Mid-term Adequacy Forecast Appendix 1

DETAILED RESULTS, SENSITIVITIES AND INPUT DATA

2019 EDITION





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Abbreviations

CWE	Central Western Europe
DSR	Demand-Side Response
EENS	Expected Energy not Served
ENS	Energy not Served
FB	Flow-Based
FBMC	Flow-Based Market Coupling
FRR	Frequency Restoration Reserves
LC	Low-Carbon
LLD	Loss of Load Duration
LOLE	Loss of Load Expectation
MAF	Midterm Adequacy Forecast
NECP	National Energy and Climate Plan
NGC	Net Generating Capacity
NRA	National Regulatory Authority
NTC	Net Transfer Capacity
P50	50th Percentile
P95	95th Percentile
PEMMDB	Pan-European Market Modelling Database
RES	Renewable Energy Sources



1 Overview of input data and scenarios

The input data for MAF 2019 is sourced from PEMMDB 3.0. More specifically, this report considers the years 2021 and 2025 and adds a Low-Carbon (LC) scenario for 2025. In total, MAF 2019 covers three scenarios. The following section will provide an overview of the input data for installed capacity for MAF 2019, point out trends and also compare the input data to the data used in MAF 2018.

Figure 1 to Figure 3 display the Net Generating Capacity (NGC) for all countries and the different scenarios by technology. As can be seen from the bar plots, Germany (DE), France (FR), Spain (ES) and Italy (IT) have the highest NGCs by 2025 at 237 GW, 160 GW, 130 GW and 115 GW, respectively. It should be noted that these total values are dominated by Renewable Energy Sources (RES) and hydro capacities, which becomes obvious in the plot of the shares of installed capacity for RES, hydro and non-RES on the map of Europe provided in Figure 4 and Figure 5. Here, it can also be seen that especially Iceland, Norway, Sweden, Switzerland and Austria have high shares of RES and hydro generation units in their power systems. In general, the share of RES rises from 2021 towards 2025 and increases further for the 2025 Low-Carbon scenario. At this point, however, it should be mentioned that the NGC of RES usually cannot be utilized fully for the provision of electrical energy.

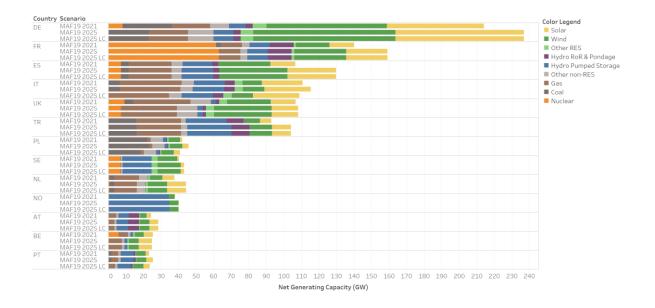


Figure 1: Net Generating Capacity (NGC) of MAF 2019 generating units for the 2021, 2025 and 2025 Low-Carbon scenarios (Part 1)



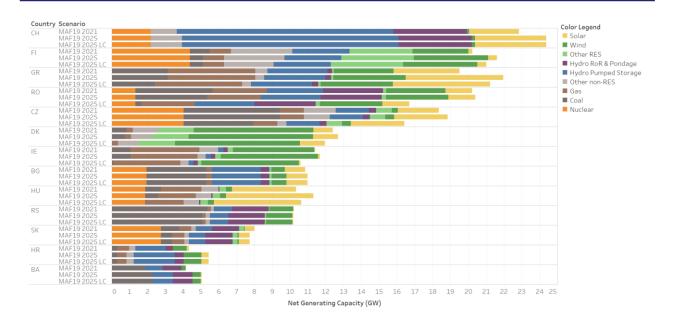


Figure 2: NGC of MAF 2019 generating units for the 2021, 2025 and 2025 Low-Carbon scenarios (Part 2)

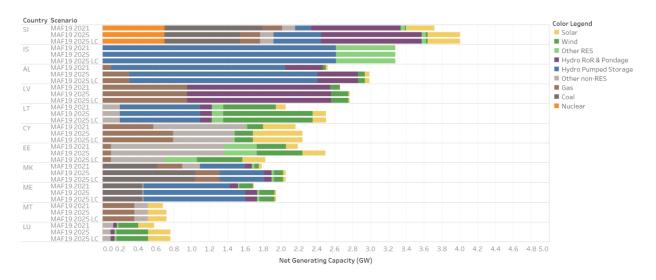


Figure 3: NGC of MAF 2019 generating units for the 2021, 2025 and 2025 Low-Carbon scenarios (Part 3)¹

¹ Due to a data issue, the net generating capacity for **Lithuania** includes an additional 400 MW of hydro turbine capacity, which should have been reserved for FRR. Furthermore, according to the latest political decisions, exchanges with Russia from 2025 and after are not available, even though they were modelled in the MAF. These additional resources were compensated by the removal of all thermal generation in the model.



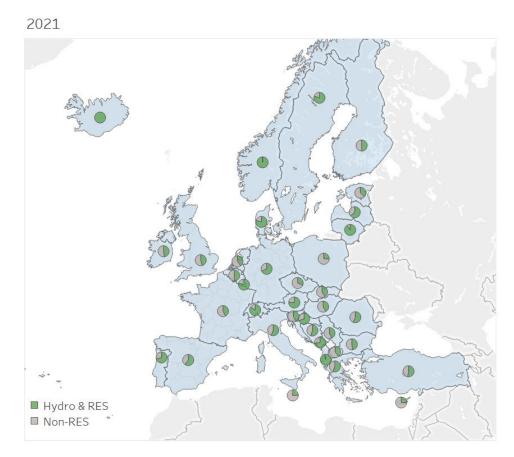


Figure 4: NGC shares of hydro and RES and non-RES for 2021

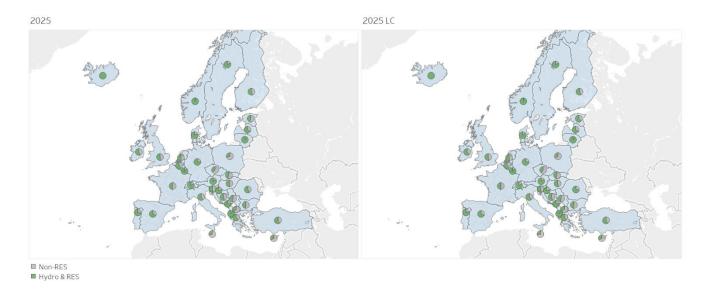


Figure 5: NGC shares of hydro and RES and non-RES for the 2025 and 2025 Low-Carbon scenarios



Taking a closer look at thermal generation, it is deduced from Figure 6 that, for 2021, the total NGC in Europe is dominated by France, Germany, Spain, Italy and the UK. In this context, thermal generation technologies include the following categories: gas, hard coal, lignite, oil, nuclear, waste and other non-RES. However, for 2025, the situation changes due to the large reduction in thermal power plant capacities, especially in Germany, Belgium and the UK. The reduction is due mainly to the planned decommissioning of nuclear and coal-fired power plants in these countries. The changes in installed capacity for thermal generation are shown as deltas between 2021 and 2025 and between 2021 and the 2025 Low-Carbon scenario in Figure 7.

Thermal NGC 2021

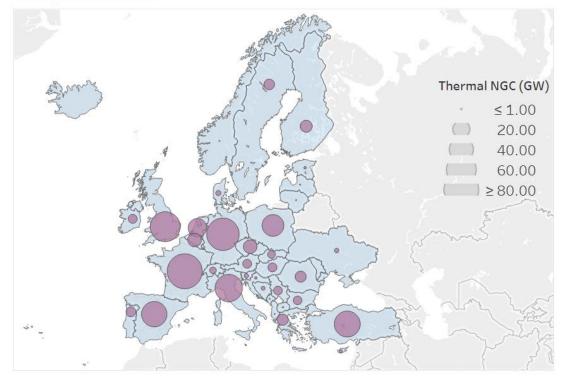


Figure 6: NGC of thermal generating units in 2021



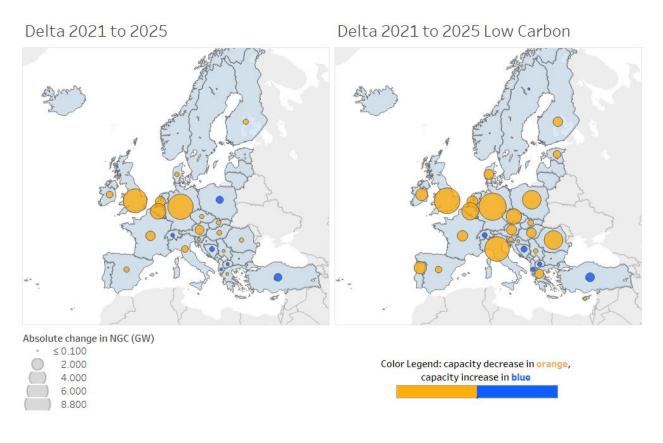


Figure 7: Changes in NGC of thermal generating units from 2021 to 2025 and from 2021 and the 2025 Low-Carbon scenario.

In the 2025 Low-Carbon scenario the following countries decrease their thermal generation fleet further: the Czech Republic, Finland, Estonia, Greece, Denmark, Italy, Hungary, Portugal, Romania, Ireland and Poland. In most cases, the decrease affects coal-fired plants for economic and / or political reasons. Figure 8 shows a more detailed visualization of the installed capacity of hard coal and lignite for all countries. The results of this scenario can be found in Section 4.

Regarding the comparison of the MAF 2018 and MAF 2019 input data, Figure 9 can be consulted for an overview. The stack charts show a direct comparison of the corresponding scenarios from MAF 2018 and MAF 2019. In general, the installed capacities for coal-fired plants tend to be lower in MAF 2019. The same holds for nuclear power plants, with the exception of France, where the targets for reducing the nuclear share in electricity production have been recently updated in the latest National Energy and Climate Plan (NECP) and indicate postponed shutdowns, leading to a nuclear generating capacity that is 4.5 GW higher for the 2025 scenario in MAF 2019 than in MAF 2018. For RES, the installed capacities are predominantly higher in the MAF 2019 scenarios. Hydro units do not differ significantly.



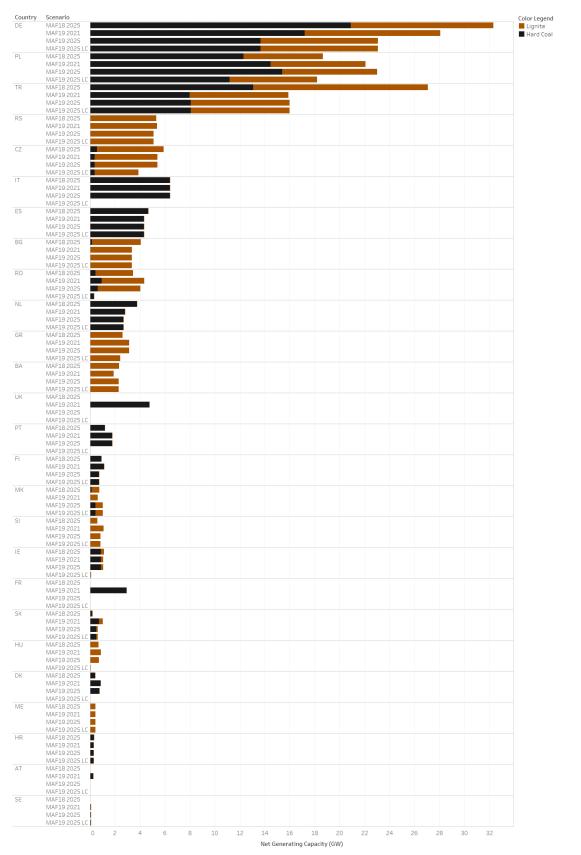


Figure 8: Installed capacity of coal-fired power plants for MAF 2018, target year 2025, and MAF 2019, target years 2021, 2025 and the 2025 Low-Carbon scenario



ntry	Scenario MAF19 2025	Color Legend Solar
	MAF18 2025	Wind
	MAF19 2025	Other RES
	MAF18 2025	Hydro RoR & Pon
	MAF19 2025	Hydro Pumped St
	MAF18 2025	Other non-RES
	MAF19 2025	Gas
	MAF18 2025	Coal
	MAF19 2025	Nuclear
	MAF18 2025	
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	MAF19 2025	
	MAF18 2025 Martin Control Cont	
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	0 20 40 60 80 100 120 140 160 180 200 220 240	

Figure 9: Comparison between projections for 2025 between MAF 2018 and MAF 2019



2 Adequacy in numbers: Base-Case results

The detailed results of the adequacy assessment for MAF 2019 are presented in this section. All results presented in the following tables are averages from the five different market modelling tools used for MAF and include:

- LOLE and EENS: mathematical expectations over the total number of Monte Carlo estimates;
- P50 of ENS and LLD: 50th percentile of the Monte Carlo estimates, i.e., 50% of the LLD/ENS estimates are above this value;
- P95 of ENS and LLD: 95th percentile of the Monte Carlo estimates, i.e., 5% of the LLD/ENS estimates are above this value;
- EENS / Annual Demand [%]: relative value of EENS with respect to the annual demand of the zone.

Results are presented in the form of detailed tables per market zone. Additionally, we present the aggregated results for some regions consisting of various zones:

- DK00: consisting of the zones DKE1, DKKF and DKW1;
- ISEM: consisting of the zones IE00 and UKNI;
- IT00: consisting of the zones ITCN, ITCS, ITN1, ITS1, ITSA and ITSI;
- NO00: consisting of the zones NOS0, NOM1 and NON1;
- SE00: consisting of the zones SE01, SE02, SE03 and SE04.

	B	ase-Case sc	enario 202	1	Ba	ase-Case sc	enario 202	5
Market Zone	EENS [GWh]	EENS / Annual Demand	P50 [GWh]	P95 [GWh]	EENS [GWh]	EENS / Annual Demand	P50 [GWh]	P95 [GWh]
AL00	-	-	-	-	-	-	-	-
AT00	-	-	-	-	0.04	-	-	-
BA00	-	-	-	-	-	-	-	-
BE00	0.68	0.001%	-	0.31	1.18	0.001%	-	3.50
BG00 ³			-	-			-	
СН00	0.08	-	-	-	0.37	-	-	-
CY00	0.03	-	-	0.11	0.88	-	0.53	2.96
CZ00	-	-	-	-	0.03	-	-	-
DE00	0.03	-	-	-	1.23	-	-	2.07
DEKF	-	-	-	-	-	-	-	-
DK00	0.14	-	-	0.04	0.28	-	0.01	0.58
DKE1	0.14	0.001%	-	0.06	0.32	0.001%	-	1.19
DKKF	-	-	-	-	-	-	-	-
DKW1	-	-	-	-	-	-	-	-

Table 1: EENS [GWh] results for Base-Case scenarios for 2021 and 2025 by zone²

² Outliers were removed from zones FR00, ITSI, NOS1 and MT00 in the 2021 results and zones CY00, ITSI, LT00 and TR00 in the 2025 results.

³ Note that in this study, demand data for Bulgaria include auxiliary consumption of power plants.



	Ba	ase-Case sc	enario 202	21	B	ase-Case sc	enario 202	5		
Market	EENS	EENS /	P50	P95	EENS	EENS /	P50	P95		
Zone	[GWh]	Annual	[GWh]	[GWh]	[GWh]	Annual	[GWh]	[GWh]		
		Demand				Demand				
EE00	0.12	0.001%	0.03	0.27	0.05	0.001%	-	0.18		
ES00	-	-	-	-	-	-	-	-		
FI00	0.06	-	-	0.21	-	-	-	-		
FR00	17.76	0.004%	-	38.41	13.87	0.004%	-	19.43		
GR00	-	-	-	-	-	-	-	-		
GR03	0.02	0.001%	-	0.11	-	0.001%	-	-		
HR00	-	-	-	-	-	-	-	-		
HU00	-	-	-	-	-	-	-	-		
ISEM	-	-	-	0.01	0.43	-	0.08	0.88		
IE00	-	-	-	-	0.46	-	0.07	2.00		
IS00	-	-	-	-	0.19	-	0.03	0.56		
IT00	4.53	0.001%	0.16	13.63	7.53	0.001%	0.75	10.14		
ITCN	1.33	0.004%	-	5.72	1.85	0.004%	-	5.61		
ITCS	-	-	-	-	-	-	-	-		
ITN1	1.67	0.001%	-	2.42	4.46	0.001%	-	4.95		
ITS1	-			-	-	-	-	-		
ITSA	0.02	-	-	0.10	0.01			0.06		
ITSI	1.64	0.008%	-	10.11	2.85	0.008%	0.78			
LT00	0.56	0.005%	-	1.03	2.42	0.004%	0.37	10.66		
LUG1	0.12	0.002%	-	-	0.74	0.002%	- 0.01	2.95		
LV00	0.19	0.003%	0.01	0.26	0.14	0.14 0.002%		0.37		
ME00	-	-	-	-	-	-	-	-		
MK00	-	-	-	-	-	-	-	-		
MT00	8.51	0.342%	7.43	17.19	13.25	0.316%	12.37	22.54		
NL00	-	-	-	-	-	-	-	-		
NO00	1.38	0.001%	-	0.03	0.05	0.001%	-	-		
NOM1	0.04	-	-	0.01	-	-	-	-		
NON1	-	-	-	-	-	-	-	-		
NOS0	1.34	0.001%	-	0.01	0.05	0.001%	-	-		
PL00	0.79	-	0.12	3.23	0.01	-	-	-		
PT00	-	-	-	-	-	-	-	-		
RO00	-	-	-	-	-	-	-	-		
RS00	-	-	-	-	-	-	-	-		
SE00	2.51	0.002%	-	0.06	0.48	0.002%	-	-		
SE01	-	-	-	-	-	-	-	-		
SE02	- 0.40	-	-	-	-	-	-	-		
SE03	0.49	0.001%	-	-	0.04	0.001%	-	-		
SE04	2.16	0.009%	-	0.01	0.68	0.009%	-	-		
SI00	-	-	-	-	-	-	-	-		
SK00	-	-	-	-	-	-	-	-		



	B	ase-Case so	enario 202	21	Base-Case scenario 2025						
Market Zone	EENS EENS / [GWh] Annual		P50 [GWh]	P95 [GWh]	EENS [GWh]	EENS / Annual	P50 [GWh]	P95 [GWh]			
		Demand				Demand					
TR00	0.02	-	-	0.03	27.85	-	25.22	57.15			
UK00	-	-	-	-	-	-	-	-			
UKNI	-	-	-	0.01	0.08	-	-	0.34			

Table 2: LOLE [h/year] results for Base-Case scenarios for 2021 and 2025 by zone⁴

Market	Base-C	ase scenari	io 2021	Base-C	ase scenari	io 2025
Zone	LOLE	P50	P95	LOLE	P50	P95
	[h/year]	[h/year]	[h/year]	[h/year]	[h/year]	[h/year]
AL00	-	-	-	-	-	-
AT00	-	-	-	0.02	-	-
BA00	-	-	-	-	-	-
BE00	0.91	-	0.72	1.09	-	3.15
BG00 ⁵	0.01	-	-	-	-	-
СН00	0.08	-	-	0.27	-	-
CY00	0.61	0.03	2.54	15.64	12.32	40.55
CZ00	-	-	-	0.05	-	-
DE00	0.02	-	-	0.29	-	1.01
DEKF	-	-	-	-	-	-
DK00	0.48	-	0.30	0.80	0.04	2.60
DKE1	0.39	-	0.65	0.67	-	3.20
DKKF	-	-	-	-	-	-
DKW1	-	-	-	0.01	-	-
EE00	0.74	0.40	1.67	0.40	0.20	1.04
ES00	-	-	-	-	-	-
FI00	0.18	-	0.72	-	-	-
FR00	4.12	-	17.14	2.75	-	6.87
GR00	-	-	-	-	-	-
GR03	0.71	0.03	4.59	-	-	-
HR00	-	-	-	-	-	-
HU00	-	-	-	-	-	-
ISEM	0.03	0.02	0.06	1.79	0.81	5.98
IE00	-	-	-	2.03	0.82	8.46
IS00	-	-	-	0.27	0.20	0.80
IT00	6.86	1.21	25.34	12.11	5.15	26.37
ITCN	2.05	-	7.69	2.51	-	7.79

⁴ Outliers were removed from zones FR00, ITSI, NOS1 and MT00 in the 2021 results and from zones CY00, ITSI, LT00 and TR00 in the 2025 results.

⁵ Note that in this study, demand data for Bulgaria include auxiliary consumption of power plants.



Market	Base-C	ase scenari	o 2021	Base-C	ase scenari	io 2025
Zone	LOLE	P50	P95	LOLE	P50	P95
	[h/year]	[h/year]	[h/year]	[h/year]	[h/year]	[h/year]
ITCS	-	-	-	-	-	-
ITN1	0.74	-	2.66	1.54	-	4.24
ITS1	-	-	-	-	-	-
ITSA	0.23	-	1.04	0.13	-	0.83
ITSI	4.22	-	25.75	8.97	4.50	32.76
LT00	1.46	-	3.62	7.48	3.00	29.52
LUG1	0.17	-	0.01	0.89	-	3.49
LV00	1.12	0.20	1.73	1.02	0.25	4.08
ME00	-	-	-	-	-	-
МК00	-	-	-	-	-	-
MT00	158.23	147.86	278.89	246.59	236.66	365.11
NL00	-	-	-	0.01	-	0.01
NO00	0.87	-	0.47	0.04	-	-
NOM1	0.12	-	0.20	-	-	-
NON1	-	-	-	-	-	-
NOS0	0.64	-	0.25	0.02	-	-
PL00	1.35	0.17	6.23	0.03	-	-
PT00	-	-	-	-	-	-
RO00	-	-	-	-	-	-
RS00	-	-	-	-	-	-
SE00	2.18	-	0.19	0.77	-	0.01
SE01	-	-	-	-	-	-
SE02	-	-	-	-	-	-
SE03	0.49	-	-	0.08	-	-
SE04	1.74	-	0.03	0.62	-	-
SI00	-	-	-	-	-	-
SK00	-	-	-	-	-	-
TR00	0.04	-	0.05	23.71	22.23	43.93
UK00	-	-	-	-	-	-
UKNI	0.03	-	0.22	0.60	0.06	2.61



3 Flow-Based sensitivity for 2021 – focusing on Central Western Europe (CWE)

The Flow-Based (FB) approach was implemented as a sensitivity for the year 2021, following the implementation of Flow-Based Market Coupling (FBMC) performed at the regional level in the PLEF study⁶. The approach for FBMC is an important step towards the more realistic modelling of the operational planning in practice nowadays. In this approach, representative historical FB domains are implemented for Central Western Europe (CWE) countries (AT, BE, DE, FR, NL) as a basis for modelling cross-border capacity while considering the effect of grid reinforcements up until 2019. The different types of FB domains used represent several situations with different levels of grid congestion. Their implementation in the model is further correlated to expected climate and consumption conditions for each day of the simulations, which are the main drivers for grid congestion. The methodology of the FB analysis is presented in detail in Appendix 2.

The simulations for the 2021 case have been performed using three market modelling tools: one FB model was built based on PEMMDB 3.0 (i.e., unit-by-unit thermal power plant data), and two models were built based on PEMMDB 2.1 (similar power plant clustering to those in PLEF and MAF 2018). FB modelling is a milestone for MAF, since the implementation of the "Clean Energy Package" will require that future adequacy assessments replace the Net Transfer Capacity (NTC) approach with FB wherever possible.

The FB approach is generally in line with the Base-Case results of the NTC approach for this study, leading, however, to some changes in the CWE region and neighbouring zones (BE00, CH00, FR00, ITCN, ITN1, LUG1). Figure 10 and Figure 11 present a comparison of the results between the Base-Case NTC approach and the FB sensitivity for the aforementioned zones. As observed, an increase in LOLE and EENS values appears in Belgium under the FB approach. To the contrary, the results of the FB sensitivity for France showcase a marginal decrease in terms of LOLE when FB is considered. Regarding the EENS of France, the decrease is almost negligible. The FB implementation in the CWE region affects the Italian zones as well but without a common trend: results for Continental North Italy show a small decrease in LOLE, while Italy North is affected negatively, i.e., by an increase in scarcity hours, via the implementation of FB. However, the impact of FB implementation in this particular study is not significant, except in the case of Belgium.

⁶ Pentalateral Energy Forum, Support Group 2, "Generation Adequacy Assessment", January 2018, http://www.benelux.int/nl/kernthemas/holder/energie/pentalateral-energy-forum



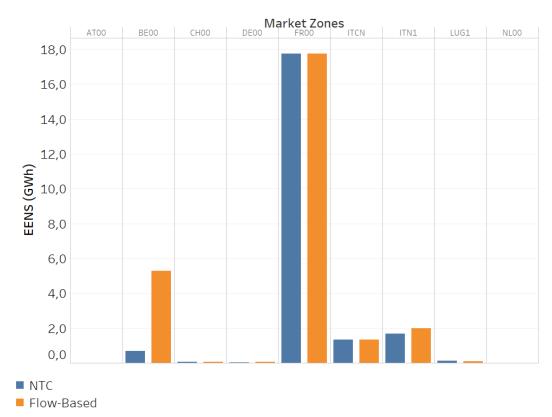


Figure 10: EENS Flow-Based vs. NTC results for target year 2021. Just CWE and affected neighbouring zones are presented in this graph.

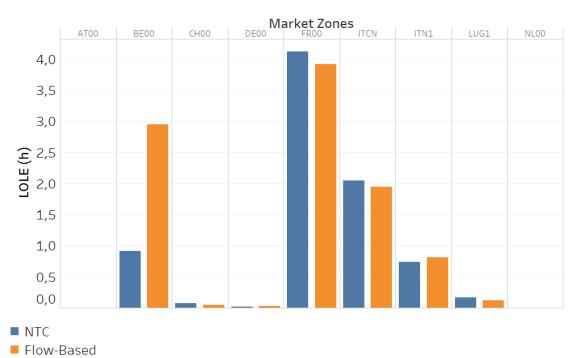


Figure 11: LOLE Flow-Based vs. NTC results for target year 2021. Just CWE and affected neighbouring zones are presented in this graph.



The reason that the results of the FB simulation for 2021 are not significantly different from the NTC results could be related (although not exclusively) to the effect of the MinRAM 20% implementation, which allows an increased capacity to be offered to the market during the Capacity Calculation stage, as opposed to the situation prior to such an implementation, within the CWE FBMC. However, the higher LOLE values observed in FB as opposed to NTC in the case of Belgium stem from the more accurate modelling of the network, which allowed the interdependencies between commercial exchanges in neighbouring countries and the physical flows occurring in the grid to be captured. Such interdependencies are important when modelling, for example, cases of so-called 'simultaneous scarcity'.



4 Low-Carbon sensitivity for 2025

In addition to the Base-Case scenarios, data were collected concerning the number and size of generation units potentially at risk of being decommissioned by 2025 due to an acceleration of "Low-Carbon (environmental) policies". Such capacity reductions could stem either directly from environmental legislations – e.g., a coal phase-out – or indirectly via the impact of environmental actions impacting the profitability of generating units. This study constitutes a **stress test**, since the decommissioned generation capacity considered in this assessment is not replaced by any other resource.

The motivation behind this scenario is manifold:

- Carbon pricing and relevant policies have an important impact on the generation fleet and adequacy of multiple zones;
- Changes in a political level lead to expected updates in the national plans regarding decreased use of coal and lignite. Thus, for some zones, this scenario is consistent with updated or expected updates in the NECP that are not accounted for in the Base-Case scenario (e.g., Greece and Italy);
- It is a scenario of specific interest to the National Regulatory Authorities (NRAs);
- The corresponding scenario in MAF 2018 was well-received by stakeholders, thus we considered it useful to update the results of such a stress test.

The input was provided by TSOs, and the reduced capacity in comparison with the Base-Case 2025 is presented in absolute numbers (GW) in Table 3. In total, around 23.6 GW of generating capacity were removed from the 2025 Base-Case scenario, mainly through reductions in lignite and hard coal capacities.

 Table 3: Net generating capacity flagged as at risk of being decommissioned by 2025 and consequently removed in the Low-Carbon sensitivity analysis

Country	-	nite ty [GW]		d coal ty [GW]	Total removed
	Base-	Low-	Base-	Low-	capacity
	Case	carbon	Case	Carbon	
Estonia	-	-	-	-	0.7*
Czech	5.0	3.5	0.4	0.4	2.4*
Denmark	-	-	1.5	0.8	0.7
Finland	-	-	1.9	1.9	0.6*
Greece	3.1	2.4	-	-	0.7
Hungary	0.7	0	0.2	0.2	0.7
Ireland	0.4	0.2	0.9	0	1.1
Italy	-	-	6.4	0	6.4
Poland	7.6	7.0	15.8	11.5	4.8
Portugal	-	-	1.8	0	1.8
Romania	3.4	0	0.6	0.3	3.7

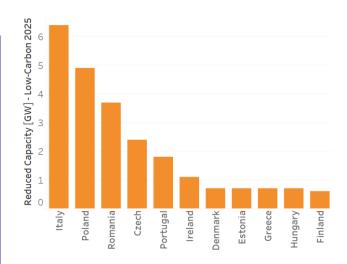


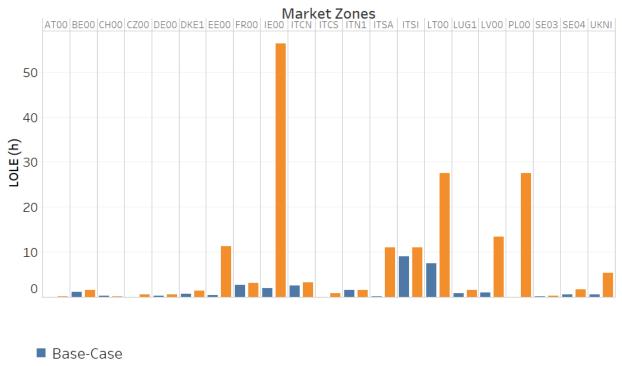
Figure 12: Reduced capacity per country in the Low-Carbon sensitivity for target year 2025

* A portion of the removed net generating capacity is from technologies other than lignite or hard coal



The regional dimension of adequacy is confirmed by this stress test analysis: Figure 13 and Figure 14 show a comparison between the LOLE and EENS results per country in the Base-Case scenario and the Low-Carbon scenario. Countries with very small LOLE values in the Low-Carbon scenario were ommited from the graph (e.g., PT00 and GR00).

It is observed from Figure 13 that the decreased capacities in Ireland, Estonia and Poland lead to increased LOLE and EENS values under this scenario. Furthermore, zones that depend to these zones for imports are also affected considerably by this scenario, e.g., Lithuania and Latvia. Lastly, all coal capacity has been removed from Italian zones, which has a considerable impact on the EENS and LOLE values, especially in the zone of Sardinia.



Low-Carbon Sensitivity

Figure 13: Comparison of LOLE values between the Base-Case and the Low-Carbon scenarios in 2025. The graph includes only zones with LOLE values above 0.5h.



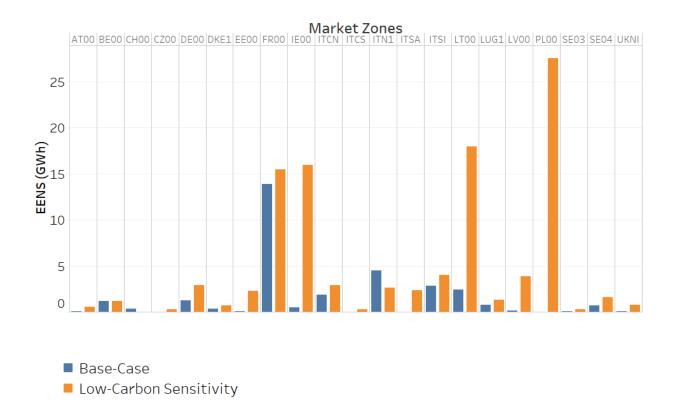


Figure 14: Comparison of EENS between the Base Case and the Low-Carbon sensitivity in 2025. The graph includes all zones with LOLE values above 0.5h.

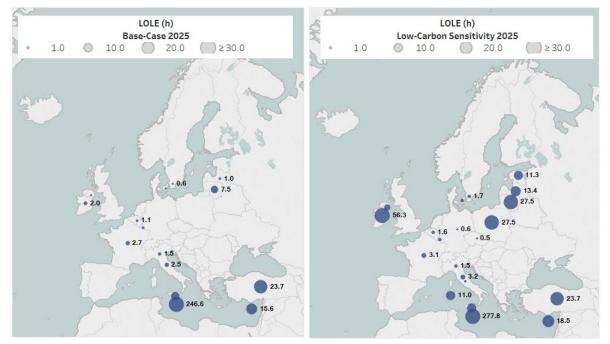


Figure 15: Comparison of LOLE values between the Low-Carbon and Base-Case for 2025. The map includes only zones with LOLE values above 0.5h.

An overview of the LOLE and EENS results per country for the Low-Carbon sensitivity are shown in Table 4.

Market Zone	LOLE [h/year]	EENS [GWh]	Market Zone	LOLE [h/year]	EENS [GWh]	Market Zone	LOLE [h/year]	EENS [GWh]
AL00	0.01	-	HR00	0.01	-	NOM1	-	-
AT00	0.11	0.33	HU00	0.09	0.02	NON1	-	-
BA00	-	-	ISEM	57.73	21.05	NOS0	-	-
BE00	1.61	2.07	IE00	56.33	20.35	PL00	27.50	23.29
BG00	-	-	IS00	-	-	РТ00	-	-
СН00	0.18	0.58	IT00	24.00	12.70	RO00	0.04	0.01
CY00	18.46	1.04	ITCN	3.20	3.16	RS00	0.01	-
CZ00	0.50	0.44	ITCS	0.88	0.50	SE00	1.68	2.17
DE00	0.59	2.40	ITN1	1.49	2.87	SE01	-	-
DEKF	-	-	ITS1	-	-	SE02	-	-
DK00	1.43	0.72	ITSA	10.96	2.04	SE03	0.34	0.23
DKE1	1.41	0.68	ITSI	11.07	4.00	SE04	1.66	1.91
DKKF	-	-	LT00	27.46	14.35	SI00	0.04	-
DKW1	0.11	0.03	LUG1	1.55	1.28	SK00	0.03	-
EE00	11.29	1.99	LV00	13.37	2.22	TR00	23.70	27.85
ES00	-	-	ME00	-	-	UA01	-	-
F100	0.16	0.04	МК00	-	-	UK00	0.01	-
FR00	3.13	16.53	MT00	277.82	14.88	UKNI	5.39	0.70
GR00	-	-	NL00	0.01	-			
GR03	0.01	-	NO00	-	-			

This sensitivity analysis should be understood as a stress test on generating capacity, and can, by definition, only result in inferior adequacy levels. The results confirm that the decommissioning of polluting generation capacity should be accompanied in some zones by the development of alternative generating capacity, e.g., development of demand-side response (DSR), storage, generation, interconnection). Higher granularity of national/regional adequacy assessments could complete the picture by assessing possible resource adjustments and detecting any local resources or network constraints which might not have been identified by the MAF. Also, the next edition of the MAF will strive to monitor the situation further through possible updates of the assumptions made for each country.

Finally, to ensure reliable predictions of future adequacy levels, it is crucial to obtain reliable and consistent data from the supply side of the system. To this end, a potential approach could be to ask European utilities to announce their (de-)commissioning and mothballing plans for 3–5 years ahead. Doing so would result in a clearer picture of future system conditions and power system evolutions.



5 Detailed results of each modelling tool

Bar charts in this section show the probabilistic range of the adequacy index LLD for both the 2021 and 2025 Base-Case scenarios. They consist of the 50th and 95th percentiles of the distributions of the simulation results (or, in other words, the results for the risk of 1 in 2 years to 1 in 20 years). Moreover, average values of adequacy indices (LOLE or EENS) of all simulated climatic years are represented as dots for all simulation tools. Figure 16 below illustrates how the results are presented in this section.

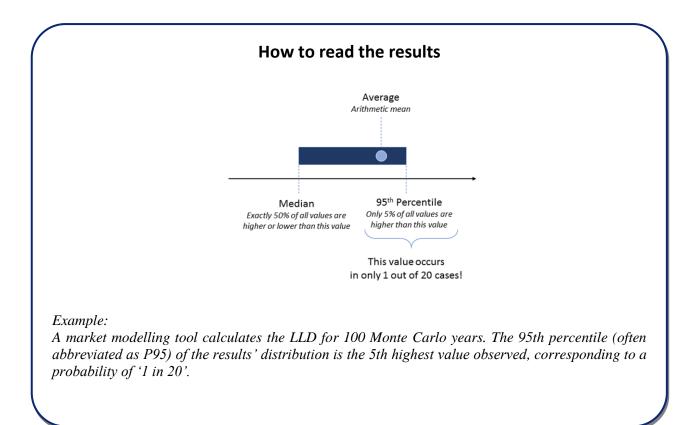


Figure 16: How to read the detailed MAF results



5.1 Adequacy results for 2021

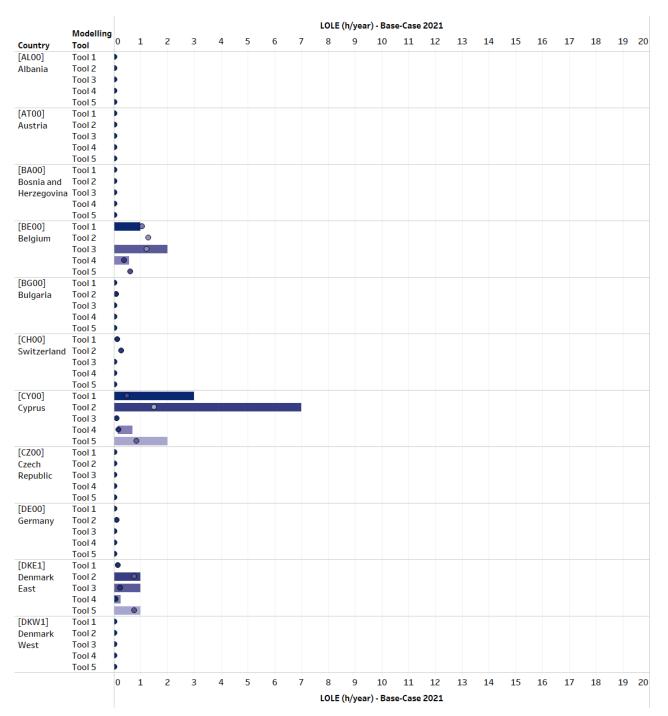
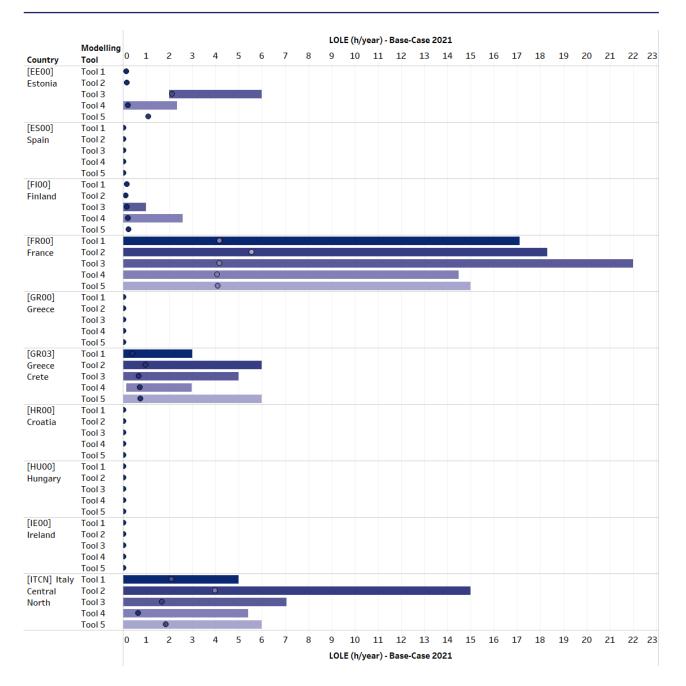
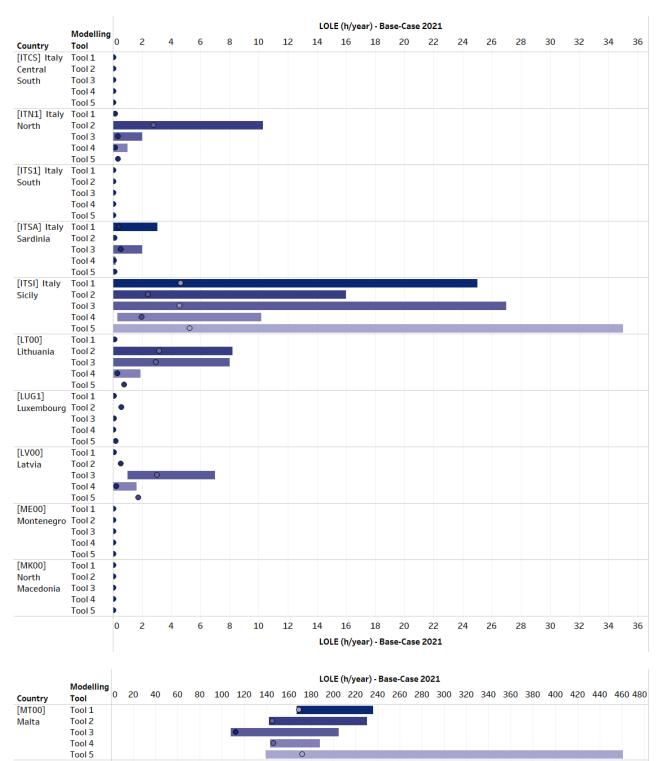


Figure 17 – LOLE (h/year) results by tool for Base-Case 2021 (part 1)











	Madallia									LOL	E (h/ye	ar) - B	ase-Ca	se 2021	L							
Country	Modelling Tool	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
[NL00]	Tool 1																					
Netherlands																						
	Tool 3																					
	Tool 4																					
	Tool 5																					
[NOM1]	Tool 1																					
Norway Mid	Tool 2																					
	Tool 3	•																				
	Tool 4																					
	Tool 5																					
[NON1]	Tool 1																					
Norway	Tool 2																					
North	Tool 3	•																				
	Tool 4																					
[NOCO]	Tool 5																					
[NOS0]	Tool 1 Tool 2	•																				
Norway South	Tool 3																					
South	Tool 4																					
	Tool 5	-	0																			
[PL00]	Tool 1	D	Ŭ																			
Poland	Tool 2	0																				
l'olaria	Tool 3		0																			
	Tool 4	•				-																
		•																				
[PT00]	Tool 1	•																				
Portugal	Tool 2																					
-	Tool 3																					
	Tool 4																					
	Tool 5																					
[RO00]	Tool 1																					
Romania	Tool 2																					
	Tool 3																					
	Tool 4																					
[D. c. c. c.]	Tool 5	•																				
[RS00]	Tool 1																					
Serbia	Tool 2 Tool 3																					
	Tool 3																					
	Tool 4																					
			_	40	45			20	25		45	50		-		70	75		05		0.5	4.0.0
		0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
										LOL	E (h/ye	ar) - B	ase-Ca	se 2021	L							



	Martella										LOLE	(h/yea	r) - Bas	e-Case	2021								
. .	Modelling	0	1	2	З	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Country	Tool		-	_		·	-						10			10		10	10		10	10	
SE01]		2																					
Sweden	Tool 2	[
	Tool 3 Tool 4	[
	Tool 5	[
SE02]	Tool 1	<u> </u>																					
Sweden	Tool 2	.																					
weuen	Tool 3	.																					
	Tool 4																						
	Tool 5																						
SE03]	Tool 1	•																					
weden	Tool 2																						
	Tool 3		•																				
	Tool 4																						
	Tool 5		•																				
SE04]	Tool 1		•																				
weden	Tool 2				0																		
	Tool 3			0	•																		
	Tool 4																						
	Tool 5				c)																	
5100]	Tool 1																						
lovenia	Tool 2																						
	Tool 3																						
	Tool 4																						
	Tool 5																						
SK00]	Tool 1																						
lovakia	Tool 2																						
	Tool 3																						
	Tool 4																						
	Tool 5																						
FR00]	Tool 1																						
urkey	Tool 2	•																					
	Tool 3	<u> </u>																					
	Tool 4																						
	Tool 5	2																					
UK00]	Tool 1	2																					
Inited	Tool 2	<u> </u>																					
ingdom	Tool 3																						
	Tool 4	[
	Tool 5	<u> </u>																					
UKNI]	Tool 1 Tool 2	(I																					
orthern eland	Tool 3	0																					
eidflu	Tool 4																						
	Tool 5	5																					
	10015	-	-	~	_				-	_			40	4.4	10	40		45	4.0	47	10	40	~
		0	1	2	3	5	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
											LOLE	(h/yea	r) - Bas	e-Case	2021								



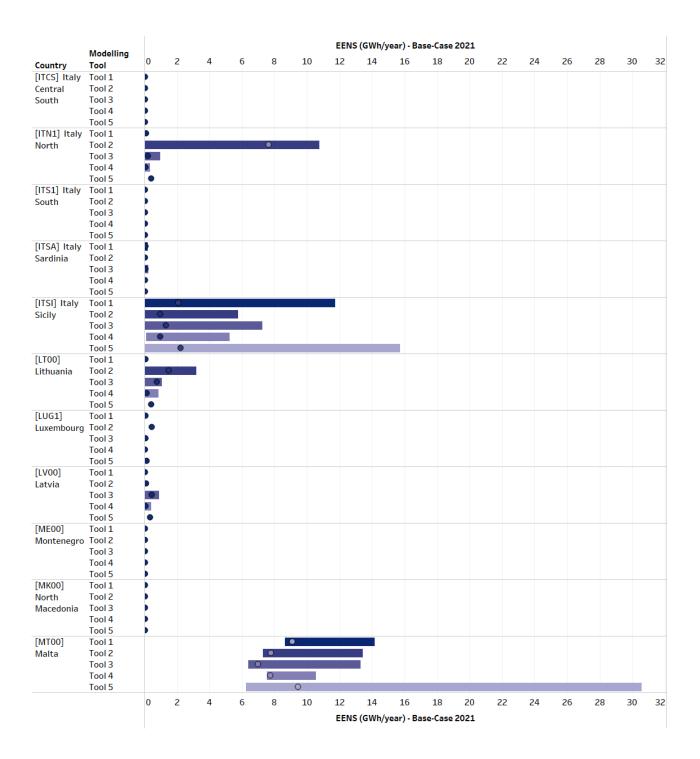
Country [AL00] Albania [AT00] Austria [BA00] Bosnia and Herzegovina [BE00] Belgium [BG00] Bulgaria [CH00]	Modelling Tool 1 Tool 2 Tool 3 Tool 4 Tool 5 Tool 1 Tool 2 Tool 2 Tool 3	0	1	2	3	4	5	6	7	ENS (G	9	10	11	12	13	14	15	16	17	18	19	20
[AL00] Albania [AT00] Austria [BA00] Bosnia and Herzegovina [BE00] Belgium [BG00] Bulgaria	Tool 1 Tool 2 Tool 3 Tool 4 Tool 5 Tool 1 Tool 2					-		-		-												
Albania [AT00] Austria [BA00] Bosnia and Herzegovina [BE00] Belgium [BG00] Bulgaria	Tool 2 Tool 3 Tool 4 Tool 5 Tool 1 Tool 2																					
[AT00] Austria [BA00] Bosnia and Herzegovina [BE00] Belgium [BG00] Bulgaria	Tool 3 Tool 4 Tool 5 Tool 1 Tool 2																					
Austria [BA00] Bosnia and Herzegovina [BE00] Belgium [BG00] Bulgaria	Tool 5 Tool 1 Tool 2	;																				
Austria [BA00] Bosnia and Herzegovina [BE00] Belgium [BG00] Bulgaria	Tool 1 Tool 2																					
Austria [BA00] Bosnia and Herzegovina [BE00] Belgium [BG00] Bulgaria	Tool 2																					
[BA00] Bosnia and Herzegovina [BE00] Belgium [BG00] Bulgaria																						
Bosnia and Herzegovina [BE00] Belgium [BG00] Bulgaria																						
Bosnia and Herzegovina [BE00] Belgium [BG00] Bulgaria	Tool 4	5																				
Bosnia and Herzegovina [BE00] Belgium [BG00] Bulgaria	Tool 5																					
Herzegovina [BE00] Belgium [BG00] Bulgaria	Tool 1																					
[BE00] Belgium [BG00] Bulgaria	Tool 2	2																				
Belgium [BG00] Bulgaria	Tool 3																					
Belgium [BG00] Bulgaria	Tool 5	5																				
Belgium [BG00] Bulgaria	Tool 1	Í	•																			
Bulgaria	Tool 2		•																			
Bulgaria	Tool 3	0																				
Bulgaria	Tool 4																					
Bulgaria	Tool 5 Tool 1	•																				
	Tool 2																					
[CH00]	Tool 3	5																				
[СН00]	Tool 4																					
[CH00]	Tool 5																					
	Tool 1	•																				
Switzerland																						
	Tool 3 Tool 4																					
	Tool 5	5																				
[CY00]	Tool 1																					
Cyprus	Tool 2																					
	Tool 3																					
	Tool 4 Tool 5																					
[CZ00]	Tool 1	5																				
Czech	Tool 2	5																				
Republic	Tool 3																					
	Tool 4																					
	Tool 5																					
[DE00]	Tool 1																					
Germany	Tool 2 Tool 3																					
	Tool 4	5																				
	Tool 5																					
[DKE1]	Tool 1																					
Denmark	Tool 2																					
East	Tool 3																					
	Tool 4 Tool 5																					
[DKW1]	Tool 1	5																				
Denmark	Tool 2																					
West	Tool 3																					
	Tool 4	Ĺ																				
	Tool 4 Tool 5																					
		0	1	2	3	4	5	6	7	8 ENS (G	9	10	11	12	13	14	15	16	17	18	19	20

Figure 18: EENS (GWh) results by tool for Base-Case 2021



	Madelline					EENS (G	Wh/year) - E	ase-Case 20	21			
Country	Modelling Tool	0	5	10	15	20	25	30	35	40	45	50
EE00]	Tool 1											
stonia	Tool 2											
stoma	Tool 3											
	Tool 4	5										
	Tool 5											
ES00]	Tool 1											
pain	Tool 2											
pani	Tool 3											
	Tool 4											
	Tool 5											
FI00]	Tool 1											
inland	Tool 2											
IIIaliu	Tool 3											
	Tool 4											
	Tool 5											
FR00]	Tool 1					•						
	Tool 2						•					
rance	Tool 3				0							
	Tool 4				0							
	Tool 5				0	0						
CD001						0						
[GR00]	Tool 1											
Greece	Tool 2											
	Tool 3											
	Tool 4											
[CD02]	Tool 5											
GR03]	Tool 1											
Greece	Tool 2	2										
Crete	Tool 3	2										
	Tool 4	2										
_	Tool 5											
HR00]	Tool 1											
Croatia	Tool 2											
	Tool 3											
	Tool 4											
	Tool 5											
HU00]	Tool 1											
lungary	Tool 2											
	Tool 3											
	Tool 4											
	Tool 5											
IE00]	Tool 1											
reland	Tool 2											
	Tool 3	•										
	Tool 4	•										
	Tool 5											
ITCN] Italy		0										
entral	Tool 2	C)									
lorth	Tool 3	0										
	Tool 4	•										
	Tool 5	•										
	10015	-		4.5	15			22	25	4.5	4-	
		0	5	10	15	20	25	30	35	40	45	50







											EENS	(GWh	/year)	- Bas	e-Cas	e 2021								
Country	Modelling Tool	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220
[NL00]	Tool 1																							
Netherlands																								
	Tool 3																							
	Tool 4																							
	Tool 5																							
[NOM1]	Tool 1																							
Norway Mid																								
	Tool 3																							
	Tool 4	•																						
	Tool 5	2																						
[NON1]	Tool 1	2																						
Norway	Tool 2																							
North	Tool 3 Tool 4																							
	Tool 5																							
[NOS0]	Tool 1	<u> </u>																						
Norway	Tool 2																							
South	Tool 3																							
boutin	Tool 4																							
	Tool 5				0																			
[PL00]	Tool 1																							
Poland	Tool 2																							
	Tool 3	•																						
	Tool 4																							
	Tool 5																							
[PT00]	Tool 1																							
Portugal	Tool 2	2																						
	Tool 3	2																						
	Tool 4	2																						
[0000]	Tool 5	-																						
[RO00] Romania	Tool 1 Tool 2																							
Komania	Tool 2																							
	Tool 4																							
	Tool 5	5																						
[RS00]	Tool 1	5																						
Serbia	Tool 2																							
	Tool 3																							
	Tool 4																							
	Tool 5																							
		0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220
											EENS	(GWh												



									I	EENS (GWh/y	vear) - E	Base-Ca	ase 202	21							
Country	Modelling	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Country	Tool 1	-	-	_	_		-	-	-													
[SE01]	Tool 1																					
Sweden	Tool 2																					
	Tool 3 Tool 4																					
	Tool 5																					
[SE02]	Tool 1	<u> </u>																				
	Tool 2																					
Sweden	Tool 3																					
	Tool 4																					
	Tool 5																					
[SE03]	Tool 1																					
	Tool 2																					
Sweden	Tool 3																					
	Tool 4		•																			
[CE04]	Tool 5	-		,																		
[SE04]	Tool 1					~																
Sweden	Tool 2				•	•																
	Tool 3																					
	Tool 4																					
[000]	Tool 5 Tool 1	_				0																
[SI00]	Tool 2																					
Slovenia																						
	Tool 3																					
	Tool 4 Tool 5																					
[00/12]	Tool 1																					
[SK00]																						
Slovakia	Tool 2																					
	Tool 3 Tool 4																					
	Tool 5 Tool 1																					
[TR00]	Tool 2																					
Turkey	Tool 3																					
	Tool 4																					
	Tool 5																					
[UK00]	Tool 1	<u> </u>																				
	Tool 2																					
United	Tool 3																					
Kingdom	Tool 4																					
	Tool 5																					
[UKNI]	Tool 1																					
Northern	Tool 2																					
Ireland	Tool 3																					
relatio	Tool 4																					
	Tool 5																					
	10013	-	-	2	_			-				10		10	12	1.4	45	10	47	10	10	20
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
									I	EENS (GWh/y	vear) - E	ase-Ca	ase 202	21							



5.2 Adequacy results for 2025

										LC	DLE (h/	year) -	Base-	Case 2	025							
Country	Modelling Tool	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100 105
[AL00]	Tool 1	•																				
Albania	Tool 2																					
	Tool 3																					
	Tool 4																					
	Tool 5																					
[AT00]	Tool 1	2																				
Austria	Tool 2 Tool 3	ζ																				
	Tool 4	. .																				
	Tool 5	5																				
[BA00]	Tool 1	5																				
Bosnia and	Tool 2																					
Herzegovina																						
5	Tool 4																					
	Tool 5																					
[BE00]	Tool 1	0																				
Belgium	Tool 2	0																				
	Tool 3																					
	Tool 4																					
[BC00]	Tool 5 Tool 1																					
[BG00] Bulgaria	Tool 2	.																				
Bulgaria	Tool 3																					
	Tool 4	5																				
	Tool 5																					
[CH00]	Tool 1	Ð																				
Switzerland	Tool 2	•																				
	Tool 3																					
	Tool 4																					
[c) (c) c]	Tool 5								_													
[CY00]	Tool 1				•																	
Cyprus	Tool 2 Tool 3																					
	Tool 4				0																	
	Tool 5																					
[CZ00] Czech		•																				
Republic	Tool 2																					
	Tool 3																					
	Tool 4																					
	Tool 5																					
[DE00]	Tool 1																					
Germany	Tool 2																					
	Tool 3 Tool 4	.																				
	Tool 5																					
[DKE1]	Tool 1	0																				
Denmark	Tool 2	0																				
East	Tool 3	•																				
	Tool 4																					
-	Tool 5	•																				
[DKW1]	Tool 1	2																				
Denmark	Tool 2	2																				
West	Tool 3																					
	Tool 4 Tool 5	(
	10013		_									-			-						-	105 1
		0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100 105



	Madallin -									LOLE	(h/yea	r) - Bas	e-Case	2025								
Country	Modelling Tool	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	2
[EE00]	Tool 1																					
Estonia	Tool 2																					
estonia	Tool 3		0																			
	Tool 4																					
	Tool 5																					
[ES00] Spain																						
[2000] opuili	Tool 2	5																				
	Tool 3																					
	Tool 4																					
	Tool 5																					
[FI00]	Tool 1																					
Finland	Tool 2																					
	Tool 3																					
	Tool 4																					
	Tool 5																					
[FR00]	Tool 1			C																		
France	Tool 2					0																
	Tool 3			C																		
	Tool 4			0																		
	Tool 5			(0																	
[GR00]	Tool 1																					
Greece	Tool 2																					
	Tool 3	2																				
	Tool 4	2																				
[0000]	Tool 5	2																				
[GR03]	Tool 1																					
Greece Crete																						
	Tool 3																					
	Tool 4																					
[1000]	Tool 5	<u>.</u>																				
[HR00]	Tool 1 Tool 2	ζ																				
Croatia	Tool 3	(
	Tool 4	(
	Tool 5	.																				
[HU00]	Tool 1	5																				
Hungary	Tool 2																					
nungury	Tool 3	5																				
	Tool 4	5																				
	Tool 5																					
[IE00]	Tool 1			0																		
Ireland	Tool 2			0																		
	Tool 3			0																		
	Tool 4		•																			
	Tool 5				•																	
[ITCN] Italy	Tool 1			•																		
Central	Tool 2						0															
North	Tool 3				0																	
	Tool 4		•																			
	Tool 5			•																		
		0	1	2	3	4	5	6	7	8	9	10					15			18		2



						LOI	.E (h/vear) -	Base-Case 20	025			
	Modelling	0	-	10	15					25	40	45
Country	Tool	0	5	10	15	20)	25	30	35	40	45
[ITCS] Italy	Tool 1	2										
Central	Tool 2											
South	Tool 3											
	Tool 4 Tool 5											
[ITN1] Italy	Tool 1											
North	Tool 2		0									
	Tool 3	•										
	Tool 4	•										
	Tool 5											
[ITS1] Italy	Tool 1											
South	Tool 2	2										
	Tool 3	1										
	Tool 4											
	Tool 5 Tool 1	-										
[ITSA] Italy Sardinia	Tool 2	,	-									
Sarunna	Tool 3											
	Tool 4	•										
	Tool 5	•										
[ITSI] Italy	Tool 1			•								
Sicily	Tool 2		0									
	Tool 3			0								
	Tool 4		•	-								
	Tool 5			•	_							
[LT00]	Tool 1	0		-								
Lithuania	Tool 2			0	0							
	Tool 3 Tool 4				0							
	Tool 5		•									
[LUG1]	Tool 1	0										
Luxembourg		0										
y	Tool 3	•										
	Tool 4											
	Tool 5	•										
[LV00]	Tool 1											
Latvia	Tool 2	0										
	Tool 3											
	Tool 4	•										
[ME00]	Tool 5 Tool 1	•										
Montenegro												
Montenegro	Tool 3	1										
	Tool 4	5										
	Tool 5											
[MK00]	Tool 1	•										
North	Tool 2	•										
Macedonia	Tool 3											
	Tool 4											
	Tool 5											
		0	5	10	15	20)	25	30	35	40	45
						1.01	E (h/vear) -	Base-Case 20				
							- (., j ear) -					
						1.01	E (b/voar) -	Base-Case 20	125			
	Modelling	0	50	100	150					400	450	F00 55
Country	Tool	0	50	100	150	200	250	300	350	400	450	500 550
[MT00]	Tool 1						0					
Malta	Tool 2						0					
	Tool 3					•						
	Tool 4						0	<u></u>				
	Tool 5							0				
		0	50	100	150	200	250	300	350	400	450	500 550



	Modelling									LOLE	(h/yea	r) - Ba	se-Case	2025								
Country	Tool	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	2
[NL00]	Tool 1	•																				
Vetherlands	Tool 2																					
	Tool 3																					
	Tool 4	2																				
	Tool 5	2																				
[NOM1] Norway Mid	Tool 1	ζ.																				
Norway Mid	Tool 3	.																				
	Tool 4	5																				
	Tool 5																					
[NON1]	Tool 1	•																				
Norway	Tool 2																					
North	Tool 3																					
	Tool 4																					
[NOCO]	Tool 5	2																				
[NOS0]	Tool 1 Tool 2	6																				
Norway South	Tool 2																					
South	Tool 4																					
	Tool 5	5																				
[PL00]	Tool 1	•																				
Poland	Tool 2																					
	Tool 3																					
	Tool 4																					
	Tool 5	<u> </u>																				
[PT00]	Tool 1 Tool 2	1																				
Portugal	Tool 3	ζ.																				
	Tool 4	.																				
	Tool 5	5																				
[RO00]	Tool 1	•																				
Romania	Tool 2																					
	Tool 3																					
	Tool 4																					
	Tool 5																					
RS00]	Tool 1	1																				
Serbia	Tool 2 Tool 3	ζ.																				
	Tool 3	(
	Tool 5	5																				
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	10	2
		U	T	2	5	4	J	0	/	0	9	10	11	12	12	14	10	10	1/	10	19	2



	Madallia					LOLE (h	/year) - Base-	Case 2025				
Country	Modelling Tool	0	5	10	15	20	25	30	35	40	45	50
[SE01]	Tool 1	•										
Sweden	Tool 2											
	Tool 3	•										
	Tool 4											
	Tool 5											
[SE02]	Tool 1											
Sweden	Tool 2	•										
	Tool 3											
	Tool 4											
	Tool 5											
[SE03]	Tool 1											
Sweden	Tool 2											
	Tool 3											
	Tool 4											
	Tool 5											
[SE04]	Tool 1	•										
Sweden	Tool 2											
	Tool 3											
	Tool 4											
[0100]	Tool 5											
[SI00]	Tool 1	[
Slovenia	Tool 2 Tool 3	[
	Tool 3	[
	Tool 5	[
[SK00]	Tool 1	<u> </u>										
Slovakia	Tool 2	(
SIUVAKIA	Tool 3	1										
	Tool 4	5										
	Tool 5	5										
[TR00]	Tool 1	ſ				•						
Turkey	Tool 2										_	
, and y	Tool 3											
	Tool 4						0					
	Tool 5				(0						
[UK00]	Tool 1											
United	Tool 2											
Kingdom	Tool 3											
	Tool 4											
	Tool 5											
[UKNI]	Tool 1	0										
Northern	Tool 2	•										
Ireland	Tool 3	•										
	Tool 4											
	Tool 5	•										
		0	5	10	15	20	25	30	35	40	45	50
							/year) - Base-	C 2025				



	Modelling									EENS	5 (6 11	n/yea	r) - Da	ise-ca	se 202	5							
Country	Tool	0	1	2	3	4	5	6	7	8	3	9	10	11	12	13	14	15	16	17	18	19	2
AL00]	Tool 1	•																					
Albania	Tool 2																						
	Tool 3																						
	Tool 4 Tool 5																						
[AT00]	Tool 1																						
Austria	Tool 2																						
	Tool 3																						
	Tool 4																						
[0400]	Tool 5	-																					
[BA00] Bosnia and	Tool 1 Tool 2																						
Herzegovina																							
licizegovina	Tool 4																						
	Tool 5																						
[BE00]	Tool 1		0																				
Belgium	Tool 2			0)		-																
	Tool 3 Tool 4		,																				
	Tool 5		•																				
[BG00]	Tool 1	•																					
Bulgaria	Tool 2																						
	Tool 3																						
	Tool 4																						
[000]	Tool 5 Tool 1	•	•																				
[CH00] Switzerland			•																				
SWIEZeriana	Tool 3		-																				
	Tool 4																						
	Tool 5																						
[CY00]	Tool 1		0	-	_																		
Cyprus	Tool 2 Tool 3		•	- 1	•																		
	Tool 4																						
	Tool 5																						
[CZ00]	Tool 1																						
Czech	Tool 2	•																					
Republic	Tool 3 Tool 4																						
	Tool 5	5																					
[DE00]	Tool 1	•																					
Germany	Tool 2					•																	
	Tool 3	•																					
	Tool 4	•					_																
[DKE1]	Tool 5 Tool 1	0																					
Denmark	Tool 2		0																				
	Tool 3	•																					
	Tool 4			_																			
	Tool 5																						
[DKW1] Denmark	Tool 1 Tool 2																						
Denmarк West	Tool 3	5																					
	Tool 4																						
	Tool 5																						



Country T [EE00] T Estonia T T T T T [ES00] T Spain T T T [FI00] T Finland T T T [FR00] T France T T T [GR00] T Greece T T T [GR03] T	Modelling Tool Tool 1 Tool 2 Tool 3 Tool 4 Tool 5 Tool 1 Tool 2 Tool 3 Tool 4 Tool 5 Tool 1 Tool 2 Tool 1 Tool 2 Tool 1 Tool 2 Tool 1 Tool 2 Tool 2 Tool 3 Tool 4 Tool 5 Tool 1		2	4	6	8	10	12	year) - Bas 14	16	18	20	22	24	26
[EE00] T Estonia T T T T T [ES00] T Spain T T T [FI00] T Finland T France T France T GR00] T Greece T T T GR03] T	Tool 1 Tool 2 Tool 3 Tool 4 Tool 5 Tool 1 Tool 2 Tool 3 Tool 4 Tool 5 Tool 1 Tool 2 Tool 3 Tool 4 Tool 3 Tool 4 Tool 5 Tool 1	•													
Estonia T T T [ES00] T Spain T T [Fl00] T Finland T Finland T T [FR00] T France T GR00] T Greece T T Greece T T GR03] T	Tool 2 Tool 3 Tool 4 Tool 5 Tool 1 Tool 2 Tool 3 Tool 4 Tool 5 Tool 1 Tool 3 Tool 3 Tool 3 Tool 4 Tool 3 Tool 4 Tool 5 Tool 1	> > > > > > > > > > > > > > > > > > >													
T [ES00] T [ES00] T [Fl00] T Finland T [FR00] T France T [FR00] T GR00] T Greece T Greece T T [GR03] T	Tool 3 Tool 4 Tool 5 Tool 1 Tool 2 Tool 3 Tool 4 Tool 5 Tool 1 Tool 2 Tool 3 Tool 4 Tool 3 Tool 4 Tool 5 Tool 4 Tool 5 Tool 1														
T [ES00] T Spain T [FI00] T Finland T [FR00] T France T France T GR00] T Greece T Greece T T [GR03] T	Tool 4 Tool 5 Tool 1 Tool 3 Tool 4 Tool 5 Tool 1 Tool 2 Tool 3 Tool 4 Tool 5 Tool 4 Tool 5 Tool 1														
T [ES00] T Spain T T T T T [FI00] T Finland T T T [FR00] T France T T T [GR00] T Greece T T T [GR03] T	Tool 5 Tool 1 Tool 2 Tool 3 Tool 4 Tool 5 Tool 2 Tool 3 Tool 4 Tool 5 Tool 3 Tool 4 Tool 5 Tool 5 Tool 3 Tool 4 Tool 5 Tool 5 Tool 5														
[ES00] T Spain T [FI00] T Finland T Finland T France T France T GR00] T GR00] T GR03] T	Tool 1 Tool 2 Tool 3 Tool 4 Tool 5 Tool 1 Tool 3 Tool 3 Tool 4 Tool 5 Tool 1														
Spain T T [FI00] T Finland T Finland T T [FR00] T France T GR00] T Greece T Greece T T GR03] T	Tool 2 Tool 3 Tool 4 Tool 5 Tool 1 Tool 2 Tool 3 Tool 4 Tool 4 Tool 5 Tool 1														
T T T T Finland T T T T T T T T T T T GR00] T T GR03]	Tool 3 Tool 4 Tool 5 Tool 1 Tool 2 Tool 3 Tool 4 Tool 5 Tool 1														
FR00] T Finland T France T France T GR00] T GR00] T Greece T T GR03] T	Tool 4 Tool 5 Tool 1 Tool 2 Tool 3 Tool 4 Tool 5 Tool 1														
FIND T Finland T Finland T T FROO] T France T T GROO] T Greece T Greece T T T GRO3] T	Tool 5 Tool 1 Tool 2 Tool 3 Tool 4 Tool 5 Tool 1	>													
FI00] T Finland T T FR00] T FR00] T France T GR00] T GR00] T Greece T T GR03] T	Tool 1 Tool 2 Tool 3 Tool 4 Tool 5 Tool 1	>													
Finland T T FR00] T FR00] T France T GR00] T GR00] T Greece T T GR03] T	Tool 3 Tool 4 Tool 5 Tool 1														
T FR00] T irance T T GR00] T GR00] T GR03] T	Tool 4 Tool 5 Tool 1														
T FR00] T rance T T GR00] T ireece T T T GR03] T	Tool 5 Tool 1														
FR00] T France T T GR00] T GR00] T T GR03] T	Tool 1														
France T T GR00] T Greece T T GR03] T		•													
T T GR00] T Greece T T T GR03] T									0						
T GR00] T Greece T T T GR03] T	Tool 2											•			
T GR00] T irreece T T T GR03] T	Tool 3						0								
GR00] T Greece T T T GR03] T	Tool 4						(
Greece T T T GR03] T	Tool 5								0						
T T [GR03] T	Tool 1														
T T [GR03] T	Tool 2														
[GR03] T	Tool 3														
[GR03] T	Tool 4														
	Tool 5														
Greece T	Tool 1														
	Tool 2														
Crete T	Tool 3														
Т	Tool 4														
	Tool 5														
	Tool 1														
	Tool 2														
Т	Tool 3														
	Tool 4														
	Tool 5														
-	Tool 1														
	Tool 2														
	Tool 3														
	Tool 4														
	Tool 5														
-	Tool 1	0													
	Tool 2	0													
	Tool 3														
	Tool 4			_											
	Tool 5														
TCN] Italy T			0												
	Tool 2			0											
	Tool 3		•												
	Tool 4														
T	Tool 5														
	10010		2	4	6	8	10	12	14	16	18	20	22	24	26



	Modelling							EE	NS (GW	h/year)	- Base	-Case 20	25						
Country	Tool	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	3
[ITCS] Italy	Tool 1	•																	
Central	Tool 2																		
South	Tool 3																		
	Tool 4																		
	Tool 5																		
[ITN1] Italy	Tool 1																		
North	Tool 2									0									
	Tool 3		(
	Tool 4																		
	Tool 5)																
[ITS1] Italy	Tool 1																		
South	Tool 2																		
	Tool 3																		
	Tool 4																		
	Tool 5																		
[ITSA] Italy																			
Sardinia	Tool 2																		
	Tool 3																		
	Tool 4																		
	Tool 5																		
[ITSI] Italy	Tool 1			0															
Sicily	Tool 2		0				_												
	Tool 3		•																
	Tool 4		•																
	Tool 5			•	_														
[LT00]	Tool 1	0								_									
Lithuania	Tool 2			C)														
	Tool 3						~												
	Tool 4						0												
[[]][[1]	Tool 5	0																	
[LUG1]	Tool 1																		
Luxembourg	Tool 3																		
	Tool 4																		
	Tool 5																		
[LV00]	Tool 1																		
Latvia	Tool 2																		
Latvia	Tool 3																		
	Tool 4																		
	Tool 5																		
[ME00]	Tool 1)																	
Montenegro																			
j.	Tool 3																		
	Tool 4																		
	Tool 5																		
[MK00]	Tool 1																		
North	Tool 2																		
Macedonia	Tool 3																		
	Tool 4																		
	Tool 5																		
[MT00]	Tool 1																		
Malta	Tool 2							•											
	Tool 3							0											
	Tool 4							0											
	Tool 5								0										
		0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
			-		5	<u> </u>	10		NS (GW			20				20	50	52	01



	Modelling									LENS	(Gwn	year).	Dase-	Case 20	125							
	Tool	0	1	2	3	4	5	6	7	8	9	10	11	. 12	13	14	15	16	17	18	19	20
[NL00]	Tool 1																					
Netherlands																						
	Tool 3																					
	Tool 4	2																				
[NO14]	Tool 5																					
[NOM1]	Tool 1																					
Norway Mid	Tool 2																					
	Tool 4																					
	Tool 5																					
[NON1]	Tool 1	5																				
Norway	Tool 2																					
North	Tool 3																					
	Tool 4																					
	Tool 5																					
[NOS0]	Tool 1																					
Norway	Tool 2	•																				
South	Tool 3																					
	Tool 4	2																				
[DL00]	Tool 5	-																				
[PL00]	Tool 1 Tool 2																					
Poland	Tool 3																					
	Tool 4																					
	Tool 5																					
[PT00]	Tool 1	5																				
Portugal	Tool 2																					
, or eagar	Tool 3																					
	Tool 4																					
	Tool 5																					
[RO00]	Tool 1																					
Romania	Tool 2																					
	Tool 3																					
	Tool 4																					
[B B B B]	Tool 5																					
[RS00]	Tool 1																					
Serbia	Tool 2																					
	Tool 3 Tool 4																					
	Tool 4 Tool 5																					
	10015			-					_						45		45			10	10	
		0	1	2	3	4	5	6	7	8	9	10	11	. 12	13	14	15	16	17	18	19	20



	Modelling	EENS (GWh/year) - Base-Case 2025														
Country	Tool	0	5	10	15	20	25	30	35	40	45	50	55	60	65	
[SE01]	Tool 1	•														
Sweden	Tool 2															
	Tool 3															
	Tool 4															
	Tool 5															
SE02]	Tool 1	2														
Sweden	Tool 2	2														
	Tool 3															
	Tool 4															
SE03]	Tool 5 Tool 1	<u> </u>														
weden	Tool 2															
weden	Tool 3	.														
	Tool 4															
	Tool 5															
SE04]	Tool 1															
weden	Tool 2															
meden	Tool 3	•														
	Tool 4															
	Tool 5	•														
SI00]	Tool 1															
Slovenia	Tool 2															
	Tool 3															
	Tool 4															
	Tool 5															
SK00]	Tool 1															
lovakia	Tool 2															
	Tool 3	2														
	Tool 4															
TDOOL	Tool 5	•														
TR00]	Tool 1 Tool 2					•		•			_					
urkey	Tool 2															
	Tool 4							0								
	Tool 5				0)		<u> </u>								
UK00]	Tool 1															
Inited	Tool 2															
lingdom	Tool 3															
5	Tool 4															
	Tool 5															
UKNI]	Tool 1															
Vorthern	Tool 2	•														
reland	Tool 3															
	Tool 4															
	Tool 5	•														
		0	5	10	15	20	25	30	35	40	45	50	55	60	65	
									N) Race	Case 2025						