	0	0	0
HU00	2.77	0	17.13
IE00	0.13	0	0.17
ITCA	0	0	0
ITCN	0.24	0	1.88
ITCS	0.19	0	1.25
ITN1	0.41	0	2.52
ITS1	0	0	0
ITSA	0	0	0
ITSI	0	0	0
LT00	0.38	0	3.06
LUG1	0.20	0	1.63
LV00	0	0	0
ME00	0	0	0
MK00	0.02	0	0
MT00	1.68	0.53	7.66
NL00	0.22	0	0.98
NOM1	0.07	0	0.003
NON1	0.001	0	0
NOS0	0	0	0

Study zone	Scenario A – TY 2030		
	Average [GWh]	P50 [GWh]	P95 [GWh]
PL00	1.20	0	10.23
PT00	0	0	0
RO00	0	0	0
RS00	0.87	0	2.04
SE01	0.33	0	1.23
SE02	0	0	0
SE03	5.88	0	34.75
SE04	3.23	0	17.62
SI00	0	0	0
SK00	0.03	0	0.02
UK00	3.54	0	18.50
UKNI	0.001	0	0

Table 17: Country EENS (average) and ENS percentiles for scenario A for TY 2030

Country	Scenario A – TY 2030		
	Average [GWh]	P50 [GWh]	P95 [GWh]
DK00	7.08	0	28.25
ISEM	0.13	0	0.17
IT00	0.83	0	5.89
LU00	0.20	0	1.63
NO00	0.07	0	0.004
SE00	9.44	0	53.41

For scenario A, TY 2033, Table 18 lists each study zone average LOLE and LLD percentiles, and Table 19 the country average LOLE and LLD percentiles for countries with multiple study zones.

Table 18: Study zone LOLE (average) and LLD percentiles for scenario A, for TY 2033

Study zone	Scenario A – TY 2033		
	Average [h/year]	P50 [h/year]	P95 [h/year]
AL00	0.19	0	1
AT00	1.44	0	7.8
BA00	3.71	1	17.8
BE00	6.18	1	32.8
BG00	1.51	0	7.8
CH00	0.26	0	1
CY00	8.47	4	34
CZ00	8.68	3	44.8
DE00	8.07	2	45.8
DKE1	7.25	0	44.8
DKW1	3.83	0	28
EE00	3.97	0	20
ES00	0.73	0	5
FI00	1.42	0	17
FR00	6.33	0	32.8
GR00	1.48	0	9
GR03	1.70	0	9
HR00	0.07	0	0
HU00	8.06	1	46.8
IE00	1.94	0	9.8
ITCA	0.03	0	0
ITCN	1.35	0	8
ITCS	1.19	0	8
ITN1	3.14	2	9
ITS1	0.01	0	0
ITSA	0.03	0	0
ITSI	0.02	0	0
LT00	3.06	0	22.8
LUG1	8.07	2	45.8
LV00	0.51	0	3
ME00	0.09	0	0
MK00	2.24	0	13.8
MT00	49.34	35	147.4
NL00	1.65	1	8
NOM1	1.14	0	8
NON1	0.51	0	3
NOS0	0.24	0	1

Study zone	Scenario A – TY 2033		
	Average [h/year]	P50 [h/year]	P95 [h/year]
PL00	8.76	6	24
PT00	0.18	0	1
RO00	0.01	0	0
RS00	6.47	3	20
SE01	0.30	0	1
SE02	0	0	0
SE03	2.47	0	19
SE04	3.13	0	23
SI00	0.27	0	1
SK00	1.29	0	8.8
UK00	23.05	17	61
UKNI	1.81	0	7.8

Table 19: Country LOLE (average) and LLD percentiles for scenario A, for TY 2033

Country	Scenario A – TY 2033		
	Average [h/year]	P50 [h/year]	P95 [h/year]
DK00	7.63	1	45
ISEM	2.88	0	11
IT00	3.67	3	11.8
LU00	8.07	2	45.8
NO00	1.64	0	9
SE00	3.29	0	24.6

For scenario A, TY 2030, Table 20 lists each study zone average EENS and ENS percentiles, and Table 21 the country average EENS and ENS percentiles for countries with multiple study zones.

Table 20: Study zone EENS (average) and ENS percentiles for scenario A, for TY 2033

Study zone	Scenario A – TY 2033		
	Average [GWh]	P50 [GWh]	P95 [GWh]
AL00	0.001	0	0
AT00	0.53	0	1.03
BA00	0.38	0	2.22
BE00	3.01	0	23.21
BG00	0.57	0	1.59
CH00	0.004	0	0
CY00	0.46	0	2.88
CZ00	9.84	0	71.69
DE00	39.75	0	305.36
DKE1	7.92	0	56.90
DKW1	5.65	0	52.38
EE00	0.30	0	2.03
ES00	1.06	0	7.55
FI00	0.81	0	5.96
FR00	20.03	0	101.84
GR00	0.40	0	0.74
GR03	0.16	0	0.93
HR00	0.006	0	0
HU00	12.32	0	74.33
IE00	0.40	0	1.27
ITCA	0	0	0
ITCN	0.02	0	0.005
ITCS	0.03	0	0.005
ITN1	0.14	0	0.02
ITS1	0	0	0
ITSA	0	0	0
ITSI	0	0	0
LT00	0.35	0	2.33
LUG1	0.52	0	3.97
LV00	0.002	0	0.007
ME00	0.002	0	0
MK00	0.26	0	2.16
MT00	3.35	1.61	13.63
NL00	0.72	0	5.73
NOM1	0.004	0	0.01
NON1	0	0	0.001
NOS0	0.007	0	0

Study zone	Scenario A – TY 2033		
	Average [GWh]	P50 [GWh]	P95 [GWh]
PL00	6.39	0	44.24
PT00	0.003	0	0
RO00	0	0	0
RS00	2.01	0	7.48
SE01	0.003	0	0
SE02	0	0	0
SE03	1.15	0	7.06
SE04	1.86	0	16.59
SI00	0.002	0	0
SK00	0.20	0	1.04
UK00	112.62	53.88	439.32
UKNI	0.31	0	0.91

Table 21: Country EENS (average) and ENS percentiles for scenario A for TY 2033

Country	Scenario A – TY 2033		
	Average [GWh]	P50 [GWh]	P95 [GWh]
DK00	13.57	0	110.73
ISEM	0.71	0	1.84
IT00	0.19	0	0.06
LU00	0.52	0	3.97
NO00	0.01	0	0.03
SE00	3.01	0	26.32

3.1.2.2 Results convergence

To be robust, the MC simulation results must have converged, meaning that the impact of additional MC realisation results on the existing results should be small or negligible (see Annex 2, Section 11.6). It can then be said that the model has converged. This is the behaviour observed in the results, once 525 MC realisations of results have been reached, as shown in Figure 9.

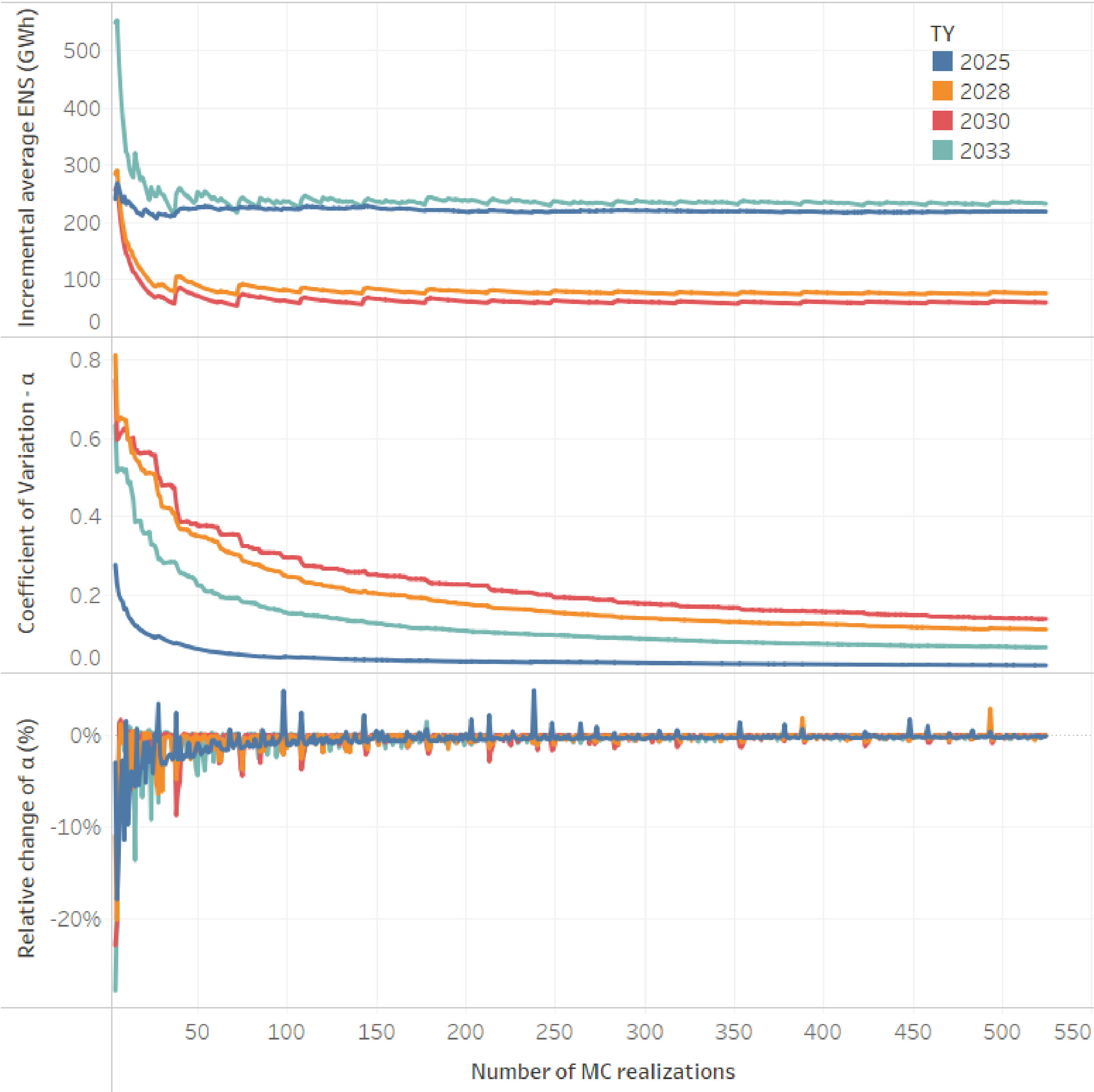

Figure 9: Incremental average ENS, Coefficient of variation α and relative change of α evolution (Scenario A)

3.2 Results – Scenario B

In this section we are presenting results for Scenario B. As a reminder, in Scenario A the CY representation in the economic viability analysis is calibrated based on the LOLE of the ERAA 2022 adequacy results aiming at the consistency of this indicator throughout the economic viability and adequacy analyses. In Scenario B the CY representation in the economic viability analysis is calculated according to the ERAA 2022 methodology, aiming at the consistency of the total system costs throughout the EVA. This scenario results in comparably measured investment reaction to price spikes.

3.2.1 EVA results

Table 22 presents the capacity change per decision variable, for each technology, TY, and most affected study zones. The values in the table represent capacity differences with respect to the 'National Trends' assumptions for each TY, i.e. if a certain capacity deemed non-viable reaches its expected decommissioning date, the non-viable capacity reported leaves out this capacity as from the TY of the expected decommissioning date. Detailed results per study zone are given in Table 23.

The trend shows significant amounts of decommissioned thermal capacity in Europe, with a peak of 59 GW in 2028. In 2033 the retired thermal capacity regarding the "National Trends" scenario totals 38 GW. Among thermal capacities, gas technologies appear more subject to EVA decommissioning than lignite and hard coal. As explained in Section 3.1.1, on the one hand the "coal before gas" scenario in the merit order (up to 2028 for the most efficient CCGT technologies) negatively affects the viability of gas capacity, especially for the less efficient technologies. On the other hand, hard coal and lignite capacity is heavily subject to exogenous phase-out trajectories due to policy targets in many Member States which are already reflected in the original PEMMDB data and as such do not show up as additional capacity change in the EVA results. In addition, ca. 18 GW in 2025 and 8 GW in 2028 are deemed not viable in the respective TYs but return to market progressively in 2030 and 2033 (Mothballing). On the other side, the EVA suggests investments in batteries, DSR and gas units in all TYs. Investments in 2025 and 2028 remain below 1 GW and 5 GW respectively, while ca. 14 GW of capacity is built in 2030 and 26 GW in 2033. Most investments in 2030 and 2033 are allocated to gas technologies (80%). DSR investments total up to 4.5 GW in 2033. In addition, life extension keeps up to 2 GW of gas capacity back into the market.

Table 22: Capacity change proposed by the EVA compared to the National Trends scenario [MW] – Non-cumulative (Scenario B)

Decision Variable	Technology	2025	2028	2030	2033	Most affected study zones
New Entry	Battery	120	120	120	1320	GR00, MT00
	DSR	510	1910	2460	4520	DE00, FI00, NL00, PT00
	Gas CCGT	0	2330	11370	19770	DE00, PL00
Life Extension	Gas CCGT	300	1620	1800	1800	BE00, DKE1, HU00
	Gas OCGT	0	80	260	260	DKW1, HU00
Mothballed	Gas CCGT	-10380	-6160	-1320	0	AT00, DE00, ES00, NL00, SK00
	Gas OCGT	-4510	0	0	0	AT00, DE00, DKW1,
	Oil	-2380	-1410	0	0	DE00, FR00
	Hard Coal	-240	0	0	0	FI00
Decommissioning	Gas CCGT	-17730	-23820	-22510	-26260	ES00, GR00, IE00, ITCA, ITCN, ITCS, ITN1, ITSI, UK00
	Gas OCGT	-6700	-6740	-3910	-2920	BG00, HR00, ITCS, ITN1, ITS1, RO00, UK00
	Oil	-4240	-1930	-1560	-580	GR03, HR00, IE00, UK00, UKNI

Decision Variable	Technology	2025	2028	2030	2033	Most affected study zones
	Lignite	-8850	-15890	-14410	-7500	BA00, BG00, CZ00, ME00, PL00, RO00, RS00
	Hard Coal	-3900	-7550	-4170	-910	CZ00, ES00, FI00, HR00, NL00, PL00
Total		-58000	-57440	-31870	-10500	CZ00, , ES00, ITCS, ITN1, UK00

Table 23: Capacity change proposed by EVA per study zone, PEMMDB technology, and decision variable [MW] – Non-cumulative (Scenario B)

Study Zone	PEMMDB Technology	EVA Type	2025	2028	2030	2033
AL00	Gas CCGT	Decommissioning	-100	-100	-100	-300
AT00	Gas CCGT	Mothballed	-300	-160	0	0
	Gas OCGT	Mothballed	-480	0	0	0
	Gas OCGT	Decommissioning	-80	0	0	0
BA00	Lignite	Decommissioning	-1520	-1600	-1600	-1600
BE00	Gas CCGT	Life Extension	300	1480	1480	1480
	Gas CCGT	Decommissioning	-380	0	0	0
BG00	Gas OCGT	Decommissioning	0	-480	-480	-550
	Hard Coal	Decommissioning	-90	0	0	0
	Lignite	Decommissioning	-450	-2840	-2500	-1900
CY00	Gas OCGT	Decommissioning	0	-100	-100	-100
CZ00	DSR	New Entry	0	0	0	180
	Hard Coal	Decommissioning	-600	-40	-40	0
	Lignite	Decommissioning	-3030	-4810	-4580	0
DE00	DSR	New Entry	0	820	820	820
	Gas CCGT	New Entry	0	0	6520	14760
	Gas CCGT	Mothballed	-4030	-3110	0	0
	Gas OCGT	Mothballed	-3430	0	0	0
	Oil	Decommissioning	-90	0	0	0
	Oil	Mothballed	-1410	-1410	0	0
DKE1	DSR	New Entry	0	50	50	50
	Gas CCGT	Mothballed	-40	0	0	0
	Gas CCGT	Life Extension	0	140	140	140
	Gas OCGT	Decommissioning	-60	0	0	0
	Gas OCGT	Mothballed	-20	0	0	0
DKW1	DSR	New Entry	0	0	10	80
	Gas OCGT	Decommissioning	-360	0	0	0
	Gas OCGT	Mothballed	-540	0	0	0
	Gas OCGT	Life Extension	0	80	170	170
	Oil	Decommissioning	-60	-30	0	0
EE00	Oil	Decommissioning	-500	0	0	0
ES00	Gas CCGT	Decommissioning	-2190	-2190	-2180	-2190
	Gas CCGT	Mothballed	-360	-310	-1320	0
	Oil	Decommissioning	-560	0	0	0
FI00	DSR	New Entry	120	120	120	120
	Gas CCGT	Decommissioning	0	0	0	-870
	Gas OCGT	Decommissioning	-20	0	0	-90
	Gas OCGT	Mothballed	-40	0	0	0
	Hard Coal	Decommissioning	0	0	0	-620

Study Zone	PEMMDB Technology	EVA Type	2025	2028	2030	2033
FR00	Hard Coal	Mothballed	-240	0	0	0
	Oil	Decommissioning	-360	0	0	0
	Oil	Mothballed	-970	0	0	0
GR00	Battery	New Entry	0	0	0	1200
	Gas CCGT	Decommissioning	-1260	-1260	-3330	-3780
	Gas OCGT	Decommissioning	-80	-150	-150	0
	Lignite	Decommissioning	0	-660	0	0
GR03	Oil	Decommissioning	-410	-410	-410	0
HR00	DSR	New Entry	0	0	0	10
	Gas OCGT	Decommissioning	-680	-680	-680	0
	Hard Coal	Decommissioning	0	-290	-290	-290
	Oil	Decommissioning	-300	-300	-300	0
HU00	DSR	New Entry	60	60	60	60
	Gas CCGT	Life Extension	0	0	180	180
	Gas OCGT	Life Extension	0	0	90	90
	Lignite	Decommissioning	-270	0	0	0
IE00	Gas CCGT	Decommissioning	-280	-550	-800	-800
	Gas OCGT	Decommissioning	0	-120	-120	-120
	Oil	Decommissioning	-290	-190	-190	-190
	Lignite	Decommissioning	0	-110	-110	0
ITCA	Gas CCGT	Decommissioning	0	-2470	-2960	-3270
	Gas OCGT	Decommissioning	0	-220	-220	-220
ITCN	Gas CCGT	Decommissioning	-390	-390	-390	-390
ITCS	Gas CCGT	Decommissioning	-480	-4010	-4010	-4660
	Gas OCGT	Decommissioning	-120	-600	-600	-600
ITN1	Gas CCGT	Decommissioning	-4130	-5250	-5250	-6050
	Gas OCGT	Decommissioning	-240	-240	-240	-240
ITS1	Gas CCGT	Decommissioning	0	-1520	-2000	-2000
	Gas OCGT	Decommissioning	-250	-250	-250	-250
ITSI	Gas OCGT	Decommissioning	0	-210	-210	-210
LT00	Gas CCGT	Decommissioning	0	0	0	-320
LT00	Gas OCGT	Decommissioning	-90	0	0	0
LV00	Gas CCGT	Decommissioning	0	0	0	-200
ME00	Lignite	Decommissioning	0	-440	-440	-220
MK00	Gas OCGT	Decommissioning	0	-60	-60	-60
MT00	Battery	New Entry	120	120	120	120
NL00	DSR	New Entry	290	420	960	2410
	Gas CCGT	Mothballed	-5380	-2580	0	0
	Hard Coal	Decommissioning	0	-3380	0	0
PL00	Gas CCGT	New Entry	0	2330	4850[10]	5010[11]
	Hard Coal	Decommissioning	-3210	-3710	-3710	0
	Lignite	Decommissioning	-1060	-3840	-3520	-2120
PT00	DSR	New Entry	0	400	400	580
	Gas CCGT	Decommissioning	-170	-170	0	0
RO00	Gas CCGT	Decommissioning	0	0	0	-880
	Gas OCGT	Decommissioning	0	-330	-330	-370
	Hard Coal	Decommissioning	0	-130	-130	0

[10] National restrictions provided by PSE amounts to 4487MW
[11] National restrictions provided by PSE amounts to 4487MW

Study Zone	PEMMDB Technology	EVA Type	2025	2028	2030	2033
	Lignite	Decommissioning	-1410	0	0	0
RS00	Lignite	Decommissioning	-810	-1360	-1430	-1430
SE01	Gas OCGT	Decommissioning	0	0	0	-100
SE03	Oil	Decommissioning	-90	-90	0	0
SI00	DSR	New Entry	40	40	40	40
	Gas OCGT	Decommissioning	-150	0	0	0
	Lignite	Decommissioning	-300	-210	-210	-210
SK00	DSR	New Entry	0	0	0	170
	Gas CCGT	Mothballed	-270	0	0	0
UK00	Gas CCGT	Decommissioning	-8350	-5910	-1490	-10
	Gas OCGT	Decommissioning	-4040	-3290	-460	0
	Oil	Decommissioning	-1190	-520	-270	0
UKNI	Gas CCGT	Decommissioning	0	0	0	-540
	Gas OCGT	Decommissioning	-530	-10	-10	-10
	Oil	Decommissioning	-390	-390	-390	-390
	Lignite	Decommissioning	0	-20	-20	-20

Country-specific results show that investments in new gas capacity in Scenario B are limited to only Poland and Germany from 2028 onwards, with a maximum of ca. 15 GW in Germany in 2033. New investments in DSR technologies occur in multiple countries throughout the whole horizon, while battery expansion is limited to Greece and Malta only.

The net effect of the EVA on the European generation mix is displayed in Figure 10Figure 10 and Figure 11 for the four TYs. Figure 10 shows the net effect focusing on the technologies assessed: hard coal (including lignite), gas, other non-RES (including oil), battery and DSR, while Figure 11 shows the net effect in the context of all European generation capacity mix. In all TYs, the net effect of the EVA is negative, meaning that more capacity is decommissioned or mothballed than capacity is being built or extended in lifetime. In 2025 and 2028, there is an overall net reduction of around 60 GW of capacity regarding the 'National Trends'. In particular, existing hard coal, lignite, gas, and oil-fired plants are decommissioned or mothballed while some batteries and DSR are commissioned. In 2030, the net reduction is lessened to roughly 30 GW and further going into 2033 to around 10 GW. In these years, mainly old gas and lignite plants are decommissioned, while new efficient gas capacity is being commissioned in Germany and Poland, around 10 GW in 2030 and 20 GW in 2033, which contributes to lower the net effect. In total, the post-EVA capacity of the assessed technologies increases from around 340 GW in 2025 to 420 GW in 2033. However, the share of these technologies in the total installed capacity decreases over the horizon, as the assessed technologies are roughly 25% of total installed capacity in 2025 down to less than 20% in 2030 as Figure 11 shows.

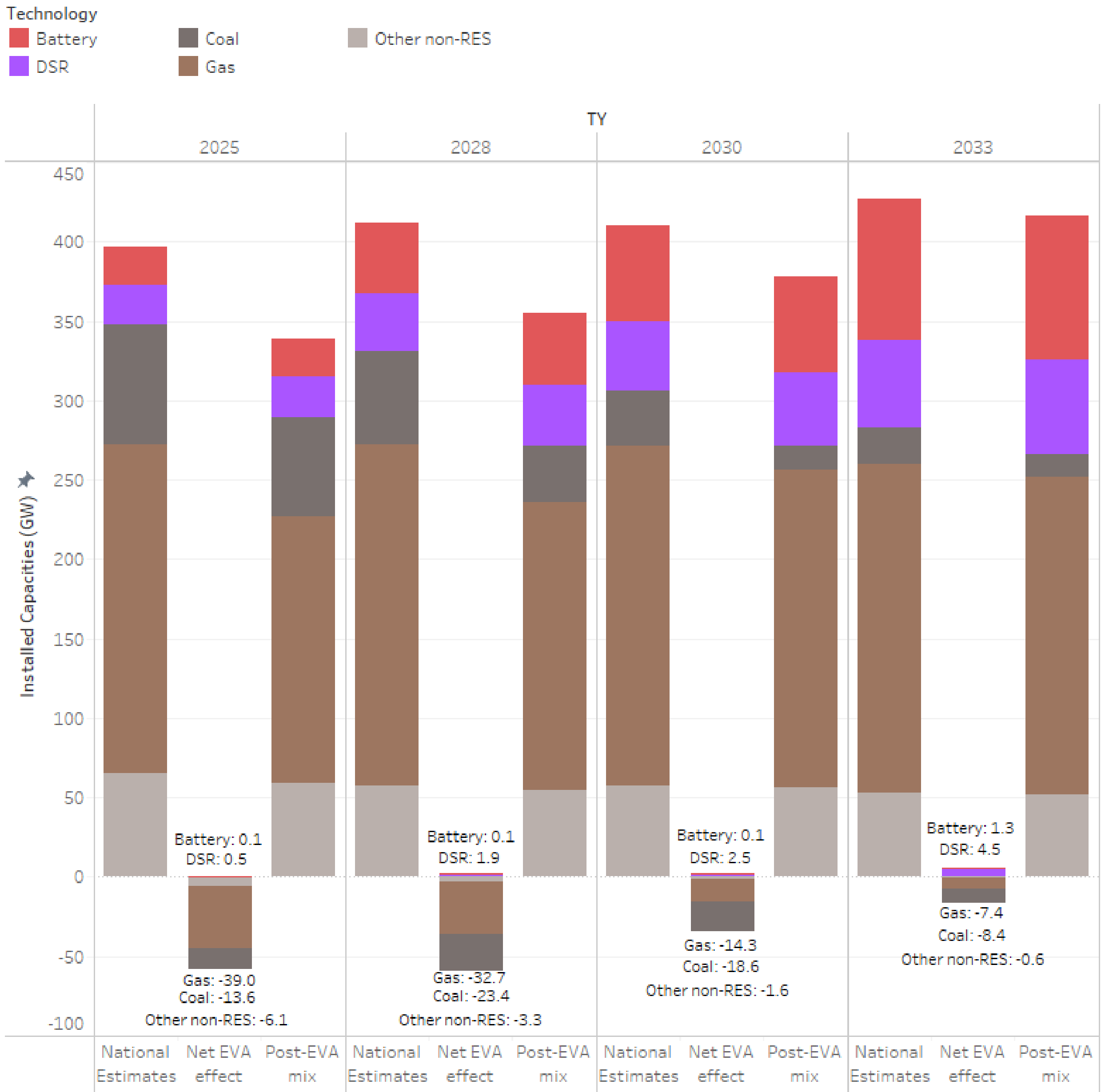

Figure 10: Net effect of the EVA on the European mix – focus on the technologies assessed (Scenario B)

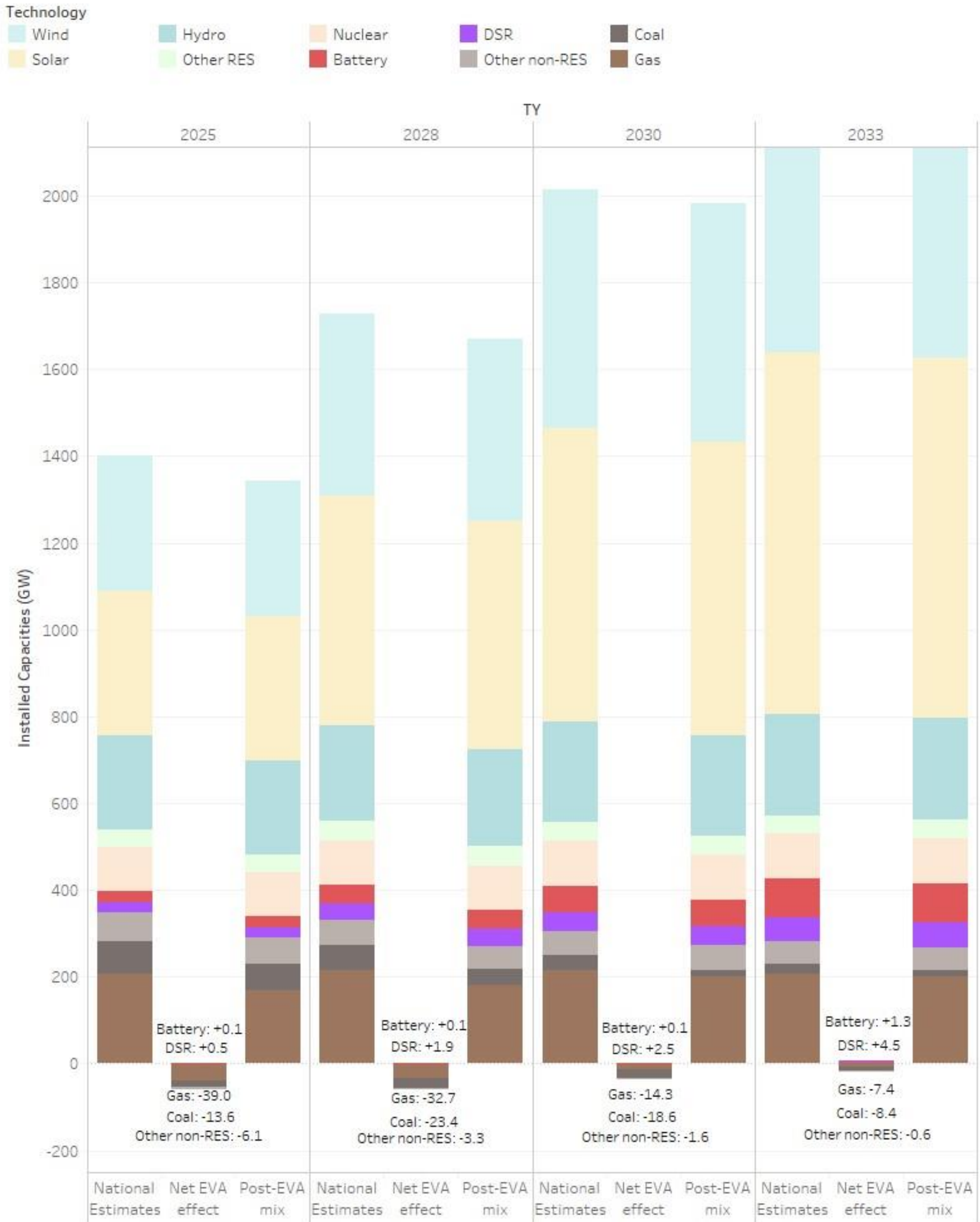

Figure 11: Net effect of the EVA on the European mix (Scenario B)

3.2.1.1 Analysis of revenues and profits of thermal expansion units

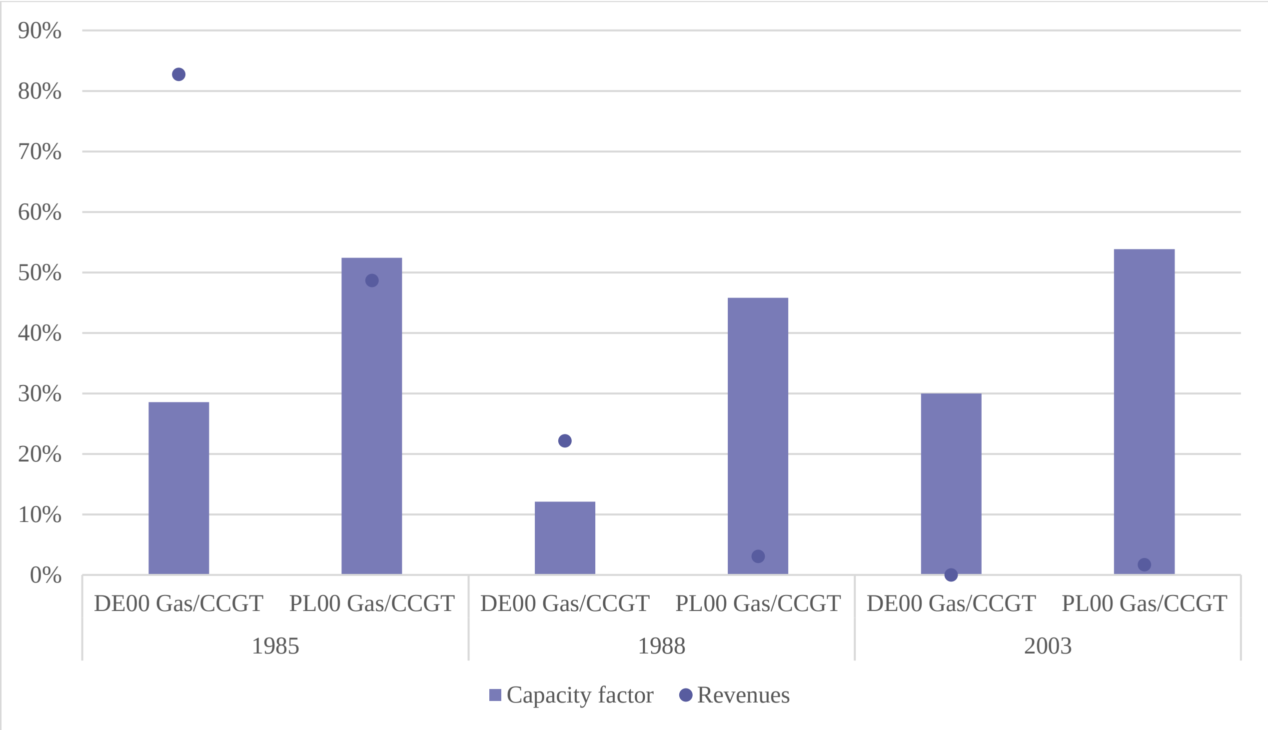

Figure 12: Scarcity revenues and average capacity factor (%) for new gas capacity (Scenario B)

Figure 12 above illustrates the share of revenues that the new gas-fired capacity invested by the EVA captures during near-scarcity hours (dots), over the whole horizon. Near-scarcity hours are defined as hours where the marginal price of electricity reaches more than 50% of the price cap (e.g. in 2030 the market price cap is 7000 €/MWh; a near-scarcity hour is here defined as an hour in which the marginal price is higher or equal to 3500 €/MWh). It follows that scarcity hours (hours at market price cap) are included in the count of near-scarcity hours. The average capacity factor is also displayed (bars) in the figure, representing the average ratio (over the horizon) of its yearly generation and its theoretical maximum energy output[12]. As the new gas-fired capacity enters the market in 2028, 2030 and 2033, the results shown include these TYs, according to the specific entry-date in each bidding zone. It can be observed that despite CY 1985 carries the highest share of revenues generated during the near-scarcity and scarcity hours, also 1988 and 2003 (the latter for Poland only) show non-zero values. Additionally, the capacity factors are above 10% for all CYs, meaning that in all climatic scenarios, the capacity generates an average yearly energy equivalent to more than 876 full-load hours (i.e. equivalent hours at maximum generating power). In particular, new gas CCGTs in Germany generates ~80% of revenues in CY 1985 during scarcity situations, although the share stays above 20% also in CY 1988. The share of revenue during scarcity for new gas CCGTs in Poland is lower than Germany, while the average capacity factors are higher and always above 45% for all 3 CYs.

[12] Capacity factor = yearly generation [GWh] / (Pnom [GW] x 8760 h)

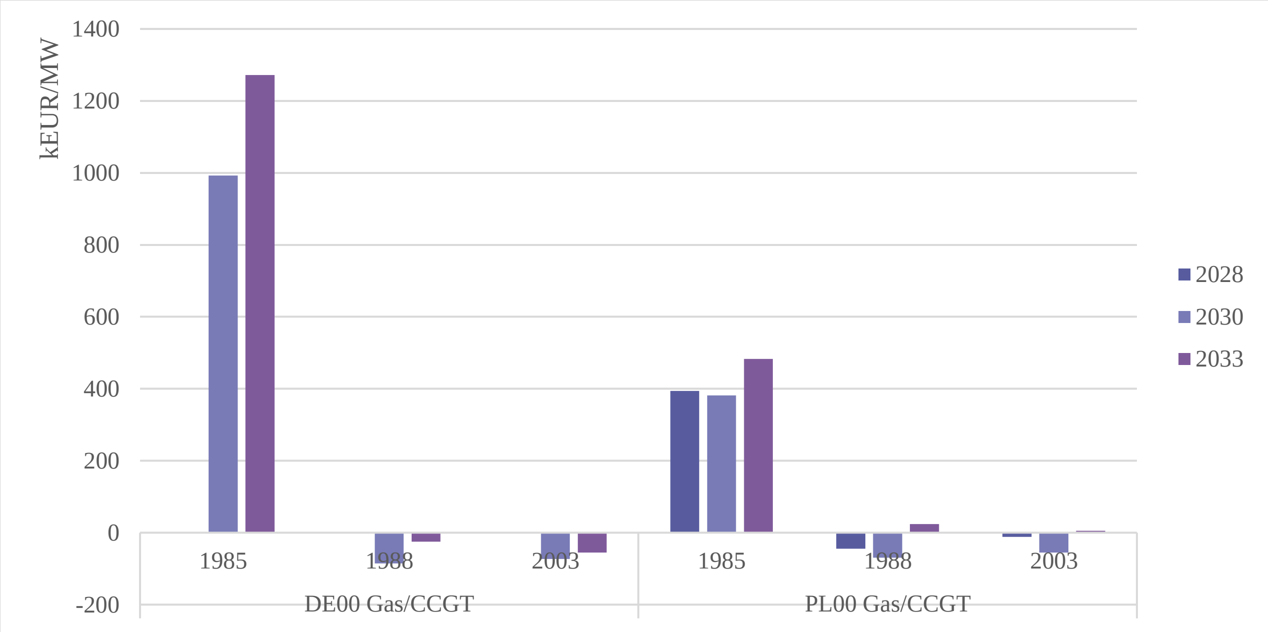

Figure 13: Yearly net profit per installed MW of new gas capacity (Scenario B)

Figure 13 shows annualized net profits by subtracting the components of capex and fixed operating costs from the net revenues of the new capacity[13]. It is apparent that in Germany the net profits are positive only for CY 1985, while Poland's new CCGTs are marginally profitable also for CY 2003 in 2033. The other CYs result in a net loss for the capacity. Profits in CY 1985 are highly driven by scarcity events, which occur with lower frequency and magnitude in 1988 and 2003. The high profits in 1985, that remain the key driver for gas expansion also in Scenario B, are offset by the low weight assigned (2.8%) which delivers less gas capacity as viable for new entry in the market: the EVA model seeks the long-term equilibrium over the modelled horizon, meaning that the CY weighted (according to Table 3) and discounted sum of net profits (and losses) over the horizon (i.e. Net Present Value) converges to zero. The distribution in Figure 13 shows the relevance of including multiple CYs in EVA, especially to assess the viability of new build peaking units.

3.2.2 Adequacy results

The following chapters give insights into the detailed results per study zone, in addition to the quantifications of the convergence of the model.

3.2.2.1 LOLE & EENS

The following tables include EENS and LOLE results per study zone for all scenarios in addition to the 50th and 95th percentiles of ENS and LLD occurrences. 95th percentile occurrences can be interpreted as a '1-time-in-20 years' occurrence and thus covers events with a lower likelihood but higher impact on adequacy. Results consider the activation of already approved out-of-market measures for Poland[14]. For scenario B, TY 2025, Table 24 lists each study zone average LOLE and LLD percentiles, and Table 25 the country average LOLE and LLD percentiles for countries with multiple study zones.

[13] Figure 8 contains cost components that are not discounted.
[14] The Scenarios account 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, including strategic reserves, which are relevant for Poland in TY 2025.

Table 24: Study zone LOLE (average) and LLD percentiles for scenario B, for TY 2025

Study zone	Scenario B – TY 2025		
	Average [h/year]	P50 [h/year]	P95 [h/year]
AL00	0.32	0	1
AT00	0.80	0	4
BA00	5.39	0	27
BE00	5.95	1	29
BG00	0	0	0
CH00	0.04	0	0
CY00	0	0	0
CZ00	5.66	1	30.2
DE00	7.35	2	31.8
DKE1	6.57	1	30.6
DKW1	5.59	0	27.8
EE00	7.70	0	43.6
ES00	7.63	5	24.8
FI00	6.27	0	38.4
FR00	4.54	0	22
GR00	0.06	0	0
GR03	1.04	0	4
HR00	0.03	0	0
HU00	7.67	3	32.8
IE00	368.80	365	532.6
ITCA	0	0	0
ITCN	4.26	0	17.8
ITCS	0.09	0	0
ITN1	3.86	1	14.8
ITS1	0	0	0
ITSA	0.06	0	0
ITSI	0.06	0	0
LT00	3.45	0	21.6
LUG1	7.35	2	31.8
LV00	0.07	0	0
ME00	0.02	0	0
MK00	0.95	0	4
MT00	497.89	448	850
NL00	1.18	0	6
NOM1	0.09	0	0
NON1	0.07	0	0
NOS0	0.05	0	0

Study zone	Scenario B – TY 2025		
	Average [h/year]	P50 [h/year]	P95 [h/year]
PL00[15]	0.31	0	2
PT00	0.08	0	1
RO00	2.32	0	13.8
RS00	5.44	1	30.8
SE01	0	0	0
SE02	0	0	0
SE03	4.25	0	25
SE04	4.65	0	25
SI00	0.46	0	2
SK00	3.55	0	16
UK00	36.89	31	89.6
UKNI	203.36	197	330

Table 25: Country LOLE (average) and LLD percentiles for scenario B, for TY 2025

Country	Scenario B – TY 2025		
	Average [h/year]	P50 [h/year]	P95 [h/year]
DK00	6.68	1	31
ISEM	384.07	378	551
IT00	4.95	1	18.8
LU00	7.35	2	31.8
NO00	0.20	0	1
SE00	4.66	0	25

[15] Poland has fully contracted DSR for year 2025. Therefore, LOLE / EENS results for Poland in 2025 for the Scenarios are lowered by the use of DSR contracted for this year.

For scenario B, TY 2025, Table 26 lists each study zone average EENS and ENS percentiles, and Table 27 the country average EENS and ENS percentiles for countries with multiple study zones.

Table 26: Study zone EENS (average) and ENS percentiles for scenario B, for TY 2025

Study zone	Scenario B – TY 2025		
	Average [GWh]	P50 [GWh]	P95 [GWh]
AL00	0.002	0	0.006
AT00	0.09	0	0.09
BA00	0.38	0	1.41
BE00	3.13	0	7.41
BG00	0.00	0	0
CH00	0.00	0	0
CY00	0.00	0	0
CZ00	0.67	0	3.97
DE00	12.05	0.14	62.48
DKE1	3.21	0.02	14.30
DKW1	8.31	0	39.38
EE00	0.52	0	2.94
ES00	8.35	3.25	35.71
FI00	1.99	0	9.71
FR00	5.23	0	22.86
GR00	0.00	0	0
GR03	0.15	0	0.36
HR00	0.00	0	0
HU00	3.41	0.02	22.71
IE00	88.77	82.50	157.14
ITCA	0.00	0	0
ITCN	3.31	0	14.84
ITCS	0.00	0	0
ITN1	4.10	0	21.62
ITS1	0.00	0	0
ITSA	0.00	0	0
ITSI	0.00	0	0
LT00	0.13	0	0.65
LUG1	0.16	0	0.81
LV00	0.00	0	0
ME00	0.00	0	0
MK00	0.00	0	0
MT00	0.06	0	0.06
NL00	35.05	30.78	66.75
NOM1	0.00	0	0
NON1	0.03	0	0
NOS0	0.00	0	0

Study zone	Scenario B – TY 2025		
	Average [GWh]	P50 [GWh]	P95 [GWh]
PL00[16]	0.08	0	0.28
PT00	0.00	0	0
RO00	0.22	0	1.17
RS00	1.02	0	4.78
SE01	0.00	0	0
SE02	0.00	0	0
SE03	5.72	0	37.68
SE04	4.08	0	23.42
SI00	0.01	0	0.01
SK00	0.16	0	0.91
UK00	77.74	46.72	249.05
UKNI	37.09	34.71	65.39

Table 27: Country EENS (average) and ENS percentiles for scenario B for TY 2025

Country	Scenario B – TY 2025		
	Average [GWh]	P50 [GWh]	P95 [GWh]
DK00	11.52	0.04	52.69
ISEM	125.86	118.63	212.12
IT00	7.41	0	34.13
LU00	0.16	0	0.81
NO00	0.03	0	0
SE00	9.80	0	57.41

[16] Poland has fully contracted DSR for year 2025. Therefore, LOLE / EENS results for Poland in 2025 for the Scenarios are lowered by the use of DSR contracted for this year.

For scenario B, TY 2028, Table 28 lists each study zone average LOLE and LLD percentiles, and Table 29 the country average LOLE and LLD percentiles for countries with multiple study zones.

Table 28: Study zone LOLE (average) and LLD percentiles for scenario B, for TY 2028

Study zone	Scenario B – TY 2028		
	Average [h/year]	P50 [h/year]	P95 [h/year]
AL00	0.02	0	0
AT00	0.83	0	4
BA00	8.74	2	35
BE00	9.85	0	44.8
BG00	2.55	0	15
CH00	0.04	0	0
CY00	0.01	0	0
CZ00	9.95	2	46
DE00	12.26	5	53
DKE1	10.29	2	56.8
DKW1	6.99	0	38
EE00	5.95	0	37.6
ES00	8.52	6	26
FI00	2.67	0	17.8
FR00	7.86	0	37
GR00	0.03	0	0
GR03	0.54	0	4
HR00	0.002	0	0
HU00	10.85	2	51
IE00	14.37	9	49.8
ITCA	0	0	0
ITCN	4.33	0	22.8
ITCS	0.75	0	5
ITN1	3.81	0	20
ITS1	0.004	0	0
ITSA	0.04	0	0
ITSI	0	0	0
LT00	6.80	0	43.6
LUG1	12.26	5	53
LV00	0.04	0	0
ME00	0	0	0
MK00	1.41	0	6.8
MT00	117.58	100	278.2
NL00	2.60	0	17
NOM1	0.54	0	0
NON1	0.18	0	0
NOS0	0.49	0	1

Study zone	Scenario B – TY 2028		
	Average [h/year]	P50 [h/year]	P95 [h/year]
PL00	5.21	1	30
PT00	0.002	0	0
RO00	0.29	0	0
RS00	11.20	3	51
SE01	0.50	0	3
SE02	0	0	0
SE03	7.68	0	45.8
SE04	8.24	0	47.8
SI00	0.88	0	4.8
SK00	2.60	0	11
UK00	16.51	11	54
UKNI	1.32	0	11

Table 29: Country LOLE (average) and LLD percentiles for scenario B, for TY 2028

Country	Scenario B – TY 2028		
	Average [h/year]	P50 [h/year]	P95 [h/year]
DK00	10.46	2	56.8
ISEM	14.50	9	49.8
IT00	4.46	0	23
LU00	12.26	5	53
NO00	1.07	0	2.8
SE00	8.25	0	47.8

For scenario B, TY 2028, Table 30 lists each study zone average EENS and ENS percentiles, and Table 31 the country average EENS and ENS percentiles for countries with multiple study zones.

Table 30: Study zone EENS (average) and ENS percentiles for scenario B, for TY 2028

Study zone	Scenario B – TY 2028		
	Average [GWh]	P50 [GWh]	P95 [GWh]
AL00	0	0	0
AT00	0.21	0	0.44
BA00	1.29	0.06	3.17
BE00	8.96	0	33.30
BG00	0.50	0	2.03
CH00	0.002	0	0
CY00	0	0	0
CZ00	8.83	0.15	35.68
DE00	46.42	7.68	182.19
DKE1	6.63	0.27	34.02
DKW1	12.37	0	72.30
EE00	0.44	0	2.91
ES00	9.27	3.77	39.30
FI00	0.54	0	2.56
FR00	25.40	0	93.59
GR00	0.001	0	0
GR03	0.06	0	0.34
HR00	0	0	0
HU00	13.07	0.22	61.68
IE00	4.01	0.75	16.61
ITCA	0	0	0
ITCN	3.82	0	15.00
ITCS	0.53	0	2.50
ITN1	7.29	0	24.53
ITS1	0	0	0
ITSA	0.001	0	0
ITSI	0	0	0
LT00	0.60	0	3.19
LUG1	0.60	0.10	2.37
LV00	0.001	0	0
ME00	0	0	0
MK00	0.12	0	0.54
MT00	8.32	5.22	25.96
NL00	1.33	0	7.75
NOM1	0.10	0	0
NON1	0.04	0	0
NOS0	0.16	0	0.02

Study zone	Scenario B – TY 2028		
	Average [GWh]	P50 [GWh]	P95 [GWh]
PL00	3.65	0	21.55
PT00	0	0	0
RO00	0.03	0	0
RS00	6.49	0.16	33.67
SE01	0.03	0	0.06
SE02	0	0	0
SE03	14.30	0	104.82
SE04	9.02	0	62.92
SI00	0.03	0	0.06
SK00	0.25	0	1.69
UK00	43.52	14.06	193.10
UKNI	0.15	0	0.81

Table 31: Country EENS (average) and ENS percentiles for scenario B for TY 2028

Country	Scenario B – TY 2028		
	Average [GWh]	P50 [GWh]	P95 [GWh]
DK00	19.00	0.39	107.85
ISEM	4.16	0.81	17.22
IT00	11.64	0	38.85
LU00	0.60	0.10	2.37
NO00	0.30	0	0.61
SE00	23.34	0	167.15

For scenario B, TY 2030, Table 32 lists each study zone average LOLE and LLD percentiles, and Table 33 the country average LOLE and LLD percentiles for countries with multiple study zones.

Table 32: Study zone LOLE (average) and LLD percentiles for scenario B, for TY 2030

Study zone	Scenario B – TY 2030		
	Average [h/year]	P50 [h/year]	P95 [h/year]
AL00	0.01	0	0
AT00	0.55	0	5
BA00	5.40	1	33.6
BE00	7.14	0	40.6
BG00	1.08	0	4
CH00	0.10	0	0.8
CY00	1.49	1	5
CZ00	6.77	1	38
DE00	11.19	3	54.4
DKE1	10.96	1	56
DKW1	3.36	0	24.8
EE00	5.37	0	32.6
ES00	0.92	0	4.8
FI00	2.15	0	22
FR00	7.11	0	39
GR00	0.07	0	1
GR03	0.51	0	3
HR00	0.008	0	0
HU00	7.55	1	41
IE00	1.32	0	6.8
ITCA	0.01	0	0
ITCN	2.03	0	13
ITCS	1.83	0	13
ITN1	2.58	1	15.8
ITS1	0	0	0
ITSA	0.06	0	0
ITSI	0.04	0	0
LT00	4.94	0	36
LUG1	11.19	3	54.4
LV00	0.12	0	1
ME00	0.006	0	0
MK00	1.16	0	6
MT00	26.40	14	101
NL00	1.54	0	7.8
NOM1	0.96	0	7
NON1	0.20	0	1
NOS0	0.37	0	1

Study zone	Scenario B – TY 2030		
	Average [h/year]	P50 [h/year]	P95 [h/year]
PL00	4.46	2	21
PT00	0.10	0	1
RO00	0.01	0	0
RS00	7.06	2	34
SE01	2.12	0	15.8
SE02	0	0	0
SE03	6.85	0	43
SE04	7.08	0	44.6
SI00	0.41	0	2
SK00	1.39	0	7
UK00	4.17	1	22
UKNI	0.14	0	1

Table 33: Country LOLE (average) and LLD percentiles for scenario B, for TY 2030

Country	Scenario B – TY 2030		
	Average [h/year]	P50 [h/year]	P95 [h/year]
DK00	10.98	1	56
ISEM	1.45	0	7.8
IT00	2.93	1	16.8
LU00	11.19	3	54.4
NO00	1.46	0	8
SE00	7.16	0	44.6

For scenario B, TY 2030, Table 34 lists each study zone average EENS and ENS percentiles, and Table 35 the country average EENS and ENS percentiles for countries with multiple study zones.

Table 34: Study zone EENS (average) and ENS percentiles for scenario B, for TY 2030

Study zone	Scenario B – TY 2030		
	Average [GWh]	P50 [GWh]	P95 [GWh]
AL00	0	0	0
AT00	0.18	0	0.21
BA00	0.81	0	3.06
BE00	6.75	0	38.68
BG00	0.26	0	0.15
CH00	0.003	0	0
CY00	0.005	0	0.004
CZ00	4.88	0	28.28
DE00	54.75	0	304.76
DKE1	11.22	0	57.58
DKW1	6.48	0	62.38
EE00	0.39	0	2.99
ES00	0.95	0	3.84
FI00	0.57	0	3.58
FR00	29.27	0	150.92
GR00	0.001	0	0
GR03	0.01	0	0.02
HR00	0	0	0
HU00	7.71	0	38.25
IE00	0.32	0	0.80
ITCA	0	0	0
ITCN	0.62	0	4.40
ITCS	0.49	0	3.05
ITN1	1.15	0	9.37
ITS1	0	0	0
ITSA	0.001	0	0
ITSI	0	0	0
LT00	1.02	0	9.86
LUG1	0.71	0	3.96
LV00	0	0	0
ME00	0	0	0
MK00	0.06	0	0.11
MT00	1.71	0.42	7.86
NL00	0.68	0	2.92
NOM1	0.04	0	0.01
NON1	0.04	0	0
NOS0	0.13	0	0

Study zone	Scenario B – TY 2030		
	Average [GWh]	P50 [GWh]	P95 [GWh]
PL00	2.97	0	19.19
PT00	0	0	0
RO00	0	0	0
RS00	4.67	0	24.36
SE01	0.38	0	1.57
SE02	0	0	0
SE03	11.01	0	84.86
SE04	6.62	0	56.79
SI00	0.02	0	0.001
SK00	0.13	0	0.43
UK00	8.16	0	51.17
UKNI	0	0	0

Table 35: Country EENS (average) and ENS percentiles for scenario B for TY 2030

Country	Scenario B – TY 2030		
	Average [GWh]	P50 [GWh]	P95 [GWh]
DK00	17.70	0	124.51
ISEM	0.32	0	0.80
IT00	2.27	0	17.58
LU00	0.72	0	3.96
NO00	0.22	0	0.06
SE00	18.01	0	142.65

For scenario B, TY 2033, Table 36 lists each study zone average LOLE and LLD percentiles, and Table 37 the country average LOLE and LLD percentiles for countries with multiple study zones.

Table 36: Study zone LOLE (average) and LLD percentiles for scenario B, for TY 2033

Study zone	Scenario B – TY 2033		
	Average [h/year]	P50 [h/year]	P95 [h/year]
AL00	0.58	0	5
AT00	2.69	0	14
BA00	10.95	4	42.8
BE00	19.59	9	91
BG00	4.31	0	20
CH00	0.22	0	1
CY00	7.77	4	31
CZ00	16.61	7	62
DE00	21.63	11	89.8
DKE1	19.44	8	86
DKW1	9.09	2	45.6
EE00	6.72	1	30
ES00	0.74	0	5
FI00	1.57	0	17
FR00	14.57	5	75.6
GR00	4.09	1	23.8
GR03	4.57	1	22
HR00	0.002	0	0
HU00	17.43	7	64
IE00	2.88	0	14
ITCA	0.07	0	0
ITCN	3.20	0	16
ITCS	3	0	16
ITN1	4.71	3	17
ITS1	0.03	0	0
ITSA	0.16	0	1
ITSI	0.09	0	0
LT00	7.02	1	41.6
LUG1	21.63	11	89.8
LV00	1.20	0	7
ME00	0.04	0	0
MK00	6.71	1	31
MT00	48.35	33	150.4
NL00	3.96	1	16
NOM1	2.09	0	13
NON1	1.00	0	6
NOS0	0.30	0	2

Study zone	Scenario B – TY 2033		
	Average [h/year]	P50 [h/year]	P95 [h/year]
PL00	12.06	7	40
PT00	0.33	0	2
RO00	0.004	0	0
RS00	16.13	8	53.6
SE01	0.69	0	5
SE02	0	0	0
SE03	4.61	0	26
SE04	6.97	0	40
SI00	1.09	0	6.8
SK00	2.69	0	14
UK00	28.37	20	80.8
UKNI	2.70	0	13

Table 37: Country LOLE (average) and LLD percentiles for scenario B, for TY 2033

Country	Scenario B – TY 2033		
	Average [h/year]	P50 [h/year]	P95 [h/year]
DK00	19.96	10	86.4
ISEM	4.29	1	19
IT00	5.81	4	19.8
LU00	21.63	11	89.8
NO00	2.99	0	15
SE00	7.13	0	40.8

For scenario B, TY 2033, Table 38 lists each study zone average EENS and ENS percentiles, and Table 39 the country average EENS and ENS percentiles for countries with multiple study zones.

Table 38: Study zone EENS (average) and ENS percentiles for scenario B, for TY 2033

Study zone	Scenario B – TY 2033		
	Average [GWh]	P50 [GWh]	P95 [GWh]
AL00	0.01	0	0.05
AT00	0.86	0	2.62
BA00	1.95	0.13	8.53
BE00	26.78	5.05	160.85
BG00	1.29	0	5.42
CH00	0.003	0	0
CY00	0.33	0	1.77
CZ00	20.41	1.64	103.20
DE00	136.01	16.20	829.35
DKE1	23.90	8.10	113.98
DKW1	15.77	0.003	114.04
EE00	0.49	0	3.22
ES00	1.27	0	7.30
FI00	0.75	0	6.45
FR00	57.58	1.03	330.72
GR00	1.86	0	12.38
GR03	0.78	0	3.94
HR00	0	0	0
HU00	27.76	3.89	94.47
IE00	0.72	0	3.10
ITCA	0	0	0
ITCN	0.25	0	1.64
ITCS	0.31	0	1.79
ITN1	0.84	0	4.91
ITS1	0.002	0	0
ITSA	0.002	0	0
ITSI	0.002	0	0
LT00	1.31	0	7.31
LUG1	1.77	0.21	10.78
LV00	0.004	0	0.02
ME00	0	0	0
MK00	0.94	0	6.21
MT00	3.26	1.36	13.48
NL00	2.10	0	11.94
NOM1	0.005	0	0.03
NON1	0.04	0	0.005
NOS0	0.02	0	0.01

Study zone	Scenario B – TY 2033		
	Average [GWh]	P50 [GWh]	P95 [GWh]
PL00	13.29	0	65.27
PT00	0	0	0.001
RO00	0	0	0
RS00	11.97	0.72	44.52
SE01	0.002	0	0.007
SE02	0	0	0
SE03	2.26	0	16.83
SE04	3.81	0	29.34
SI00	0.02	0	0.02
SK00	0.43	0	2.28
UK00	138.79	69.69	522.22
UKNI	0.37	0	1.59

Table 39: Country EENS (average) and ENS percentiles for scenario B for TY 2033

Country	Scenario B – TY 2033		
	Average [GWh]	P50 [GWh]	P95 [GWh]
DK00	39.67	10.70	238.03
ISEM	1.09	0	3.91
IT00	1.41	0	8.95
LU00	1.77	0.21	10.78
NO00	0.06	0	0.10
SE00	6.07	0	45.90

3.2.2.2 Results convergence

To be robust, the MC simulation results must have converged, meaning that the impact of additional MC realisation results on the existing results should be small or negligible (see Annex 2, Section 11.6). It can then be said that the model has converged. This is the behaviour observed in the results, once 525 MC realisations of results have been reached, as shown in Figure 14.

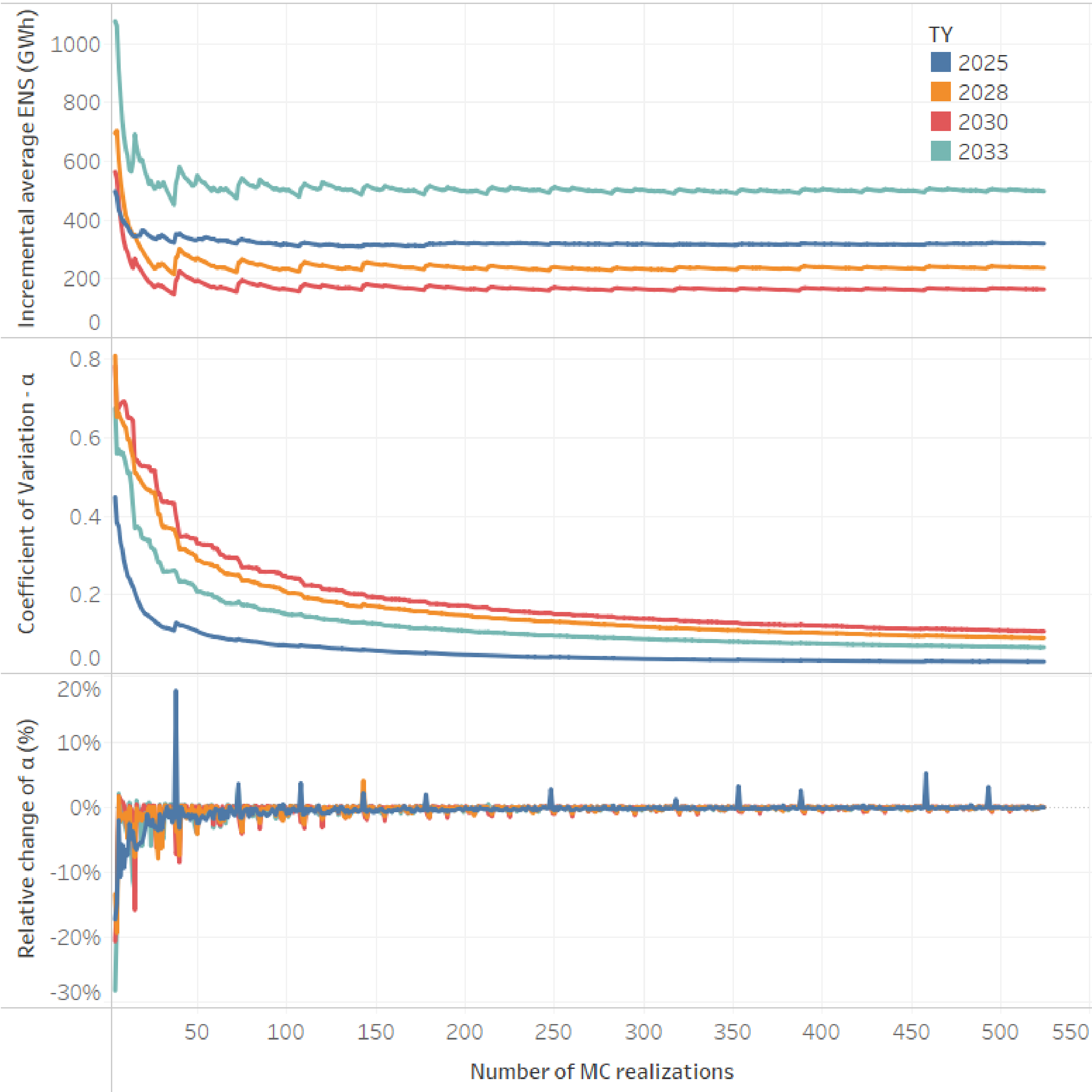

Figure 14: Incremental average ENS, Coefficient of variation α and relative change of α evolution (Scenario B)