European Resource Adequacy Assessment

2021 Edition

entsoe

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1 Introduction

In this Annex, detailed tables and graphs aim to provide insights on the results for all national and central reference scenarios. These results cannot be dissociated from the assumptions (cf. Annex 1) and the overall methodology followed in the European Resource Adequacy Assessment (ERAA) 2021 (cf. Annex 3). The presentation of results is organised per scenario and include results from the single reference tool, used for the simulations of all ERAA 2021 reference scenarios. For a further understanding of the uncertainty regarding these results, the reader should also see Annex 6, where results from benchmarking tools are presented for the reference scenarios.

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 bidding 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 bidding 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 bidding zone were also calculated. Readers should refer to Annex 3 for more details on the calculation methodology. Mathematical descriptions of the above can be found in Annex 3.

In addition, the results of some bidding zones were aggregated to the country level, namely:

- Danish bidding zones DKE1 and DKW1 are aggregated in DK00. Zone DKKF does not include any demand and is thus excluded from the country level aggregation.
- Irish bidding zones IE00 and UKNI are aggregated in I-SEM.
- Italian bidding zones ITCA, ITCN, ITCS, ITN1, ITS1, ITSA and ITSI are aggregated in IT00.
- Norwegian bidding zones NOS0, NOM1 and NON1 are aggregated in NO00.
- Swedish bidding zones SE01, SE02, SE03 and SE04 are aggregated in SE00.
- Zone DEKF does not include any demand, thus demand in Germany is reflected in DE00 alone.

Notably, 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.

All results in this annex were produced with the reference tool. Results with other tools were produced, and benchmarking visuals were placed in Annex 6.

[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.

2 Scenario National Estimates

Table 1: LOLE[2] (average LLD) and 50th and 95th LLD percentiles in the National Estimates scenarios for TYs 2025 and 2030

Bidding Zone	National Estimates – TY 2025			National Estimates – TY 2030		
	Average [h/year]	P50 [h/year]	Average [h/year]	Average [h/year]	P50 [h/year]	P95 [h/year]
AL00	0.00	0.00	0.00	0.00	0.00	0.00
AT00	0.00	0.00	0.00	0.00	0.00	0.00
BA00	0.00	0.00	0.00	0.00	0.00	0.00
BE00	0.11	0.00	0.00	0.04	0.00	0.00
BG00	0.00	0.00	0.00	0.00	0.00	0.00
CH00	0.00	0.00	0.00	0.00	0.00	0.00
CY00	0.11	0.00	0.00	0.06	0.00	0.00
CZ00	0.00	0.00	0.00	0.02	0.00	0.00
DE00	0.02	0.00	0.00	0.18	0.00	1.00
DEKF	0.00	0.00	0.00	0.00	0.00	0.00
DK00	0.34	0.00	2.00	6.39	3.00	24.00
DKE1	0.34	0.00	2.00	6.39	3.00	24.00
DKKF	0.00	0.00	0.00	0.00	0.00	0.00
DKW1	0.01	0.00	0.00	0.22	0.00	0.05
EE00	1.04	0.00	6.00	0.15	0.00	0.00
ES00	0.00	0.00	0.00	0.00	0.00	0.00
FI00	1.54	0.00	13.00	0.36	0.00	0.00
FR00	0.90	0.00	4.00	0.06	0.00	0.00
GR00	0.00	0.00	0.00	0.00	0.00	0.00
GR03	0.00	0.00	0.00	0.00	0.00	0.00
HR00	0.00	0.00	0.00	0.00	0.00	0.00
HU00	0.00	0.00	0.00	0.46	0.00	3.00
ISEM	0.86	0.00	3.00	0.02	0.00	0.00
IE00	0.86	0.00	3.00	0.02	0.00	0.00
IT00	127.41	115.50	230.05	0.00	0.00	0.00
ITCA	0.00	0.00	0.00	0.00	0.00	0.00
ITCN	0.16	0.00	2.00	0.00	0.00	0.00
ITCS	0.69	0.00	5.00	0.00	0.00	0.00
ITN1	0.00	0.00	0.00	0.00	0.00	0.00

[2] Bidding zones neighbouring other bidding zones with LOLE might not be correctly presented as curtailments are modelled for each bidding zone individually (no implementation of curtailment sharing principles).

Bidding Zone	National Estimates – TY 2025			National Estimates – TY 2030		
	Average [h/year]	P50 [h/year]	Average [h/year]	Average [h/year]	P50 [h/year]	P95 [h/year]
ITS1	0.08	0.00	0.00	0.00	0.00	0.00
ITSA	122.07	110.00	227.05	0.00	0.00	0.00
ITSI	5.87	2.00	25.00	0.00	0.00	0.00
LT00	7.52	0.00	44.00	1.82	0.00	9.00
LU00	0.02	0.00	0.00	0.18	0.00	1.00
LV00	0.11	0.00	0.00	0.00	0.00	0.00
ME00	0.00	0.00	0.00	0.00	0.00	0.00
MK00	0.00	0.00	0.00	0.00	0.00	0.00
MT00	556.05	532.50	804.00	203.60	191.50	371.05
NL00	0.00	0.00	0.00	0.17	0.00	0.05
NO00	0.00	0.00	0.00	0.03	0.00	0.00
NOM1	0.00	0.00	0.00	0.00	0.00	0.00
NON1	0.00	0.00	0.00	0.00	0.00	0.00
NOS0	0.00	0.00	0.00	0.03	0.00	0.00
PL00	0.00	0.00	0.00	0.01	0.00	0.00
PT00	0.00	0.00	0.00	0.00	0.00	0.00
RO00	0.00	0.00	0.00	0.00	0.00	0.00
RS00	0.00	0.00	0.00	0.00	0.00	0.00
SE00	0.01	0.00	0.00	0.04	0.00	0.00
SE01	0.00	0.00	0.00	0.00	0.00	0.00
SE02	0.00	0.00	0.00	0.00	0.00	0.00
SE03	0.00	0.00	0.00	0.00	0.00	0.00
SE04	0.01	0.00	0.00	0.04	0.00	0.00
SI00	0.00	0.00	0.00	0.00	0.00	0.00
SK00	0.00	0.00	0.00	0.01	0.00	0.00
TR00	4.65	0.00	28.00	1.88	0.00	8.00
UA01	0.00	0.00	0.00	0.06	0.00	0.00
UK00	0.25	0.00	2.00	0.04	0.00	0.00
UKNI	0.00	0.00	0.00	0.00	0.00	0.00

Table 2: EENS (average ENS) and 50th and 95th ENS percentiles in the National Estimates scenarios for TYs 2025 and 2030

Bidding Zone	National Estimates – TY 2025				National Estimates – TY 2030			
	Average [GWh]	EENS / Annual Demand	P50 [GWh]	P95 [GWh]	Average [GWh]	EENS / Annual Demand	P50 [GWh]	P95 [GWh]
AL00	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
AT00	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
BA00	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
BE00	0.06	0.000%	0.00	0.00	0.03	0.000%	0.00	0.00
BG00	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
CH00	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
CY00	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
CZ00	0.00	0.000%	0.00	0.00	0.01	0.000%	0.00	0.00
DE00	0.04	0.000%	0.00	0.00	0.69	0.000%	0.00	0.91
DEKF	0.00	-	0.00	0.00	0.00	-	0.00	0.00
DK00	0.08	0.000%	0.00	0.31	1.98	0.003%	0.34	7.90
DKE1	0.07	0.000%	0.00	0.31	1.86	0.007%	0.34	7.87
DKKF	0.00	-	0.00	0.00	0.00	-	0.00	0.00
DKW1	0.01	0.000%	0.00	0.00	0.13	0.000%	0.00	0.00
EE00	0.28	0.003%	0.00	0.80	0.03	0.000%	0.00	0.00
ES00	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
FI00	0.89	0.001%	0.00	5.80	0.26	0.000%	0.00	0.00
FR00	3.73	0.001%	0.00	4.85	0.23	0.000%	0.00	0.00
GR00	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
GR03	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
HR00	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
HU00	0.00	0.000%	0.00	0.00	0.20	0.000%	0.00	1.18
ISEM	0.18	0.000%	0.00	0.87	0.00	0.000%	0.00	0.00
IE00	0.18	0.000%	0.00	0.87	0.00	0.000%	0.00	0.00
IT00	23.70	0.007%	18.24	61.36	0.00	0.000%	0.00	0.00
ITCA	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
ITCN	0.10	0.000%	0.00	0.42	0.00	0.000%	0.00	0.00
ITCS	0.39	0.001%	0.00	1.89	0.00	0.000%	0.00	0.00
ITN1	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
ITS1	0.02	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
ITSA	21.39	0.175%	15.53	55.37	0.00	0.000%	0.00	0.00
ITSI	1.80	0.007%	0.15	8.52	0.00	0.000%	0.00	0.00
LT00	2.60	0.013%	0.00	12.83	0.79	0.004%	0.00	2.28
LU00	0.00	0.000%	0.00	0.00	0.01	0.000%	0.00	0.01
LV00	0.03	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
ME00	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00

Bidding Zone	National Estimates – TY 2025				National Estimates – TY 2030			
	Average [GWh]	EENS / Annual Demand	P50 [GWh]	P95 [GWh]	Average [GWh]	EENS / Annual Demand	P50 [GWh]	P95 [GWh]
MK00	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
MT00	33.16	1.062%	30.73	56.07	11.06	0.305%	9.89	22.70
NL00	0.00	0.000%	0.00	0.00	0.31	0.000%	0.00	0.00
NO00	0.01	0.000%	0.00	0.00	0.06	0.000%	0.00	0.00
NOM1	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
NON1	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
NOS0	0.01	0.000%	0.00	0.00	0.06	0.000%	0.00	0.00
PL00	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
PT00	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
RO00	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
RS00	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
SE00	0.00	0.000%	0.00	0.00	0.02	0.000%	0.00	0.00
SE01	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
SE02	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
SE03	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
SE04	0.00	0.000%	0.00	0.00	0.02	0.000%	0.00	0.00
SI00	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
SK00	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00
TR00	6.04	0.002%	0.00	39.25	1.62	0.000%	0.00	7.85
UA01	0.00	0.000%	0.00	0.00	0.01	0.000%	0.00	0.00
UK00	0.43	0.000%	0.00	3.06	0.12	0.000%	0.00	0.00
UKNI	0.00	0.000%	0.00	0.00	0.00	0.000%	0.00	0.00

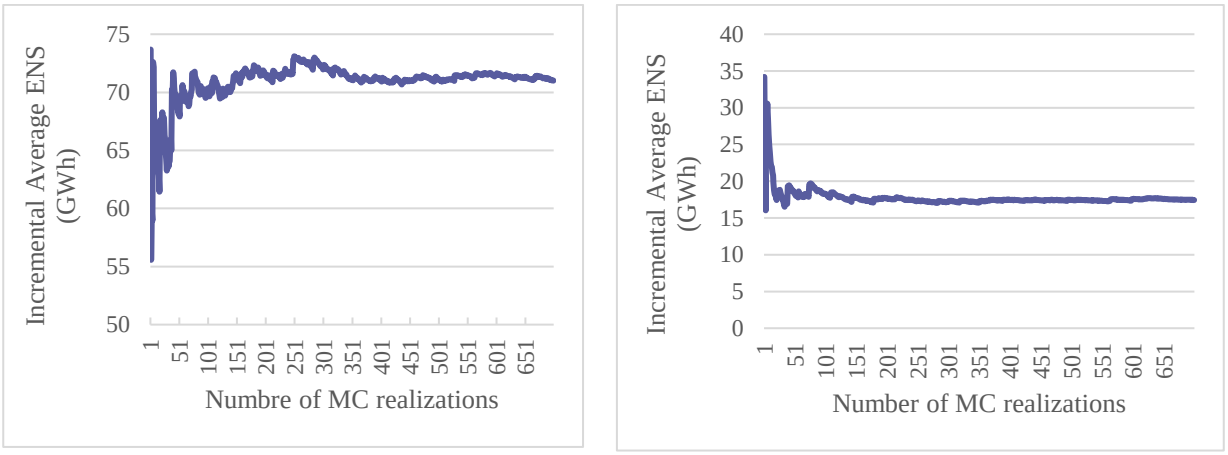


Figure 1: Incremental average ENS with increasing number of MC samples – National Estimates TY 2025 & TY 2030

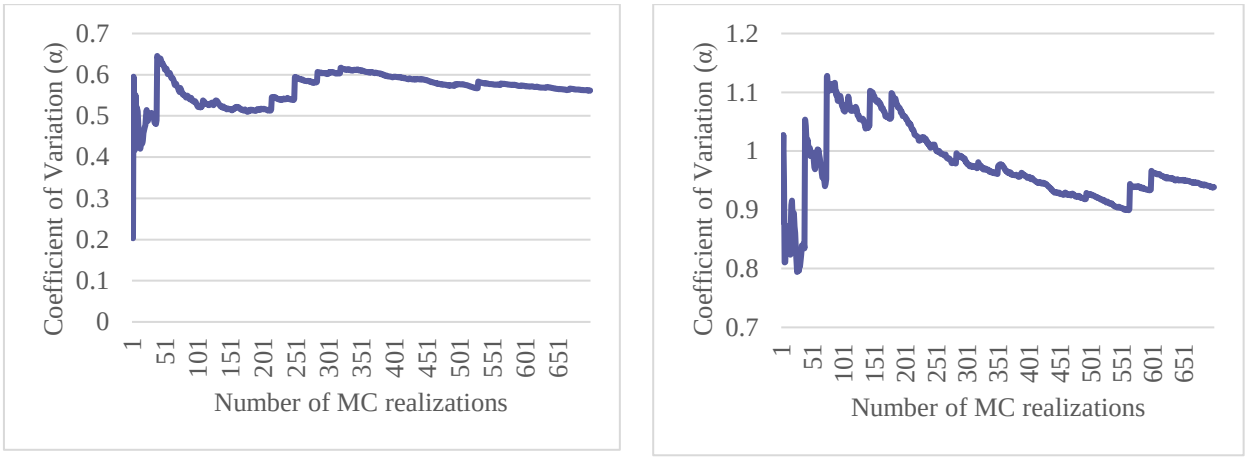


Figure 2: Coefficient of variation ($\alpha = \sigma_n / \mu_n$) with increasing number of MC samples – National Estimates TY 2025 & TY 2030

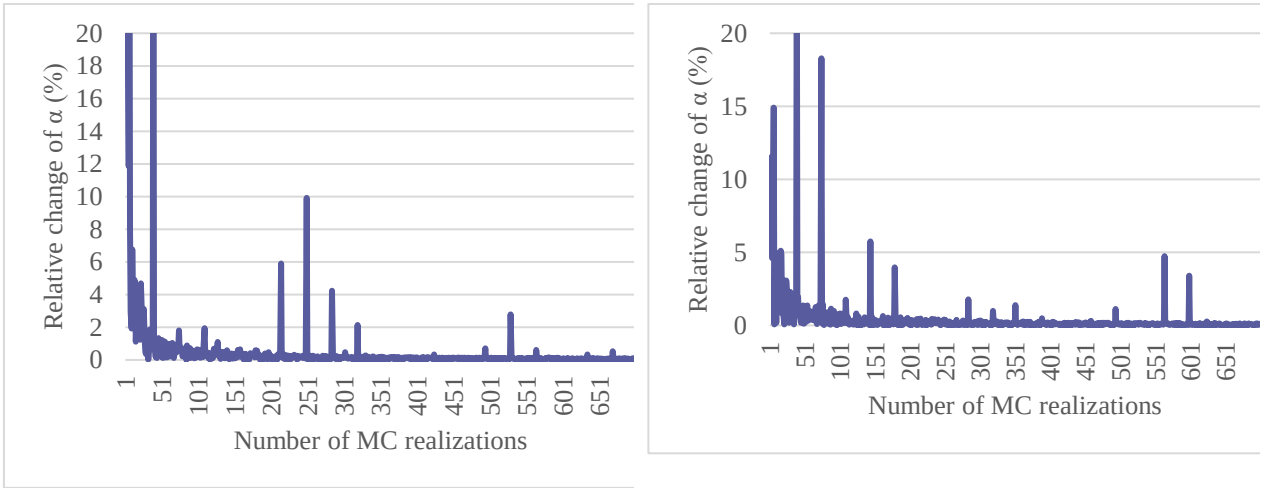


Figure 3: Relative change of the coefficient of variation ($|\alpha_n - \alpha_{n-1}| / \alpha_{n-1}$) with increasing number of MC samples – National Estimates TY 2025 & TY 2030

3 Scenario EVA without CM

3.1.1 EVA results

The EVA step showed occasional large capacity changes depending on the country. Lignite and coal technologies appear more likely to be decommissioned than gas, mostly because of increasing CO_2 prices. Figure 4 illustrates the capacity change per bidding zones, including information about the technology. Positive values indicate unit commissioning units whereas negative values indicate unit decommissioning. Only bidding zones with the largest amount of capacity change are represented, excluding Turkey. In Spain, there is a high overcapacity of gas, leading to the economic decommissioning of more than 14 GW of gas, while large amounts of lignite and coal are decommissioned for Germany (DE00), Poland (PL00), Czech Republic (CZ00), Great Britain (UK00), and the Netherlands (NL00).

The total economic decommissioning of 75 GW (60 GW if excluding Turkey) is higher than the total economic commissioning of 13 GW (3 GW if excluding Turkey). Turkey is assessed during the EVA as being fully modelled in the ERAA. However, it shows a considerable capacity change whose analysis may be out of the scope of this study. For that reason, Turkey is not presented in the following figures. Figure 5 illustrates the total capacity change per technology. Economic commissioning of capacity is evenly split between demand side response (DSR) and gas overall.

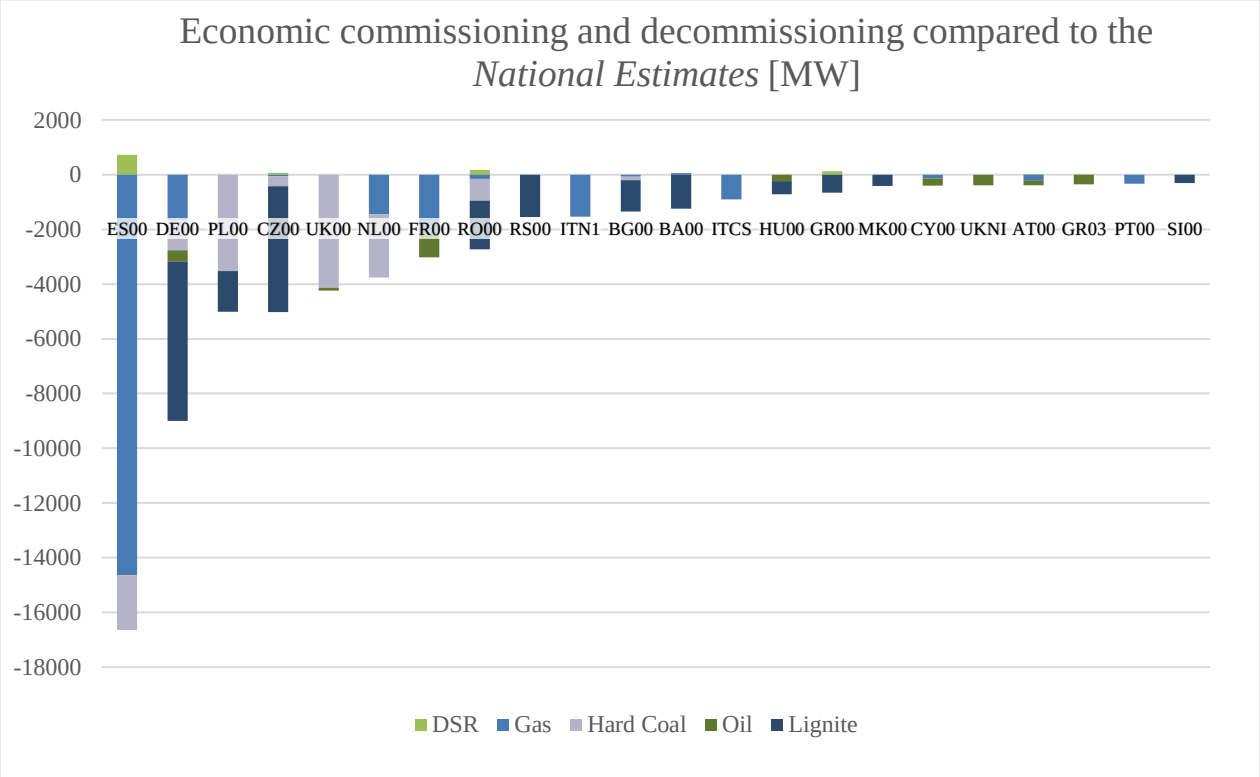


Figure 4: Capacity change [MW] in the scenario EVA without CM compared to the National Estimates scenario, by bidding zone for TY 2025

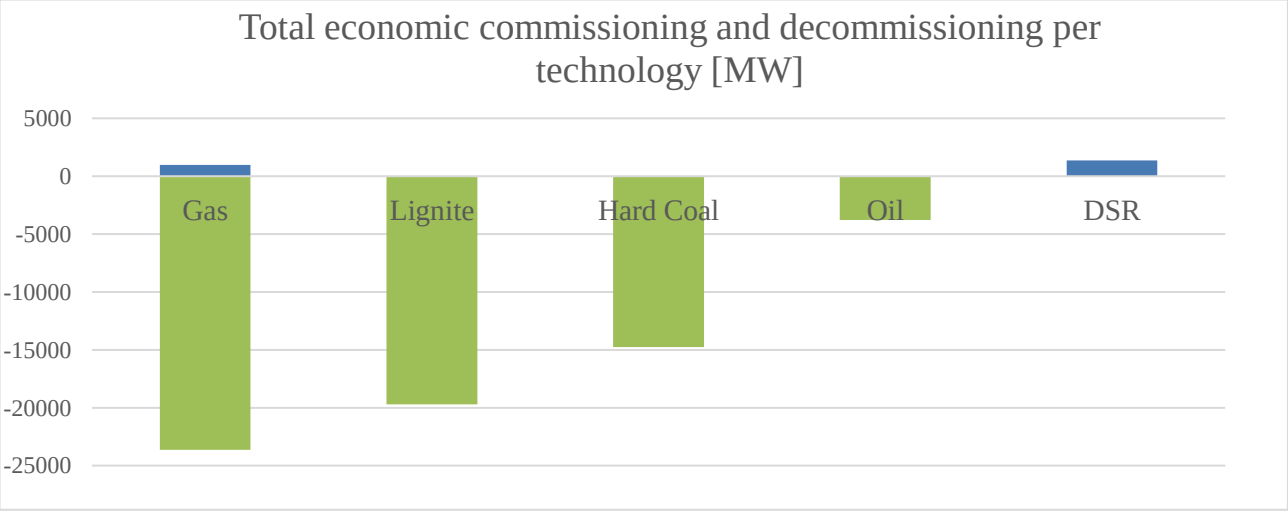


Figure 5: Capacity change [MW] in the scenario EVA without CM compared to the National Estimates scenario, by technology for TY 2025 (excl. Turkey)

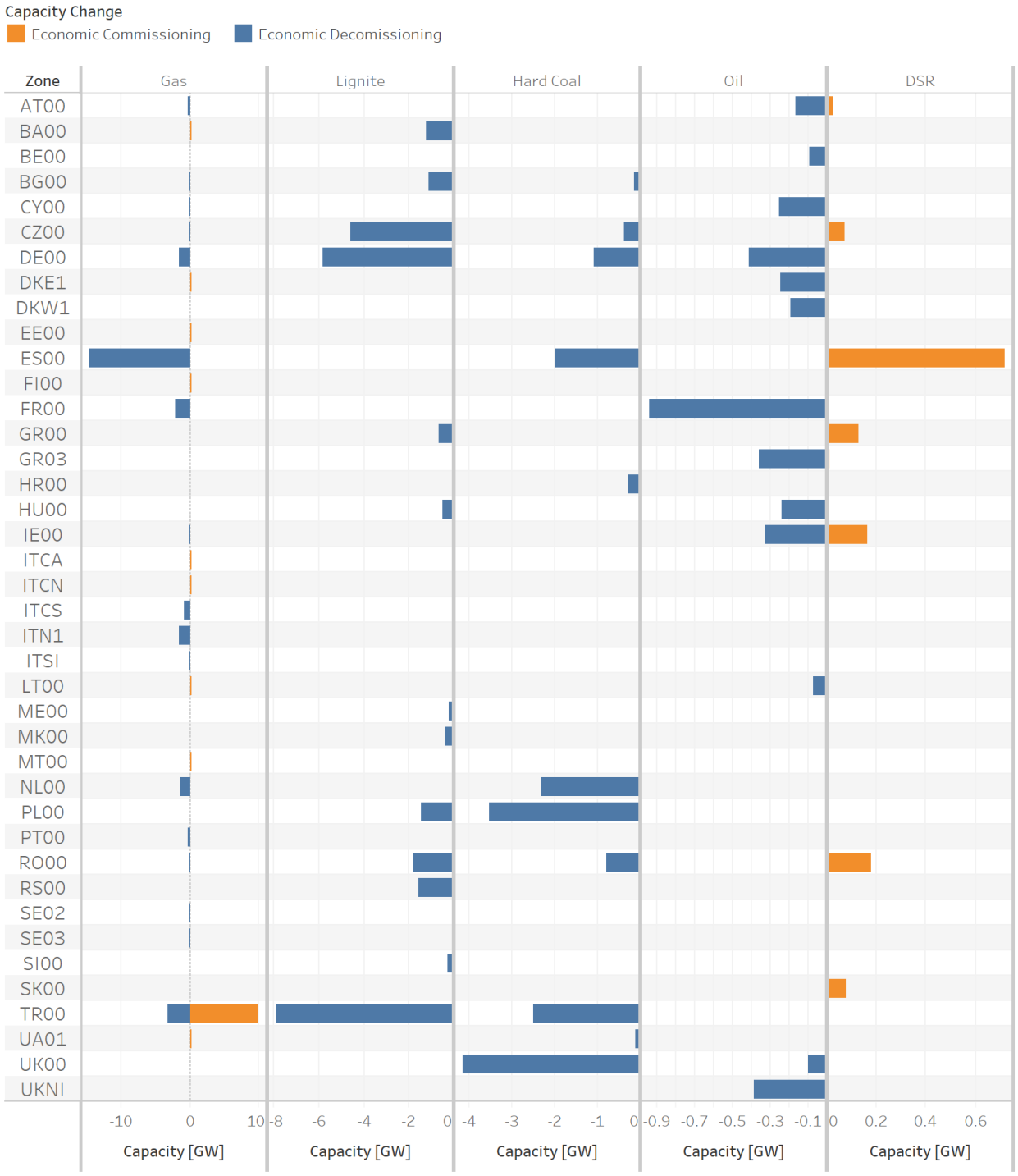


Figure 6: Capacity change [MW] compared to the National Estimates scenario in the scenario without CM, by bidding zone and technology for TY 2025

The capacity change by bidding zone represented in Figure 6 should be interpreted considering the high regional interdependency: for instance, any capacity added or removed in one country can greatly influence its neighbours. An important range of uncertainty will intrinsically remain, even as our models grow increasingly robust and are applied more widely. Thus, bidding zones results are not a prediction but are indicative, and capacity changes should be seen on a regional level.

Table 3: Capacity change [MW] compared to the National Estimates scenarios in the scenario without CM, by bidding zone and technology for TY 2025

Bidding Zones	Economic Decommissioning					Economic Commissioning		
	Gas	Coal	Oil	Lignite	*Total*	DSR	Gas	*Total*
AT00	222	0	164	0	386	23	0	23
BA00	0	0	0	1243	1243	0	58	58
BE00[3]	0	0	90	0	90	0	0	0
BG00	70	135	0	1145	1350	0	0	0
CY00	145	0	250	0	395	0	0	0
CZ00	57	368	0	4597	5021	72	0	72
DE00	1659	1100	410	5832	9000	0	0	0
DKE1	0	0	246	0	246	0	182	182
DKW1	0	0	191	0	191	0	0	0
EE00	0	0	0	0	0	0	114	114
ES00	14643	1998	0	0	16641	719	0	719
FI00	0	0	0	0	0	0	190	190
FR00	2087	0	939	0	3026	0	0	0
GR00	0	0	0	660	660	129	0	129
GR03	0	0	358	0	358	8	0	8
HR00	0	290	0	0	290	0	0	0
HU00	0	0	240	479	719	0	0	0
IE00	90	0	324	0	414	165	0	165
ITCA	0	0	0	0	0	0	15	15
ITCN	0	0	0	0	0	0	108	108
ITCS	900	0	0	0	900	0	0	0
ITN1	1541	0	0	0	1541	0	0	0
ITSI	106	0	0	0	106	0	0	0
LT00	0	0	75	0	75	0	155	155
ME00	0	0	0	225	225	0	0	0
MK00	0	0	0	410	410	0	0	0
MT00	0	0	0	0	0	0	36	36
NL00	1443	2311	0	0	3754	0	0	0
PL00	0	3530	0	1479	5009	0	0	0
PT00	330	0	0	0	330	0	0	0
RO00	155	793	0	1785	2734	176	0	176
RS00	0	0	0	1546	1546	0	0	0
SE02	54	0	0	0	54	0	0	0
SE03	141	0	0	0	141	0	0	0
SI00	0	0	0	305	305	0	0	0

[3] For Belgium, a significant amount of new-built gas (2.4 GW in TY 2025) is assumed as 'existing' in 2025 whereas its commissioning date is assumed as Dec 2024. CAPEX is thus not accounted for in the EVA for this capacity according to the current methodology. The consideration of CAPEX will imply that these new-built capacities will not be profitable (see 'section 1.5.2 Qualitative assessment for National Estimates TY 2025' below for further details and Belgium country comments.)

Bidding Zones	Economic Decommissioning					Economic Commissioning		
	Gas	Coal	Oil	Lignite	*Total*	DSR	Gas	*Total*
SK00	0	0	0	0	0	78	0	78
TR00	3277	2482	0	7898	13657	0	10000	10000
UA01	0	105	0	0	105	0	126	126
UK00	0	4139	102	0	4240	0	0	0
UKNI	0	0	389	0	389	0	0	0

3.1.2 Adequacy results

Table 4: LOLE (average LLD) and 50th and 95th LLD percentiles in the scenario without CM, for TY 2025

Zone	EVA without CM – TY 2025		
	Average [h/year]	P50 [h/year]	P95 [h/year]
AL00	0.01	0.00	0.00
AT00	0.00	0.00	0.00
BA00	0.50	0.00	2.00
BE00	4.15	0.00	20.05
BG00	0.00	0.00	0.00
CH00	0.00	0.00	0.00
CY00	61.79	55.00	129.05
CZ00	15.09	9.00	57.00
DE00	6.79	3.00	22.05
DEKF	0.00	0.00	0.00
DK00	4.65	2.00	18.05
DKE1	4.60	2.00	18.05
DKKF	0.00	0.00	0.00
DKW1	0.69	0.00	4.05
EE00	0.51	0.00	1.00
ES00	1.14	0.00	6.00
FI00	0.95	0.00	3.00
FR00	4.28	0.00	22.05
GR00	0.03	0.00	0.00
GR03	0.22	0.00	2.00
HR00	0.02	0.00	0.00
HU00	0.80	0.00	3.00
ISEM	4.31	2.00	17.00
IE00	4.19	2.00	17.00
IT00	129.45	114.50	238.05
ITCA	0.00	0.00	0.00
ITCN	1.38	0.00	7.00
ITCS	2.42	0.00	12.05
ITN1	0.26	0.00	2.00

Zone	EVA without CM – TY 2025		
	Average [h/year]	P50 [h/year]	P95 [h/year]
ITS1	0.17	0.00	1.00
ITSA[4]	122.43	110.00	226.05
ITSI	7.50	4.00	28.00
LT00[4]	4.28	0.00	23.05
LU00	6.79	3.00	22.05
LV00	0.06	0.00	0.00
ME00	0.03	0.00	0.00
MK00	0.08	0.00	0.00
MT00	355.36	342.50	541.10
NL00	2.27	0.00	12.00
NO00	0.01	0.00	0.00
NOM1	0.00	0.00	0.00
NON1	0.00	0.00	0.00
NOS0	0.01	0.00	0.00
PL00	4.10	1.00	18.00
PT00	0.00	0.00	0.00
RO00	0.24	0.00	2.00
RS00	0.34	0.00	1.00
SE00	0.12	0.00	0.00
SE01	0.00	0.00	0.00
SE02	0.00	0.00	0.00
SE03	0.00	0.00	0.00
SE04	0.11	0.00	0.00
SI00	0.00	0.00	0.00
SK00	0.10	0.00	0.00
TR00	17.07	7.00	78.05
UA01	1.40	0.00	6.00
UK00	5.31	3.00	19.00
UKNI	0.29	0.00	3.00

Table 5: EENS (average ENS) and 50th and 95th ENS percentiles in the scenario without CM, for TY 2025

Bidding zone	EVA without CM – TY 2025			
	Average [GWh]	EENS / Annual Demand	P50 [GWh]	P95 [GWh]
AL00	0.00	0.000%	0.00	0.00

[4] Note that the reference tool has not sufficiently converged for ITSA for which it would need a higher number of random draws. LOLE is observed to be higher for ITSA when consulting the results of other tools. An overview of the LOLE range and uncertainty can be found by consulting results from other tools in Annex 6.

Bidding zone	EVA without CM – TY 2025			
	Average [GWh]	EENS / Annual Demand	P50 [GWh]	P95 [GWh]
AT00	0.00	0.000%	0.00	0.00
BA00	0.18	0.001%	0.00	0.49
BE00	8.28	0.009%	0.00	47.85
BG00	0.00	0.000%	0.00	0.00
CH00	0.00	0.000%	0.00	0.00
CY00	3.75	0.063%	2.92	9.70
CZ00	15.38	0.019%	5.89	61.98
DE00	30.99	0.005%	9.25	128.92
DEKF	0.00	-	0.00	0.00
DK00	2.42	0.005%	0.23	13.29
DKE1	2.19	0.010%	0.22	11.51
DKKF	0.00	-	0.00	0.00
DKW1	0.24	0.001%	0.00	1.49
EE00	0.11	0.001%	0.00	0.10
ES00	1.99	0.001%	0.00	10.23
FI00	0.58	0.001%	0.00	1.18
FR00	21.15	0.005%	0.00	105.28
GR00	0.01	0.000%	0.00	0.00
GR03	0.05	0.001%	0.00	0.24
HR00	0.00	0.000%	0.00	0.00
HU00	0.77	0.001%	0.00	2.13
ISEM	1.24	0.003%	0.31	6.30
IE00	1.20	0.003%	0.29	6.09
IT00	27.37	0.008%	19.60	70.03
ITCA	0.00	0.000%	0.00	0.00
ITCN	1.40	0.004%	0.00	6.84
ITCS	1.61	0.003%	0.00	9.54
ITN1	0.15	0.000%	0.00	1.03
ITS1	0.04	0.000%	0.00	0.12
ITSA	21.87	0.179%	15.99	57.38
ITSI	2.31	0.009%	0.47	10.97
LT00	1.41	0.007%	0.00	9.06
LU00	0.34	0.004%	0.10	1.40
LV00	0.01	0.000%	0.00	0.00
ME00	0.00	0.000%	0.00	0.00
MK00	0.02	0.000%	0.00	0.00
MT00	18.81	0.602%	17.24	34.79
NL00	2.28	0.002%	0.00	12.61
NO00	0.03	0.000%	0.00	0.00

Bidding zone	EVA without CM – TY 2025			
	Average [GWh]	EENS / Annual Demand	P50 [GWh]	P95 [GWh]
NOM1	0.00	0.000%	0.00	0.00
NON1	0.00	0.000%	0.00	0.00
NOS0	0.03	0.000%	0.00	0.00
PL00	4.63	0.003%	0.05	24.51
PT00	0.00	0.000%	0.00	0.00
RO00	0.09	0.000%	0.00	0.27
RS00	0.18	0.000%	0.00	0.22
SE00	0.04	0.000%	0.00	0.00
SE01	0.00	0.000%	0.00	0.00
SE02	0.00	0.000%	0.00	0.00
SE03	0.00	0.000%	0.00	0.00
SE04	0.04	0.000%	0.00	0.00
SI00	0.00	0.000%	0.00	0.00
SK00	0.01	0.000%	0.00	0.00
TR00	27.47	0.008%	4.66	156.27
UA01	0.27	0.000%	0.00	0.95
UK00	15.87	0.006%	4.05	74.27
UKNI	0.03	0.000%	0.00	0.17

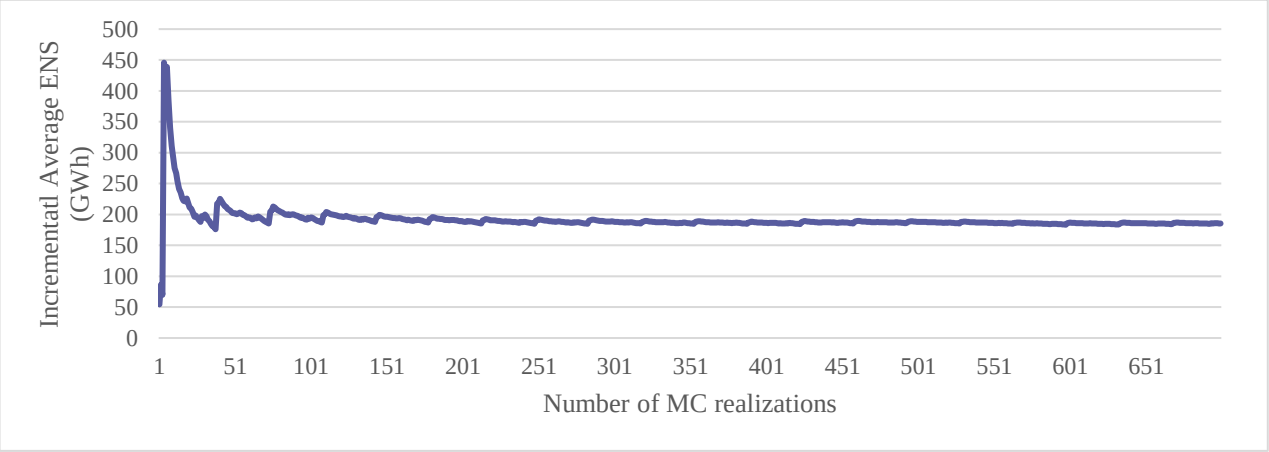


Figure 7: Incremental average ENS with increasing number of MC samples – EVA without CM TY 2025

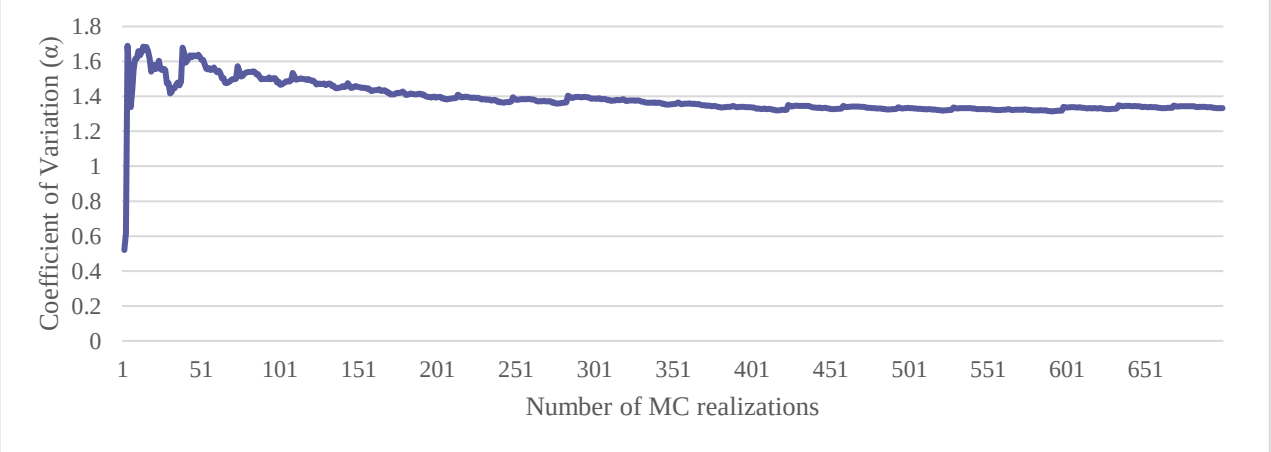


Figure 8: Coefficient of variation ($\alpha = \sigma_n / \mu_n$) with increasing number of MC samples – **EVA without CM** TY 2025

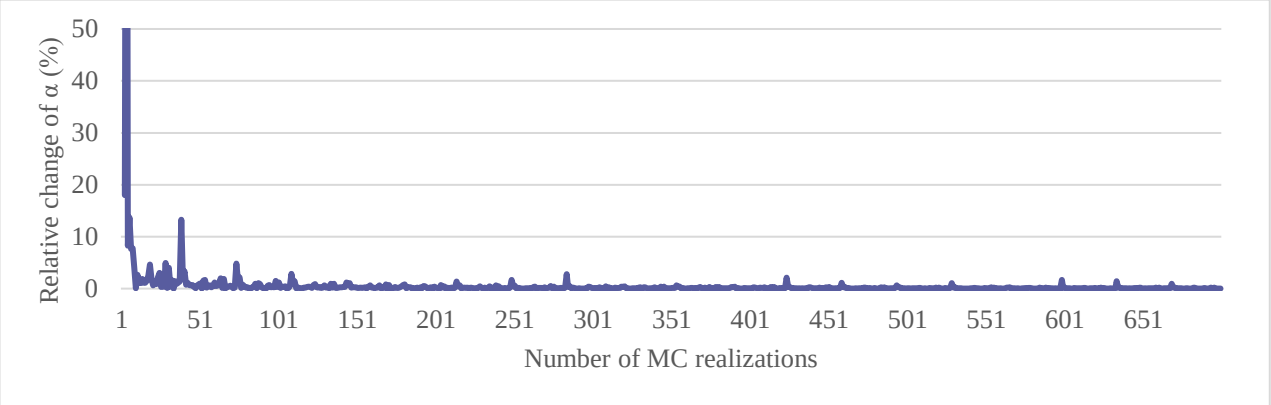
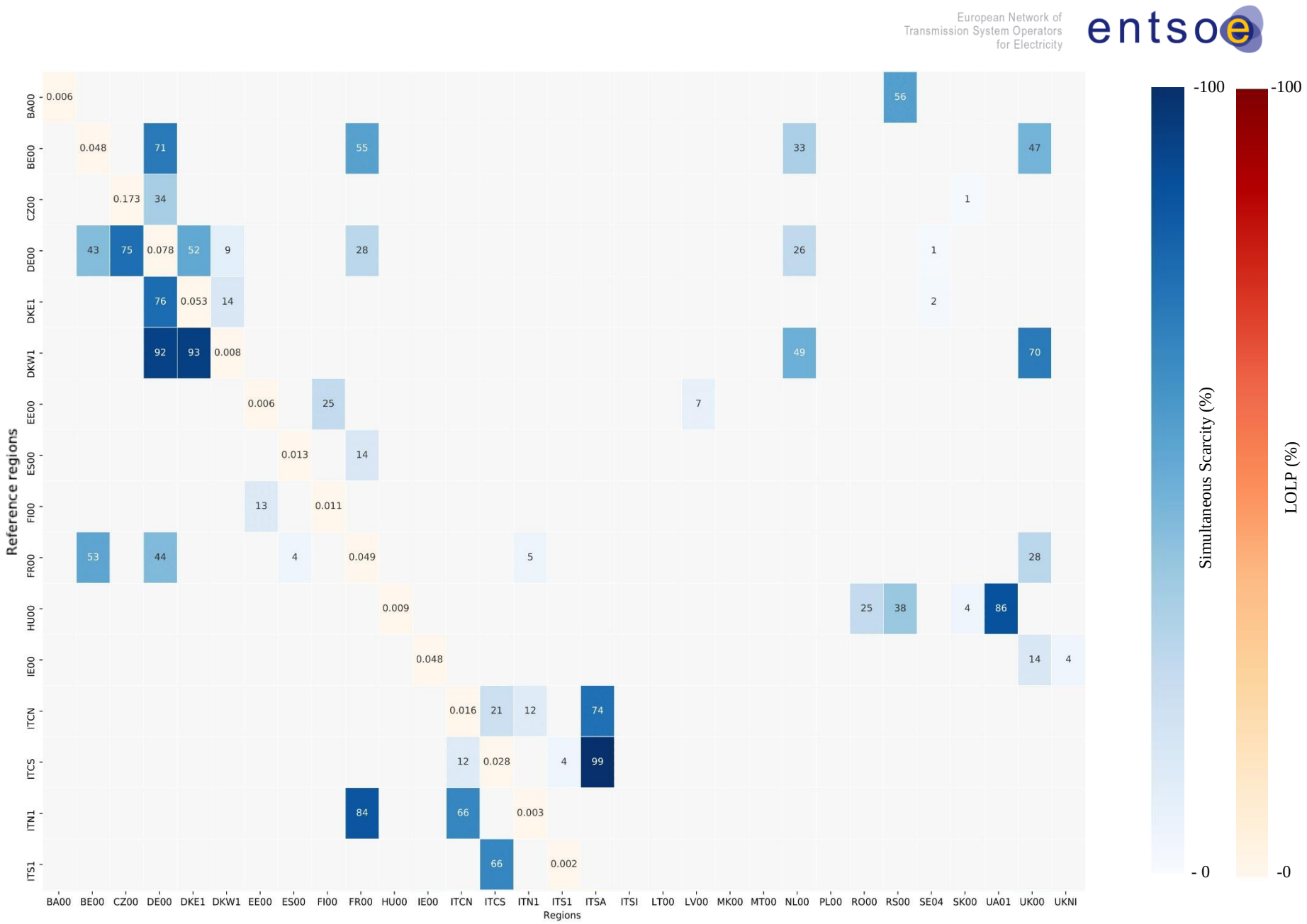


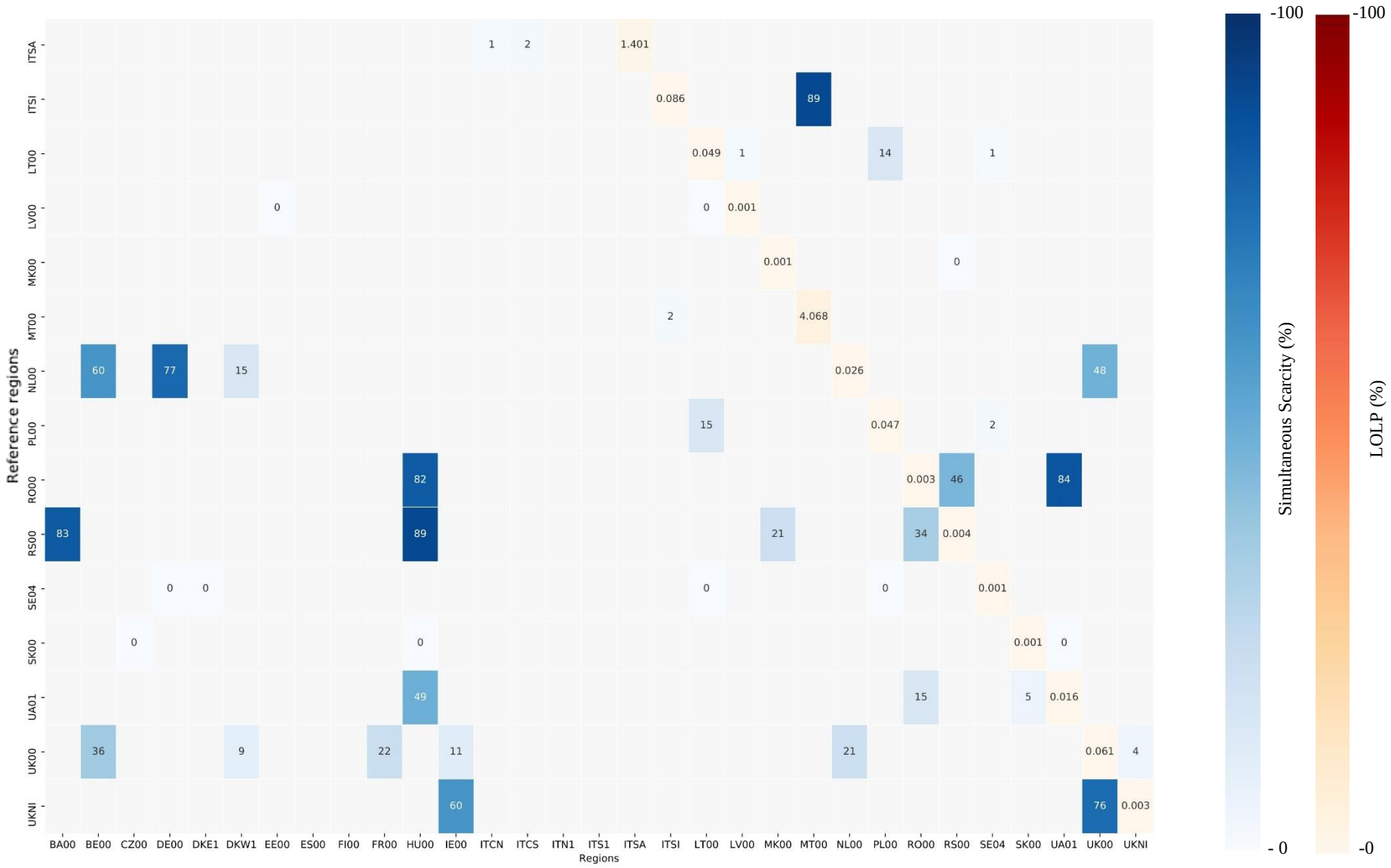
Figure 9: Relative change of the coefficient of variation ($|\alpha_n - \alpha_{n-1}| / \alpha_{n-1}$) with increasing number of MC samples – EVA without CM TY 2025

3.1.2.1 Analysis of simultaneous ENS events

Figure below[5] displays an overview of the frequency of simultaneous scarcity between reference regions and their respective neighbouring regions. The Y-axis displays the reference regions which are being analysed in relation to their neighbouring regions, represented in the X-axis. Reference regions that are not in simultaneous scarcity with neighbouring regions are not displayed in the Figure. The rows in the matrix present two indices, which are the LOLP in % (see definition) and the simultaneous scarcity %. The simultaneous scarcity ratio (blue colour) in the figure is the percentage of hours of the total amount of scarcity hours for region Y in the situation that X is in scarcity. As for the LOLP %, it represents the probability of loss of load for the reference region. As an example, DE00 has a 0.078% LOLP, and in 75% and 52% of the scarcity situations in DE00 there is scarcity in CZ00 and DKE1 respectively.

[5] Note that the curtailment sharing principle has not been implemented in this study. Implementing curtailment sharing will alter the simultaneous scarcity results.


European Network of
Transmission System Operators
for Electricity
entsoe
Reference regions
BA00
BE00
CZ00
DE00
DKE1
DKW1
EE00
ES00
FI00
FR00
HU00
IE00
ITCN
ITCS
ITN1
ITS1
0.006 56
0.048 71 55 33 47
0.173 34 1
43 75 0.078 52 9 28 26 1
76 0.053 14 2
92 93 0.008 49 70
0.006 25 7
0.013 14
13 0.011
53 44 4 0.049 5 28
0.009 25 38 4 86
0.048 14 4
0.016 21 12 74
12 0.028 4 99
84 66 0.003
66 0.002
BA00 BE00 CZ00 DE00 DKE1 DKW1 EE00 ES00 FI00 FR00 HU00 IE00 ITCN ITCS ITN1 ITS1 ITSA ITSI LT00 LV00 MK00 MT00 NL00 PL00 RO00 RS00 SE04 SK00 UA01 UK00 UKNI
Regions
-100
- 0
Simultaneous Scarcity (%)
-100
-0
LOLP (%)


Reference regions
ITSA
ITSI
LT00
LV00
MK00
MT00
NL00
PL00
RO00
RS00
SE04
SK00
UA01
UK00
UKNI
1
2
1.401
0.086
89
0.049
1
14
1
0
0
0.001
0.001
0
2
4.068
60
77
15
0.026
48
15
0.047
2
82
0.003
46
84
83
89
21
34
0.004
0
0
0
0
0.001
0
0
0.001
0
49
15
5
0.016
36
9
22
11
21
0.061
4
60
76
0.003
BA00
BE00
CZ00
DE00
DKE1
DKW1
EE00
ES00
FI00
FR00
HU00
IE00
ITCN
ITCS
ITN1
ITS1
ITSA
ITSI
LT00
LV00
MK00
MT00
NL00
PL00
RO00
RS00
SE04
SK00
UA01
UK00
UKNI
Regions
-100
- 0
Simultaneous Scarcity (%)
-100
-0
LOLP (%)

3.1.2.2 Analysis of net position

The figures below display boxplots that demonstrate the exchange balances of regions while in (either single or simultaneous) scarcity events from the NTC simulations results. It is an hourly distribution of net positions; the Y-axis shows the net position of a region in MW, with negative values representing net imports and positive values representing net exports. The figures show that all regions are net importers during scarcity moments. It must be noted that net positions of the market zones connected to Luxembourg (FR00, BE00 and DE00) are postprocessed by subtracting the flow to/from interconnections with Luxembourg as these interconnections are considered as internal links of the joint zones BE00+LUB1, FR00+LUF1, DE00+LUG1.

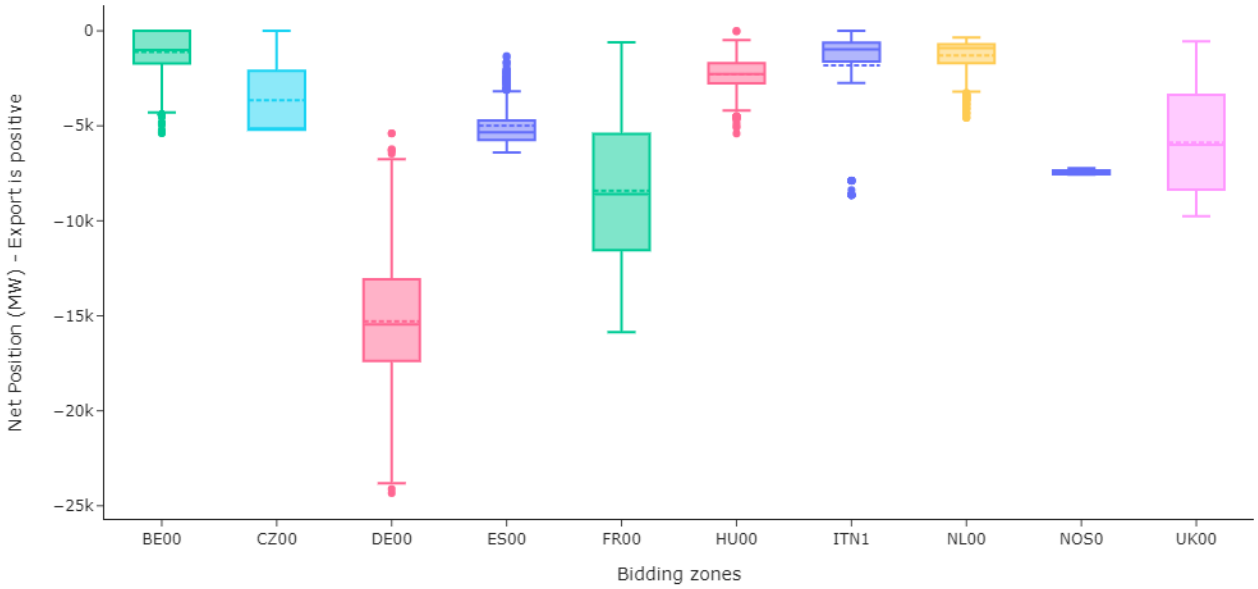


Figure 10: Net position of bidding zones during scarcity [graph 1 of 2]

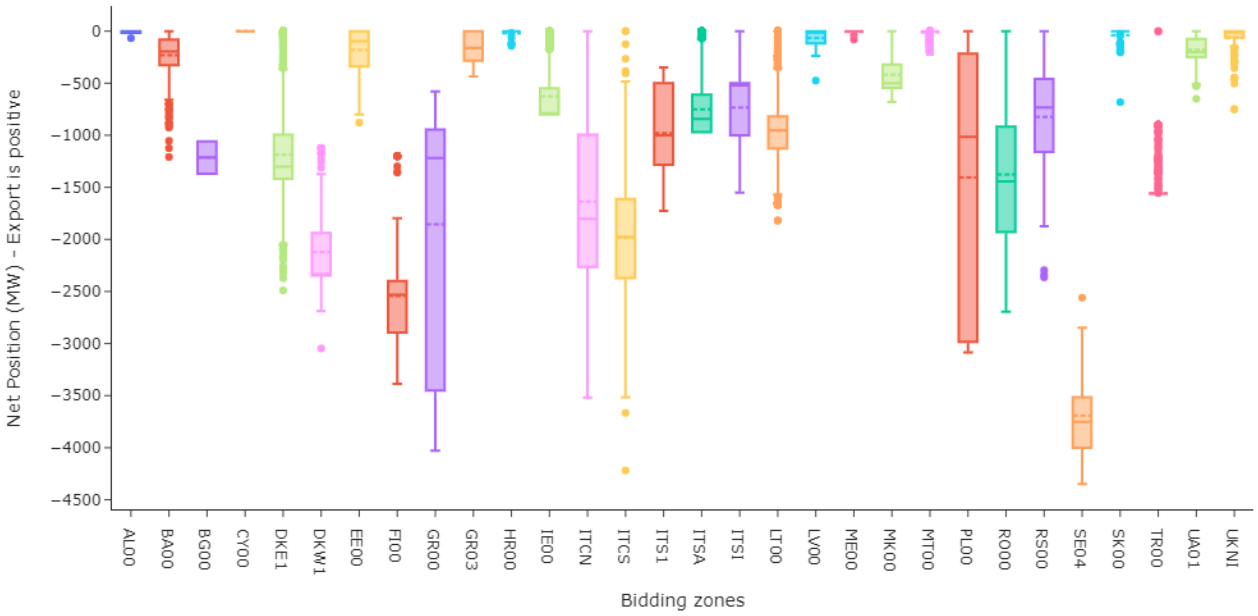


Figure 11: Net position of bidding zones during scarcity [graph 2 of 2]

4 Scenario EVA with CM

4.1 CM iterations

After the EVA, the reliability standard in several countries is not met. The need for additional capacity in the system is assessed during an iterative process of adding capacity, the principle of which is explained in Annex 3. A re-entry of a unit or a new unit in this scenario refers to a re-entry or additional capacity with respect to the generation mix of the scenario without CM. Part of the newly added capacity are re-entered units that were retired during the EVA. The other part is made up of new units that were not on the grid before the EVA. In total, 4.5 GW are added to the system, made up of 3 GW of re-entry and 1.5 GW of new entry. It is worth mentioning that out-of-market resources, such as capacity reserves, are still not included in the scenario with CM. The change in LOLE and the change in capacity are shown Table 6 and Figure 12.

The solution of this problem is not unique as adding new capacity in a bidding zone necessarily impacts not only this bidding zone but also its neighbours. Thus, these results should be consulted with care and understood on a regional scale. In this particular case, capacity has been increased (either re-entered or added compared to the scenario without CM) to Belgium, France, Italy and the UK, where we can see that most of these are close or below their reliability standard. As a result, Poland, the Netherlands, Germany and Denmark see a decrease in LOLE as well without any new capacity added, whereas Spain is not affected by the additional capacity of France. This iterative process of adding capacity to a bidding zone and observing the impact on others has its limitations, mostly imposed by computational effort and available simulation time. This limited number of iteration leaves some countries with LOLE still above their reliability standard, although they are closer to it compared to the scenario without CM. The latter is the case with Germany, Italy and Poland.

Table 6: Reliability standard and LOLE [h] for bidding zones that have an RS in LOLE - Scenarios with and without CM for TY 2025[6]

Member state or single price areas	Type of reliability standard	Value	LOLE [h/year]	
			Without CM	With CM
BE*	LOLE	3 h/year	4.2	2.8
BG	LOLE	16 h/year	0	0
DE	LOLE	5 h/year	6.8	5.3
ES	LOLE	3 h/year	1.1	1.1
FR*	LOLE	3 h/year	4.3	2.8
GR	LOLE	3 h/year	0	0
ISEM	LOLE	8 h/year	4.3	4
IT*	LOLE	3 h/year	129.4	3.8
LT	LOLE	8 h/year	4.3	4.9
NL	LOLE	4 h/year	2.3	1.6
PT	LOLE	5 h/year	0	0
PL	LOLE	3 h/year	4.1	3.5
UK (GB only) *	LOLE	3 h/year	5.3	1.2

[6] " * " *For the scenario with CM, capacity has been added in these zones – for changes in the capacities see Figure* Figure 12

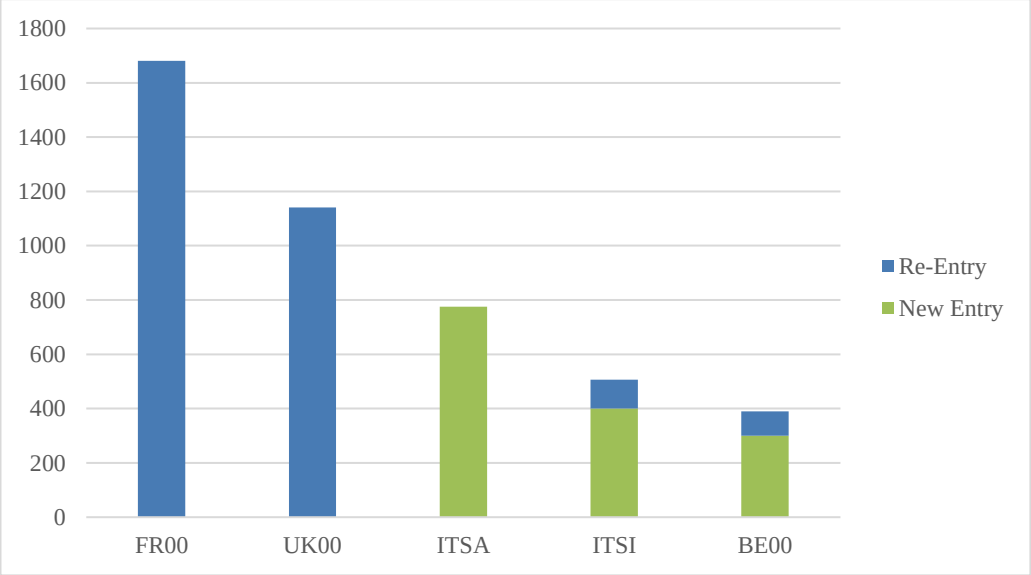


Figure 12: Capacity entry (new or re-entry) [MW] in the scenario with CM compared to the scenario without CM, by technology for TY 2025. For some countries, i.e. IT, DE and PL, the RS is still not met after adding the capacity presented – this implies that more capacity could have been given to these regions in order for the aforementioned countries to comply with their RS.

4.2 Adequacy Results

Table 7: LOLE (average LLD) and 50th and 95th LLD percentiles in the scenario with CM, for TY 2025

Bidding zone	EVA with CM - TY 2025		
	Average [h/year]	P50 [h/year]	P95 [h/year]
AL00	0.01	0.00	0.00
AT00	0.00	0.00	0.00
BA00	0.31	0.00	1.00
BE00	2.81	0.00	12.00
BG00	0.01	0.00	0.00
CH00	0.00	0.00	0.00
CY00	61.48	54.00	129.20
CZ00	13.23	7.00	50.05
DE00	5.33	2.00	19.00
DEKF	0.00	0.00	0.00
DK00	3.76	1.00	16.00
DKE1	3.73	1.00	16.00
DKKF	0.00	0.00	0.00
DKW1	0.53	0.00	3.00
EE00	0.55	0.00	2.00
ES00	1.08	0.00	5.05
FI00	0.89	0.00	8.00

Bidding zone	EVA with CM - TY 2025		
	Average [h/year]	P50 [h/year]	P95 [h/year]
FR00	2.84	0.00	14.00
GR00	0.01	0.00	0.00
GR03	0.17	0.00	1.00
HR00	0.02	0.00	0.00
HU00	0.59	0.00	3.00
ISEM	4.00	2.00	15.00
IE00	3.94	2.00	15.00
IT00	3.80	1.00	17.00
ITCA	0.00	0.00	0.00
ITCN	0.88	0.00	5.00
ITCS	1.27	0.00	8.00
ITN1	0.20	0.00	2.00
ITS1	0.06	0.00	0.00
ITSA	1.62	0.00	10.00
ITSI	1.09	0.00	7.00
LT00	4.88	0.00	26.05
LU00	5.33	2.00	19.00
LV00	0.07	0.00	0.00
ME00	0.01	0.00	0.00
MK00	0.06	0.00	0.00
MT00	340.48	323.50	536.15
NL00	1.58	0.00	8.00
NO00	0.00	0.00	0.00
NOM1	0.00	0.00	0.00
NON1	0.00	0.00	0.00
NOS0	0.00	0.00	0.00
PL00	3.53	1.00	16.05
PT00	0.00	0.00	0.00
RO00	0.17	0.00	1.00
RS00	0.23	0.00	1.00
SE00	0.12	0.00	0.00
SE01	0.00	0.00	0.00
SE02	0.00	0.00	0.00
SE03	0.00	0.00	0.00
SE04	0.12	0.00	0.00
SI00	0.00	0.00	0.00
SK00	0.08	0.00	0.00
TR00	17.21	7.00	78.00

Bidding zone	EVA with CM - TY 2025		
	Average [h/year]	P50 [h/year]	P95 [h/year]
UA01	1.05	0.00	4.00
UK00	3.19	1.00	13.05
UKNI	0.20	0.00	2.00

Table 8: EENS (average ENS) and 50th and 95th ENS percentiles in the scenario with CM, for TY 2025

Bidding Zone	EVA with CM – TY 2025			
	Average [GWh]	EENS / Annual Demand [%]	P50 [GWh]	P95 [GWh]
AL00	0.00	0.000%	0.00	0.00
AT00	0.00	0.000%	0.00	0.00
BA00	0.10	0.001%	0.00	0.14
BE00	5.13	0.005%	0.00	23.88
BG00	0.00	0.000%	0.00	0.00
CH00	0.00	0.000%	0.00	0.00
CY00	3.73	0.063%	2.92	9.74
CZ00	12.91	0.016%	4.59	45.82
DE00	23.77	0.004%	4.87	108.38
DEKF	0.00	-	0.00	0.00
DK00	2.05	0.004%	0.08	11.08
DKE1	1.86	0.008%	0.08	10.45
DKKF	0.00	-	0.00	0.00
DKW1	0.18	0.001%	0.00	0.99
EE00	0.13	0.002%	0.00	0.19
ES00	1.95	0.001%	0.00	10.46
FI00	0.49	0.000%	0.00	2.01
FR00	12.72	0.003%	0.00	52.46
GR00	0.00	0.000%	0.00	0.00
GR03	0.03	0.001%	0.00	0.12
HR00	0.00	0.000%	0.00	0.00
HU00	0.57	0.001%	0.00	1.19
ISEM	1.17	0.003%	0.24	5.94
IE00	1.14	0.003%	0.24	5.94
IT00	2.35	0.001%	0.08	16.81
ITCA	0.00	0.000%	0.00	0.00
ITCN	0.92	0.003%	0.00	4.78
ITCS	0.79	0.001%	0.00	4.77
ITN1	0.13	0.000%	0.00	0.70

Bidding Zone	EVA with CM – TY 2025			
	Average [GWh]	EENS / Annual Demand [%]	P50 [GWh]	P95 [GWh]
ITS1	0.01	0.000%	0.00	0.00
ITSA	0.25	0.002%	0.00	1.60
ITSI	0.26	0.001%	0.00	1.29
LT00	1.74	0.009%	0.00	8.66
LU00	0.26	0.003%	0.05	1.17
LV00	0.01	0.000%	0.00	0.00
ME00	0.00	0.000%	0.00	0.00
MK00	0.01	0.000%	0.00	0.00
MT00	17.46	0.559%	15.93	33.22
NL00	1.60	0.001%	0.00	8.83
NO00	0.01	0.000%	0.00	0.00
NOM1	0.00	0.000%	0.00	0.00
NON1	0.00	0.000%	0.00	0.00
NOS0	0.01	0.000%	0.00	0.00
PL00	3.97	0.002%	0.05	23.07
PT00	0.00	0.000%	0.00	0.00
RO00	0.08	0.000%	0.00	0.13
RS00	0.12	0.000%	0.00	0.17
SE00	0.05	0.000%	0.00	0.00
SE01	0.00	0.000%	0.00	0.00
SE02	0.00	0.000%	0.00	0.00
SE03	0.00	0.000%	0.00	0.00
SE04	0.05	0.000%	0.00	0.00
SI00	0.00	0.000%	0.00	0.00
SK00	0.01	0.000%	0.00	0.00
TR00	27.39	0.007%	4.04	148.50
UA01	0.20	0.000%	0.00	0.86
UK00	9.50	0.003%	0.51	48.22
UKNI	0.02	0.000%	0.00	0.09

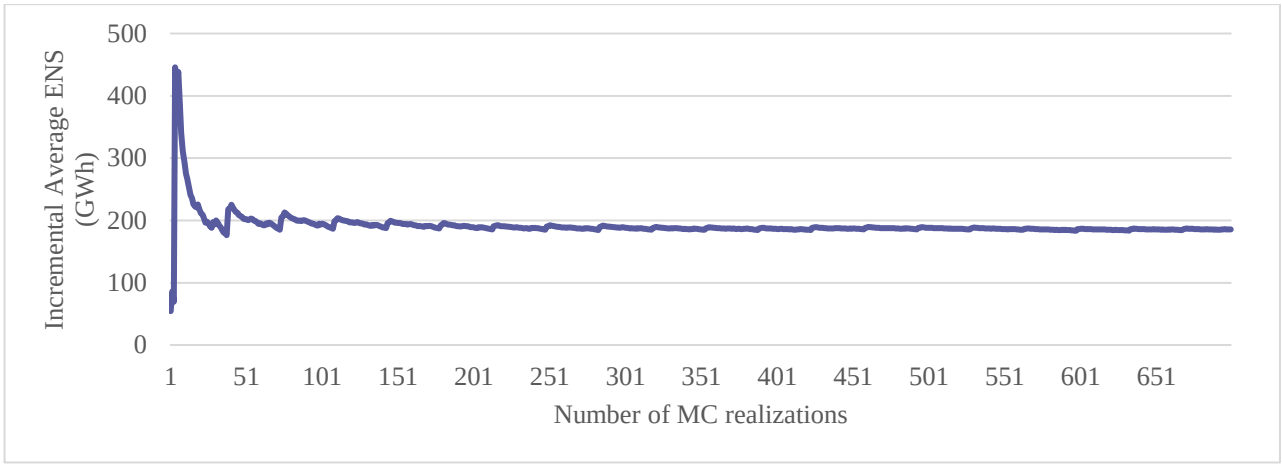


Figure 12: Incremental average ENS with increasing number of MC samples – EVA with CM TY 2025

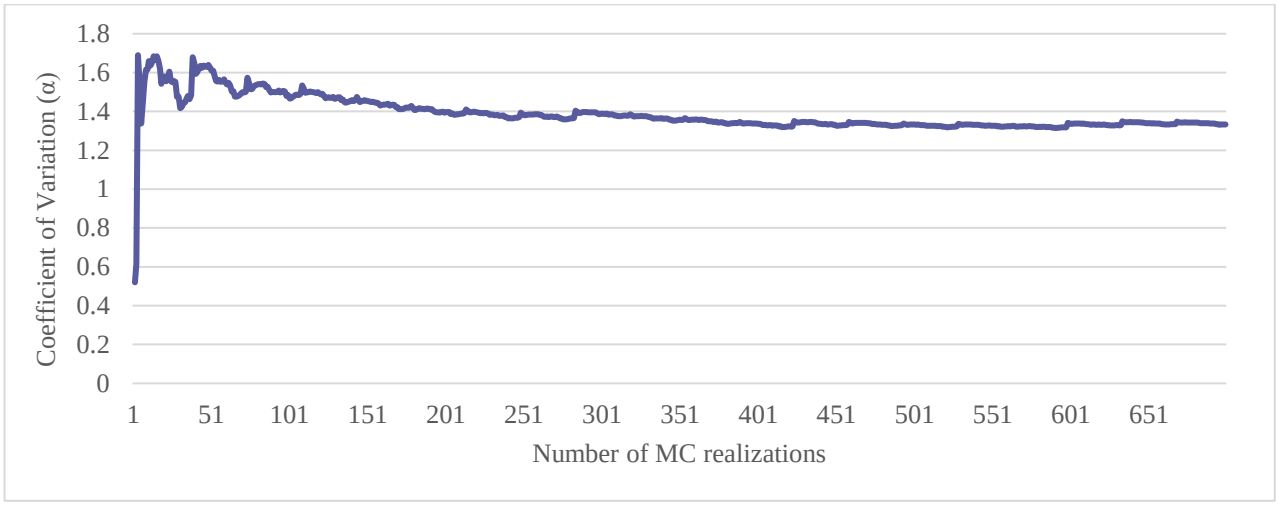


Figure 13: Coefficient of variation ($\alpha = \sigma_n / \mu_n$) with increasing number of MC samples – **EVA with CM** TY 2025

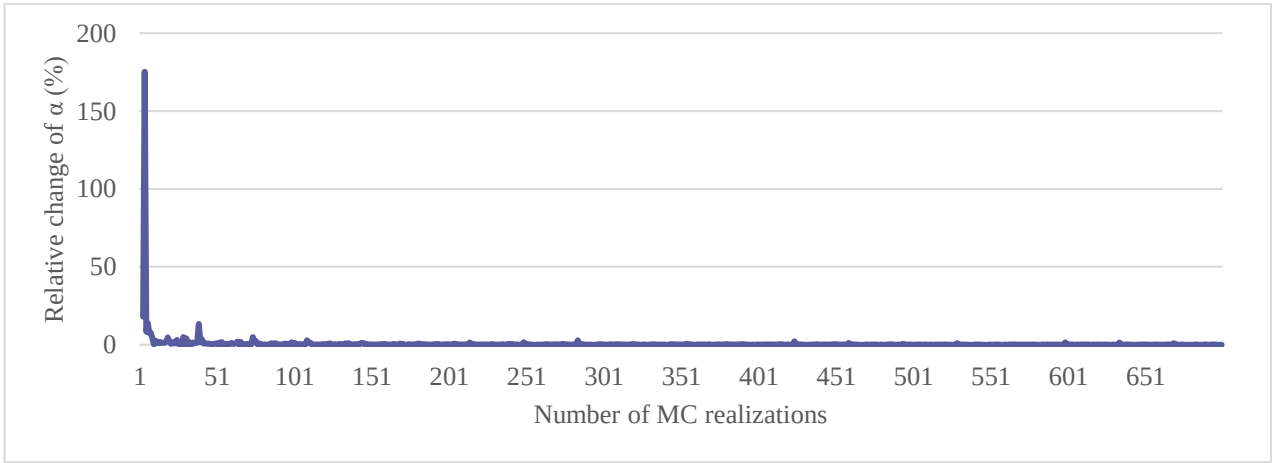


Figure 14: Relative change of the coefficient of variation ($|\alpha_n - \alpha_{n-1}| / \alpha_{n-1}$) with increasing number of MC samples – EVA with CM TY 2025

5 Scenario National Estimates with low thermal capacity

Table 9: LOLE (average LLD) and 50th and 95th LLD percentiles in the National Estimates with low thermal capacity scenarios for TYs 2025 and 2030

Bidding Zone	National Estimates with low thermal capacity – TY 2025			National Estimates with low thermal capacity – TY 2030		
	Average [h/year]	P50 [h/year]	P95 [h/year]	Average [h/year]	P50 [h/year]	P95 [h/year]
AL00	0.00	0.00	0.00	0.00	0.00	0.00
AT00	0.00	0.00	0.00	0.00	0.00	0.00
BA00	0.00	0.00	0.00	0.00	0.00	0.00
BE00	0.60	0.00	4.00	1.01	0.00	6.00
BG00	0.00	0.00	0.00	0.00	0.00	0.00
CH00	0.00	0.00	0.00	0.00	0.00	0.00
CY00	0.09	0.00	0.00	0.06	0.00	0.00
CZ00	0.00	0.00	0.00	0.25	0.00	1.00
DE00	0.61	0.00	5.00	3.26	0.00	16.05
DEKF	0.00	0.00	0.00	0.00	0.00	0.00
DK00	0.94	0.00	6.00	11.12	6.00	41.05
DKE1	0.93	0.00	6.00	11.05	6.00	41.05
DKKF	0.00	0.00	0.00	0.00	0.00	0.00
DKW1	0.04	0.00	0.00	1.53	0.00	12.00
EE00	0.98	0.00	4.05	1.17	0.00	9.00
ES00	0.00	0.00	0.00	0.00	0.00	0.00
FI00	1.71	0.00	11.05	0.64	0.00	3.00
FR00	3.50	0.00	21.00	0.74	0.00	3.00
GR00	0.01	0.00	0.00	0.00	0.00	0.00
GR03	0.01	0.00	0.00	0.00	0.00	0.00
HR00	0.00	0.00	0.00	0.00	0.00	0.00
HU00	0.00	0.00	0.00	0.51	0.00	3.00
ISEM	0.86	0.00	4.00	0.03	0.00	0.00
IE00	0.86	0.00	4.00	0.02	0.00	0.00
IT00	126.46	112.00	234.05	0.17	0.00	0.00
ITCA	0.00	0.00	0.00	0.00	0.00	0.00
ITCN	0.55	0.00	4.00	0.08	0.00	0.00
ITCS	1.29	0.00	8.00	0.00	0.00	0.00
ITN1	0.04	0.00	0.00	0.12	0.00	0.00
ITS1	0.17	0.00	1.00	0.00	0.00	0.00
ITSA[4]	120.22	107.00	225.00	0.00	0.00	0.00

Bidding Zone	National Estimates with low thermal capacity – TY 2025			National Estimates with low thermal capacity – TY 2030		
	Average [h/year]	P50 [h/year]	P95 [h/year]	Average [h/year]	P50 [h/year]	P95 [h/year]
ITSI	6.96	3.00	27.05	0.00	0.00	0.00
LT00	6.30	0.00	35.00	27.98	20.00	87.05
LU00	0.61	0.00	5.00	3.26	0.00	16.05
LV00	0.10	0.00	0.00	0.14	0.00	0.00
ME00	0.00	0.00	0.00	0.00	0.00	0.00
MK00	0.00	0.00	0.00	0.00	0.00	0.00
MT00	562.13	545.00	791.10	203.60	191.50	371.05
NL00	0.00	0.00	0.00	1.66	0.00	9.00
NO00	0.01	0.00	0.00	0.03	0.00	0.00
NOM1	0.00	0.00	0.00	0.00	0.00	0.00
NON1	0.00	0.00	0.00	0.00	0.00	0.00
NOS0	0.01	0.00	0.00	0.03	0.00	0.00
PL00 [7]	10.34	8.00	30.00	3967.05	3955.50	4427.05
PT00	0.00	0.00	0.00	0.00	0.00	0.00
RO00	0.00	0.00	0.00	0.00	0.00	0.00
RS00	0.00	0.00	0.00	0.00	0.00	0.00
SE00	0.05	0.00	0.00	0.44	0.00	3.00
SE01	0.00	0.00	0.00	0.00	0.00	0.00
SE02	0.00	0.00	0.00	0.00	0.00	0.00
SE03	0.00	0.00	0.00	0.00	0.00	0.00
SE04	0.05	0.00	0.00	0.44	0.00	3.00
SI00	0.00	0.00	0.00	0.00	0.00	0.00
SK00	0.00	0.00	0.00	0.20	0.00	0.00
TR00	4.60	0.00	29.05	1.88	0.00	8.00
UA01	0.01	0.00	0.00	0.35	0.00	2.00
UK00	0.66	0.00	4.05	0.34	0.00	3.00
UKNI	0.00	0.00	0.00	0.01	0.00	0.00

[7] In the case of Poland, only hard coal / lignite units with already concluded contracts on the Capacity Market are considered in the National Estimates with Low Thermal Capacity scenario for the year 2025 and 2030. The remaining units, in this scenario, are early decommissioned as they cannot receive support from the Capacity Market in the present form, due to the 550 kg CO_2 emission limits coming into force from July 2025. More details can be found in Annex 5 – country comments.

Table 10: EENS (average ENS) and 50th and 95th ENS percentiles in the National Estimates with low thermal capacity scenarios for TYs 2025 and 2030

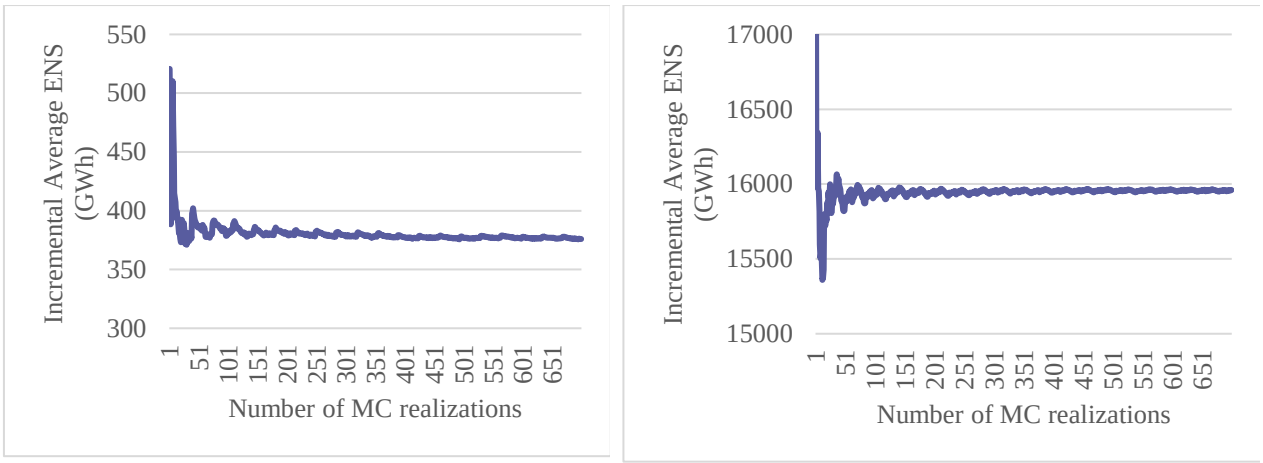


Figure 15: Incremental average ENS with increasing number of MC samples – National Estimates with low thermal capacity TY 2025 & TY 2030

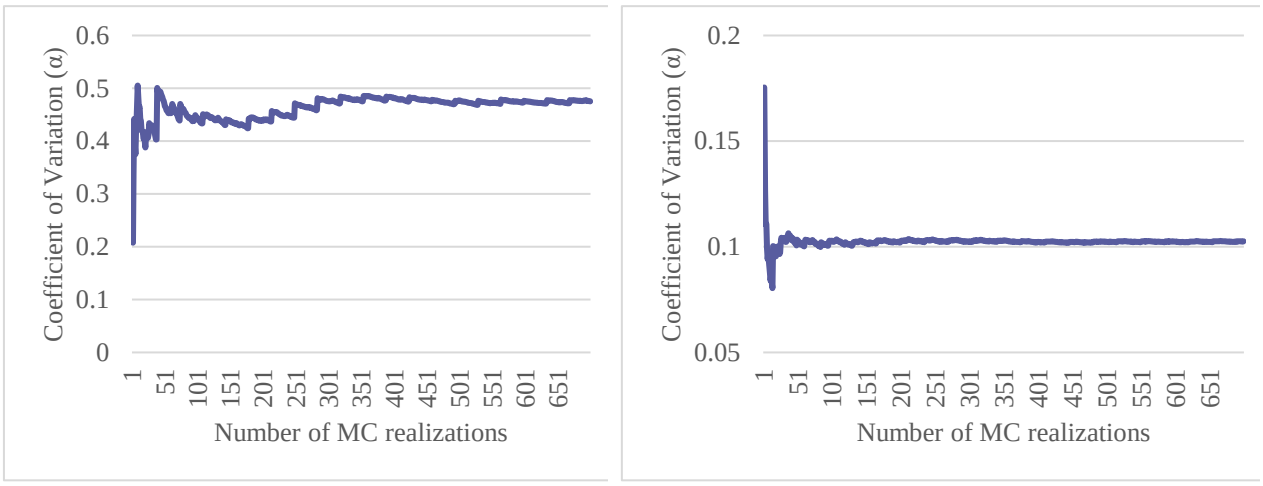


Figure 16: Coefficient of variation ($\alpha = \sigma_n / \mu_n$) with increasing number of MC samples – National Estimates with low thermal capacity TY 2025 & TY 2030

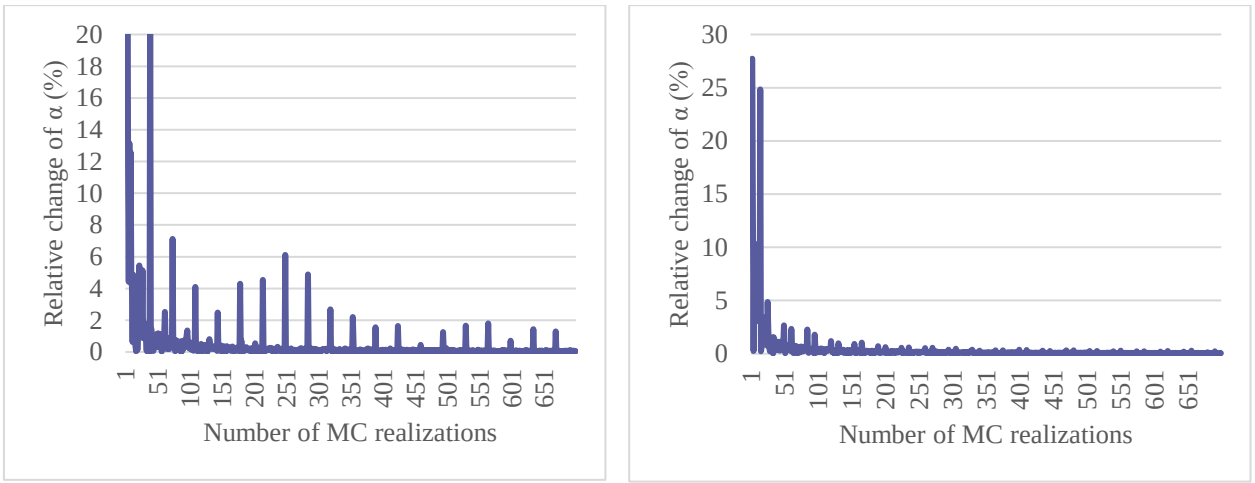


Figure 17: Relative change of the coefficient of variation ($|\alpha_n - \alpha_{n-1}| / \alpha_{n-1}$) with increasing number of MC samples – National Estimates with low thermal capacity TY 2025 & TY 2030

6 Revenues and Costs – a qualitative economic viability assessment of National Estimates Scenarios

The qualitative assessment is performed to assess the profitability of the technologies in the Bidding zone based on their net revenues compared to their fixed operations and maintenance (FOM) costs. Investment costs are considered a sunk cost and are therefore not included in the profitability assessment. The capacity mix change depending on the scenario has major impact on the results, from a scenario where most technologies are unprofitable to a scenario where most are.

The results are presented aggregated by fuel type. The net revenue and fixed cost for a fuel type in a bidding zone is the weighted average revenue and cost of all units based on this fuel that are on the market in this zone and mainly rely on EOM (units subject to the EVA). A lower net revenue than fixed cost in a category means that, on average, the units of this category are not profitable. However, some units of this group can be profitable, especially the most modern and efficient technologies. Conversely, a unit within a profitable category can be unprofitable, especially the oldest technologies.

We present the results of the qualitative assessment in the charts below. The green bar represents the total net revenue (including net revenue during ENS) in euros per kW of installed capacity by category. This is the price received by the units minus their marginal cost (i.e. their inframarginal rent). The blue bar represents the share of the net revenue earned during hours with unserved energy. This gives the part of the revenue directly impacted by the price cap. The grey bar represents the fixed cost of the category. A unit is profitable if its net revenue is greater than its fixed cost.

For the sake of clarity, a limited number of bidding zones are displayed in the charts. The full table for 2030 is given at the end of this sub-section. This qualitative assessment does not include all actual potential cost and revenue streams available to units. For example, neither start costs nor potential revenues from hedging (i.e. optionality value), the provision of reserves and other ancillary services are included in the assessment. Nevertheless, it gives insights about the evolution of the profitability depending on the scenario.

6.1.1 Qualitative assessment for National Estimates TY 2025

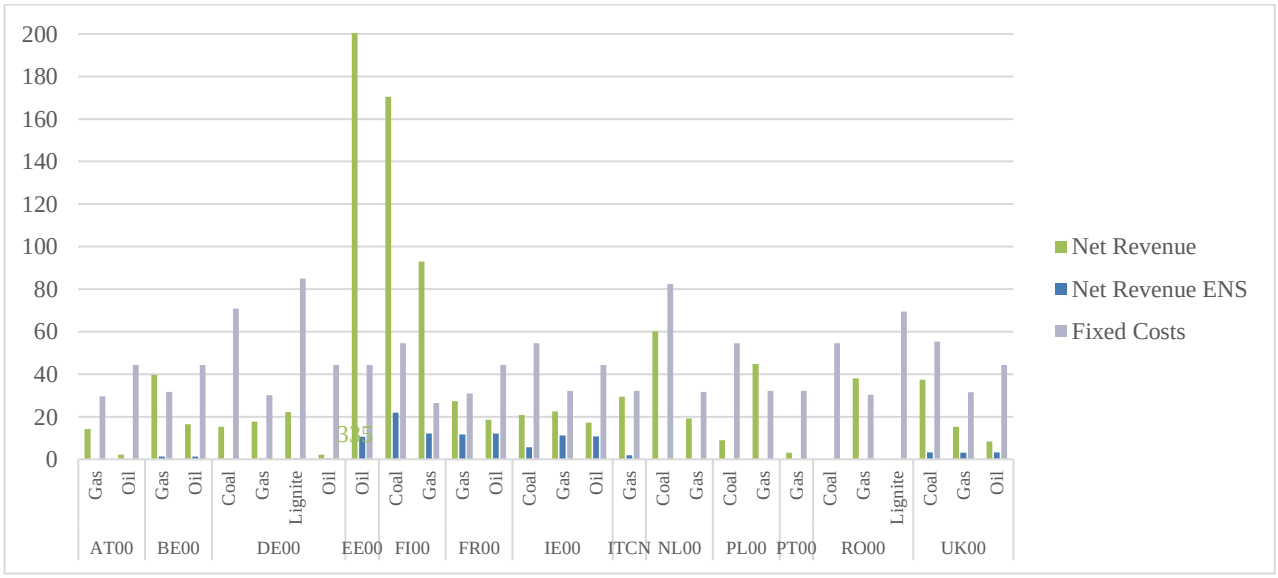


Figure 18: Revenues and costs [€/kW] by technology for reference bidding zones in the scenario National Estimates for TY 2025

The net revenues of most technologies for the National Estimates scenario for TY 2025 do not cover the fixed costs. Approximatively 75% of the assessed capacity is unprofitable. A few bidding zones have most of their assessed capacities profitable, such as Belgium[8], Finland[9], Estonia and Lithuania. Half of Polish and Romanian assessed capacities are profitable. Almost all remaining capacities are unprofitable. However, in the actual market, this does not mean that 75% of net generating capacity (NGC) should close, the reason being that closing a unit would likely boost profits for the remaining units in the market.

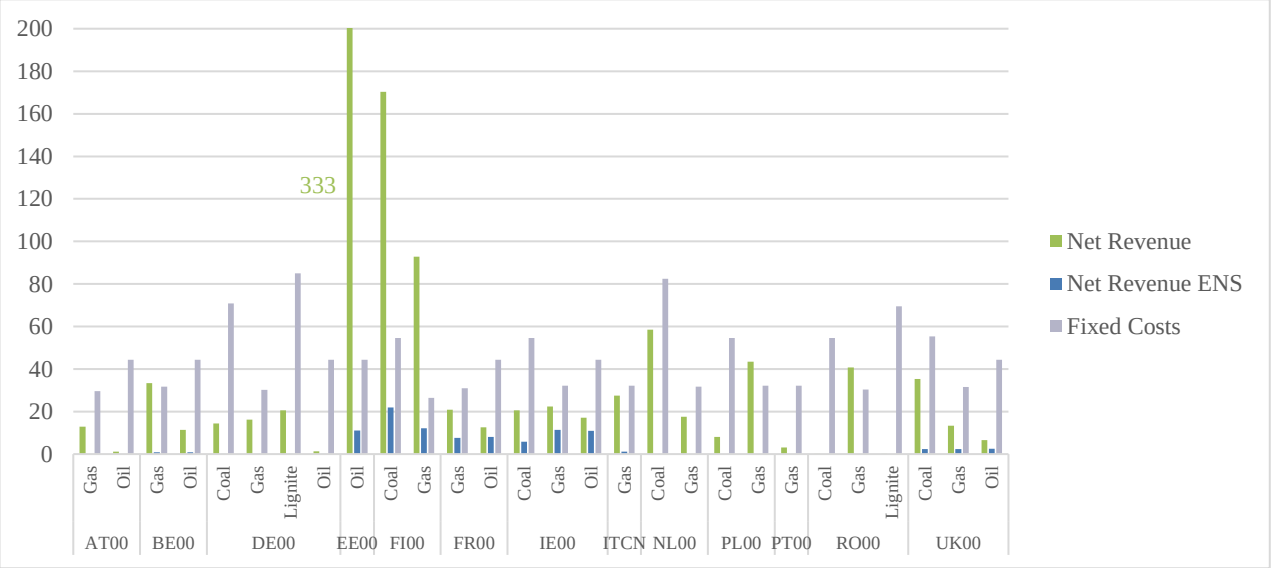


Figure 19: Revenues and costs [€/kW] by technology for reference bidding zones in the scenario National Estimates with low thermal capacity for TY 2025

The net revenues of most technologies for the National Estimates with low thermal scenario for TY 2025 do not cover the fixed costs. The results are very similar to the previous case.

[8] In Belgium a significant amount of new-built gas (2.4 GW) is included for which CAPEX is not accounted for. Consideration of CAPEX will imply that the assessed capacities are not profitable.

[9] In Finland and possibly nearby price areas, the revenues might be slightly inflated during tight hours due to the modelling methodology applied for Finnish fast disturbance reserves. For more information, please see Annex 5 (Finnish section in Country Comments).

6.1.2 Qualitative assessment for National Estimates TY 2030

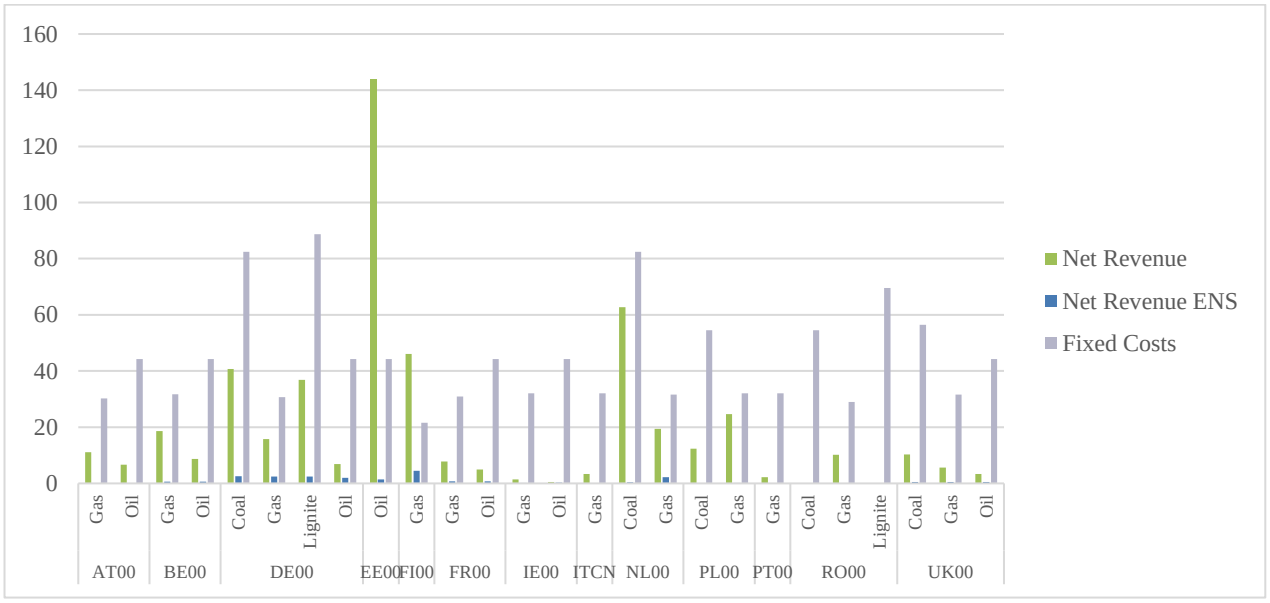


Figure 20: Revenues and costs [€/kW] by technology for reference bidding zones in the scenario National Estimates for TY 2030

In the National Estimates 2030 scenario, net revenues do not cover fixed costs for most technologies. In the event that all capacity in the scenario was to stay in the market, 75% of the total assessed NGC would be unprofitable. Profitable categories are mainly located in Finland[10], Latvia, Malta, Estonia and DKE1, where all assessed units are profitable. In the remaining countries, almost all assessed categories are unprofitable. For the same reason as for 2025, less than 75% should be retired to reach profitability for the remaining capacities. Thus, this chart suggests that there is an overcapacity in 2030, but it does not indicate the extent of it.

[10] In Finland and possibly nearby price areas, the revenues might be slightly inflated during tight hours due to the modelling methodology applied for Finnish fast disturbance reserves. For more information, please see Annex 5 (Finnish section in Country Comments).

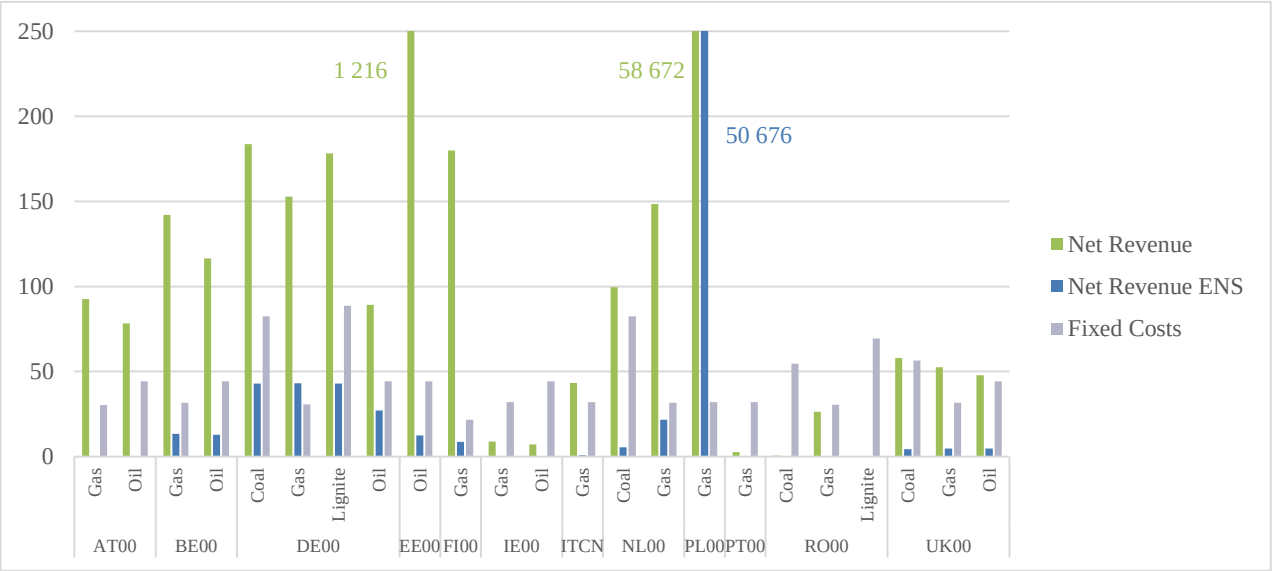


Figure 21: Revenues and costs [€/kW] by technology for reference bidding zones in the scenario National Estimates with low thermal capacity for TY 2030. EE00 and PL00 net revenue is not entirely shown in the chart to allow for better visualisation - EE00 oil net revenue is 1200 €/kW whereas PL00 gas net revenue is 58670 €/kW and its revenue during ENS is 50680 €/kW.

The net revenues of most technologies for the scenario National Estimates with low thermal capacity for 2030 do not cover the fixed costs. In Estonia (EE00) and Poland (PL), assessed technologies have very high net revenue compared to the fixed costs. Poland's unserved energy periods are mainly driving these high net revenues. In terms of capacity, 70% of the assessed capacity is profitable. Some units are decommissioned between the two scenarios presented above. France (FR00) does not appear on the chart because there is no capacity subject to the qualitative assessment in this scenario.

6.1.3 Detailed revenues and costs for National Estimates TY 2025

The full results for the qualitative assessment 2025 National Estimates are given in the Table 11.

Table 11: Revenues and costs [€/kW] by technology and Bidding zone in the National Estimates and National Estimates with low thermal capacity scenarios for TY 2025

Bidding zone	Technology	National Estimates – 2025			National Estimates with low thermal capacity – 2025		
		Net Revenue [€/kW]	Net Revenue ENS [€/kW]	Fixed Costs [€/kW]	Net Revenue [€/kW]	Net Revenue ENS [€/kW]	Fixed Costs [€/kW]
AL00	Gas	0	0	32	0	0	32
AT00	Gas	13	0	30	14	0	30
AT00	Oil	1	0	44	2	0	44
BA00	Lignite	9	0	75	9	0	75
BE00	Gas	33	1	32	40	1	32
BE00	Oil	11	1	44	17	1	44
BG00	Coal	0	0	55	0	0	55
BG00	Gas	11	0	24	10	0	24

Bidding zone	Technology	National Estimates – 2025			National Estimates with low thermal capacity – 2025		
		Net Revenue [€/kW]	Net Revenue ENS [€/kW]	Fixed Costs [€/kW]	Net Revenue [€/kW]	Net Revenue ENS [€/kW]	Fixed Costs [€/kW]
BG00	Lignite	7	0	70	6	0	70
CY00	Gas	2	1	32	2	1	32
CY00	Oil	1	1	44	1	1	44
CZ00	Coal	2	0	55	3	0	55
CZ00	Gas	22	0	32	23	0	32
CZ00	Lignite	11	0	73	12	0	73
DE00	Coal	14	0	71	15	0	71
DE00	Gas	16	0	30	18	0	30
DE00	Lignite	21	0	85	22	0	85
DE00	Oil	1	0	44	2	0	44
DKE1	Gas	12	4	32	13	5	32
DKE1	Oil	6	4	44	7	4	44
DKW1	Gas	2	0	22	3	0	22
DKW1	Oil	2	0	44	3	0	44
EE00	Oil	333	11	44	335	11	44
ES00	Coal	0	0	55	0	0	55
ES00	Gas	0	0	32	0	0	32
FI00	Coal	170	22	55	170	22	55
FI00	Gas	93	12	26	93	12	26
FR00	Gas	21	8	31	27	12	31
FR00	Oil	13	8	44	19	12	44
GR00	Gas	32	0	32	30	0	32
GR00	Lignite	1	0	95	N/A	N/A	N/A
GR03	Oil	0	0	44	0	0	44
HR00	Coal	21	0	82	20	0	82
HR00	Gas	29	0	32	28	0	32
HU00	Gas	21	0	31	21	0	31
HU00	Lignite	2	0	70	3	0	70
HU00	Oil	1	0	44	2	0	44
IE00	Coal	21	6	55	21	6	55
IE00	Gas	22	11	32	22	11	32
IE00	Oil	17	11	44	17	11	44
ITCN	Gas	27	1	32	29	2	32
ITCS	Gas	34	7	32	36	8	32
ITN1	Gas	11	0	31	13	0	31
LT00	Gas	230	58	32	234	58	32
LT00	Oil	251	91	44	255	92	44

Bidding zone	Technology	National Estimates – 2025			National Estimates with low thermal capacity – 2025		
		Net Revenue [€/kW]	Net Revenue ENS [€/kW]	Fixed Costs [€/kW]	Net Revenue [€/kW]	Net Revenue ENS [€/kW]	Fixed Costs [€/kW]
ME00	Lignite	22	0	82	21	0	82
NL00	Coal	59	0	82	60	0	82
NL00	Gas	18	0	32	19	0	32
PL00	Coal	8	0	55	9	0	55
PL00	Gas	44	0	32	45	0	32
PT00	Gas	3	0	32	3	0	32
RO00	Coal	0	0	55	0	0	55
RO00	Gas	41	0	30	38	0	30
RO00	Lignite	0	0	70	0	0	70
RS00	Gas	46	0	32	44	0	32
RS00	Lignite	20	0	80	18	0	80
SE02	Gas	0	0	22	0	0	22
SE03	Gas	14	0	30	15	0	30
SI00	Gas	1	0	22	2	0	22
SI00	Lignite	8	0	70	9	0	70
SK00	Coal	263	0	55	264	0	55
SK00	Gas	26	0	32	27	0	32
TR00	Coal	127	57	55	127	57	55
TR00	Gas	149	58	32	149	58	32
TR00	Lignite	67	58	70	67	58	70
TR00	Oil	200	63	44	200	63	44
UA01	Coal	2	0	55	3	0	55
UK00	Coal	35	2	55	37	3	55
UK00	Gas	13	2	32	15	3	32
UK00	Oil	7	2	44	8	3	44
UKNI	Gas	1	0	22	1	0	22
UKNI	Oil	1	0	44	1	0	44

6.1.4 Detailed revenues and costs for National Estimates TY 2030

The full results for the qualitative assessment 2030 are given in Table 12. As shown in the figures above, the net revenue of most technologies does not cover the fixed cost in the National Estimates scenario, whereas 60% of the technologies are in the scenario National Estimates with low thermal capacity. For some regions, e.g. the case of Malta (MT00), revenues are particularly high as a result of many hours with ENS[11]. During hours with ENS, the hourly price becomes equal to the price cap, which is set to 15 k€/MWh across all the

[11] Note that ENS hours in Malta are partly the result of not considering 'out-of-market measures' in the available capacity in the ERAA 2021. A total of 215 MW capacity is, however, available in MT00 to mitigate risks.

modelled perimeter. This eventually leads to high revenues. A similar situation is observed in Poland (PL00) for the scenario with low thermal capacity and is discussed in sub-section 6.1.2. This situation impacts the close neighbour's revenue, mainly Estonia (EE00), Slovakia (SK00) and Lithuania (LT00), where revenues are high but mainly earned during non-ENS hours because prices are driven by the exports to Poland.

Table 12: Revenues and costs [€/kW] by technology and Bidding zone in the National Estimates and National Estimates with low thermal capacity scenarios for TY 2030

Bidding zone	Technology	National Estimates – 2030			National Estimates with low thermal capacity – 2030		
		Net Revenue [€/kW]	Net Revenue ENS [€/kW]	Fixed Costs [€/kW]	Net Revenue [€/kW]	Net Revenue ENS [€/kW]	Fixed Costs [€/kW]
AL00	Gas	9	0	32	19	0	32
AT00	Gas	11	0	30	93	0	30
AT00	Oil	7	0	44	78	0	44
BA00	Lignite	19	0	79	25	0	79
BE00	Gas	19	1	32	142	13	32
BE00	Oil	9	1	44	116	13	44
BG00	Gas	6	0	26	8	0	24
BG00	Lignite	5	0	70	11	0	70
CY00	Gas	2	1	32	2	1	32
CY00	Oil	1	1	44	1	1	44
CZ00	Gas	20	0	32	173	3	32
CZ00	Lignite	25	0	75	160	3	75
DE00	Coal	41	3	82	184	43	82
DE00	Gas	16	2	31	153	43	31
DE00	Lignite	37	2	89	178	43	89
DE00	Oil	7	2	44	89	27	44
DKE1	Gas	93	82	32	253	144	32
DKE1	Oil	83	80	44	230	142	44
DKW1	Gas	10	3	22	143	21	22
DKW1	Oil	9	3	44	137	21	44
EE00	Oil	144	1	44	1216	13	44
ES00	Gas	0	0	32	0	0	32
FI00	Gas	46	4	22	180	9	22
FR00	Gas	8	1	31	N/A	N/A	N/A
FR00	Oil	5	1	44	N/A	N/A	N/A
GR00	Gas	8	0	32	17	0	32
GR03	Oil	0	0	44	0	0	44
HR00	Coal	30	0	82	39	0	82
HR00	Gas	1	0	32	7	0	32
HU00	Gas	19	5	31	104	6	31
HU00	Oil	12	5	44	94	5	44
IE00	Gas	1	0	32	9	0	32

Bidding zone	Technology	National Estimates – 2030			National Estimates with low thermal capacity – 2030		
		Net Revenue [€/kW]	Net Revenue ENS [€/kW]	Fixed Costs [€/kW]	Net Revenue [€/kW]	Net Revenue ENS [€/kW]	Fixed Costs [€/kW]
IE00	Oil	0	0	44	7	0	44
ITCN	Gas	3	0	32	43	1	32
ITCS	Gas	5	0	32	7	0	32
ITN1	Gas	4	0	31	37	1	31
ITSA	Gas	1	0	26	2	0	26
LT00	Gas	68	22	32	9034	325	32
LT00	Oil	55	23	44	9435	338	44
ME00	Lignite	27	0	82	35	0	82
MT00	Gas	1666	1566	32	1666	1566	32
NL00	Coal	63	0	82	100	6	82
NL00	Gas	19	2	32	148	22	32
PL00	Coal	12	0	55	N/A	N/A	N/A
PL00	Gas	25	0	32	58672	50676	32
PT00	Gas	2	0	32	3	0	32
RO00	Coal	0	0	55	1	0	55
RO00	Gas	10	0	29	26	0	31
RO00	Lignite	0	0	70	0	0	70
RS00	Gas	15	0	32	30	0	32
RS00	Lignite	23	0	80	32	0	80
SE02	Gas	1	0	22	5	0	22
SE03	Gas	10	0	22	128	0	22
SI00	Gas	5	0	22	54	0	22
SI00	Lignite	10	0	70	68	0	70
SK00	Coal	454	0	55	598	3	55
SK00	Gas	14	0	32	131	2	32
TR00	Coal	139	21	55	140	21	55
TR00	Gas	138	22	32	138	22	32
TR00	Lignite	102	23	77	102	23	77
TR00	Oil	204	25	44	204	25	44
UA01	Coal	15	1	55	127	5	55
UK00	Coal	10	0	56	58	4	56
UK00	Gas	6	1	32	53	5	32
UK00	Oil	3	1	44	48	5	44
UKNI	Gas	1	0	22	8	0	22
UKNI	Oil	0	0	44	7	0	44

7 Sensitivity Analyses

A sensitivity analysis was conducted to assess the impact of an increased price of CO_2 or a decrease of the price cap on the capacity change in the system. The central reference scenario in the ERAA 2021, referred to here as *PC15C40*, considers a price cap of 15 k€/MWh and a CO_2 price of 40 €/ton. In the first sensitivity, referred as *PC15C60*, the CO_2 price is changed to be 60 €/ton while the price cap remains unchanged. In the second sensitivity, referred to as PC3C40, the price cap is set at 3 k€/MWh whereas the CO_2 price is 40 €/ton. Figure 22 shows the amount of capacity economically decommissioned and commissioned, per technology and sensitivity (in the graphs, results for Turkey are omitted).

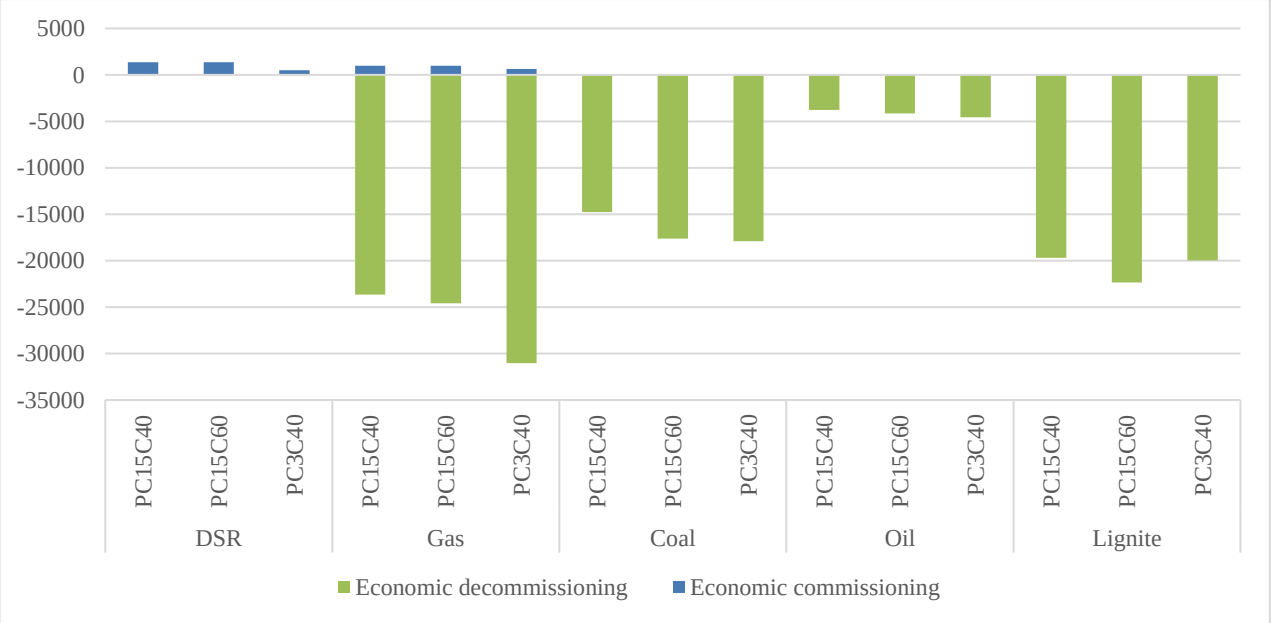


Figure 22: Capacity change [MW] per technology and sensitivity price (excl. Turkey). 'PC' stands for price cap and 'C' for CO_2 price

Figure 23 shows the result of the economic commissioning and decommissioning decision of the sensitivity, per technology, market zone and sensitivity, for the market zones where the capacity changed. For each market zone, three bars represent, from left to right, the scenarios PC15C40, PC15C60 and PC3C40. The countries are sorted from by total capacity change, from the country with the highest amount of net economic decommissioning to the highest amount of net commissioning.

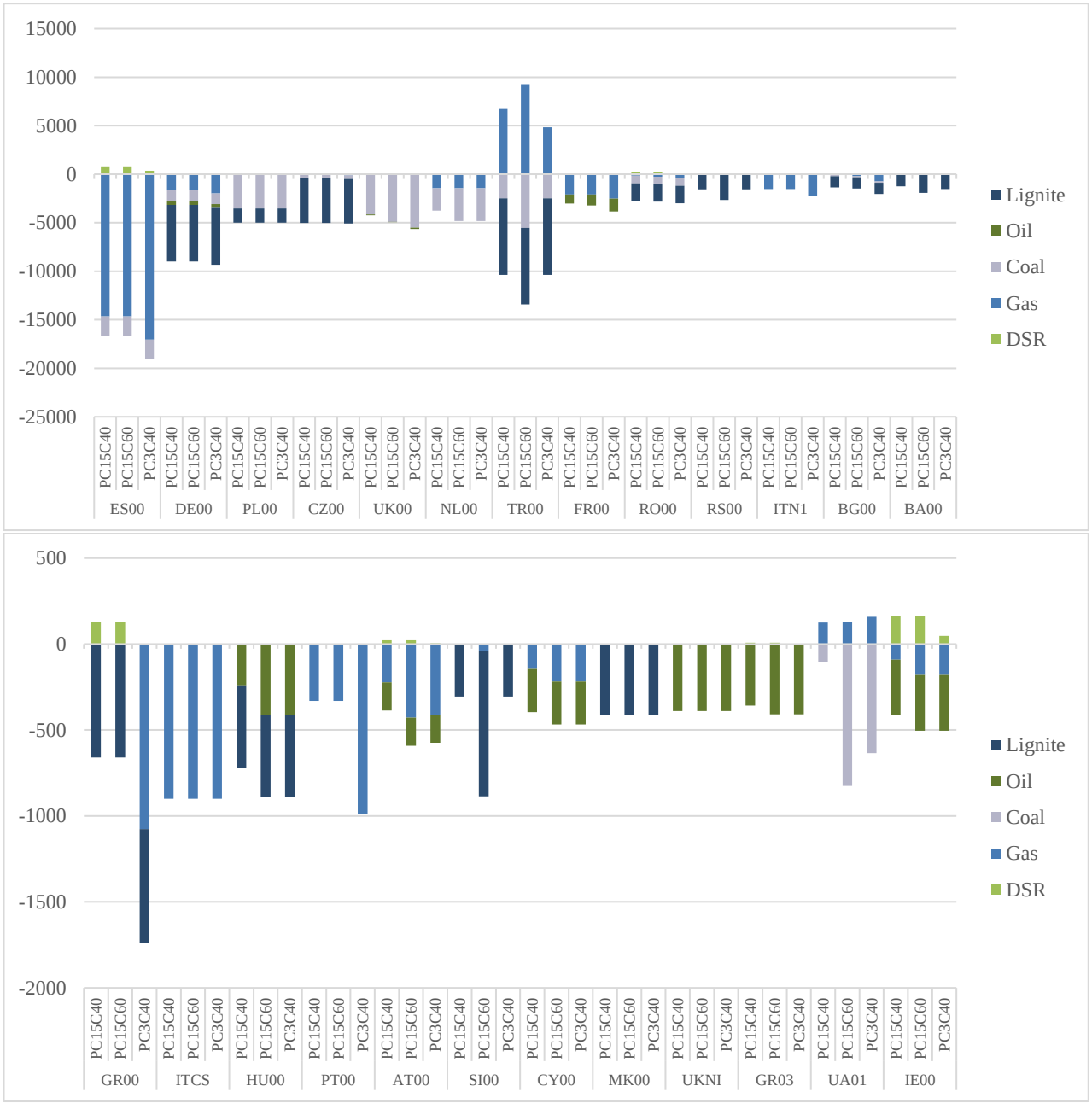

15000
10000
5000
0
-5000
-10000
-15000
-20000
-25000
PC15C40
PC15C60
PC3C40
ES00
DE00
PL00
CZ00
UK00
NL00
TR00
FR00
RO00
RS00
ITN1
BG00
BA00
Lignite
Oil
Coal
Gas
DSR
500
0
-500
-1000
-1500
-2000
GR00
ITCS
HU00
PT00
AT00
SI00
CY00
MK00
UKNI
GR03
UA01
IE00
Lignite
Oil
Coal
Gas
DSR

Figure 23: Capacity change [MW] per technology and sensitivity price. 'PC' stands for price cap and 'C' for CO_2 price