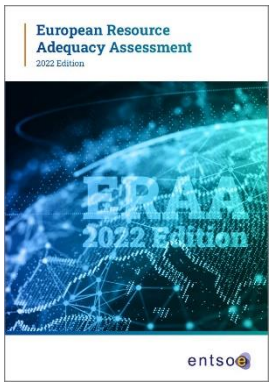
ENTSO-E:

Denmark needs additional dispatchable capacity by 2030

The growth of weather dependent electricity production without storage makes it increasingly difficult to maintain a continuous balance between consumption and generation. This challenge has been anticipated for at least 20 years, but no solution has been implemented in the same scale as the non-dispatchable capacity.

Danish authorities have analyzed the security of supply for electricity[1][2]. The analyses do not cover the full range of reliability problems. It takes more than one indicator to characterize the national security of supply. For instance have risks of energy shortage been ignored since 2013. It is an open question if energy cost should be an element of security of supply.

Grid limitations for interconnections are recorded and published, hour by hour, but the data do not show if the limitations are due to technical outages or local bottlenecks.



ENTSO-E[3] makes advanced analyses of security of supply for electricity in Europe. This note is based on the ERAA[4] 2022 Edition.

The ERAA is a pan-European monitoring assessment of resource adequacy ten years ahead. The geographical scope of the ERAA covers 37 countries encompassing all EU members and the ENTSO-E perimeter. The target years for ERAA 2022 are 2025, 2027 and 2030.

Unexpected improvement for Denmark for 2030

The reliability of supply for a country or a price zone is expressed as Loss of Load Expectation (LOLE) in hours per year. It is the expected number of hours when the system cannot cover the full electricity demand.

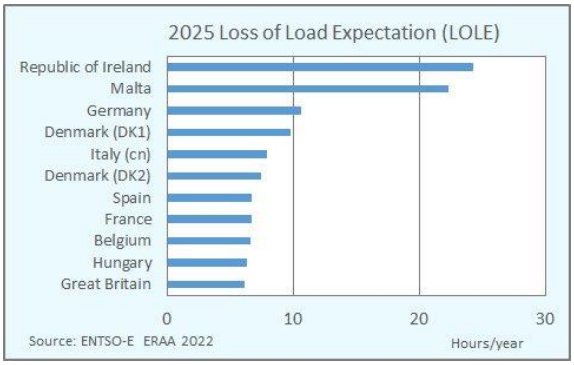


Fig. 1 - Top 11 countries after LOLE 2025

Fig. 2 - Top 11 countries after LOLE 2027

[1] Danish Energy Agency: Climate Change Agreement Analysis 1 - Main Report - January 2022
[2] Energinet: Security of Electricity Supply Report 2019
[3] ENTSO-E: The European Network of Transmission System Operators for Electricity
[4] ERAA: European Resource Adequacy Assessment

It is not surprising that West Denmark has about the same risk of capacity shortage as Germany in 2025 and 2027, because DK1 belongs to the same continental AC-grid as Germany. The difference between DK2 and SE4 (Southern Sweden) is less obvious, but it confirms previous Danish assessments.

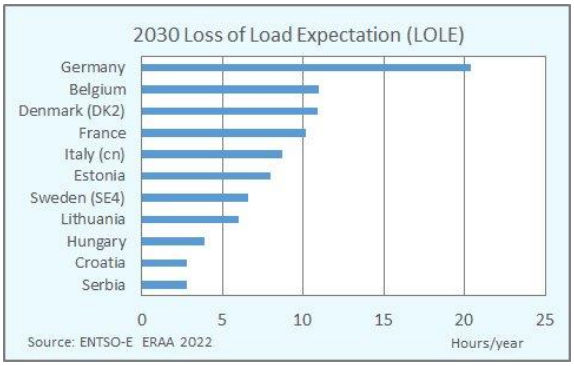


Fig. 3 – Denmark (DK1): 2.3 hours/year in 2030

The change from 2027 to 2030 is the real surprise (fig. 3). The Danish situation seems to be much better, particularly for DK1. We would like to know the reasons for the improvement.

The Danish Energy Agency publishes every year its "prerequisites for analyses" ("Analyseforudsætninger"). The recent version is AF22.

EVA modifies the national plans

ERAA 2022 is based on National Estimates, but they are modified through the application of Economic Viability Assessment (EVA). When EVA finds a production unit unprofitable, the unit is excluded from the analysis. The assumption is that the owner will decommission or mothball unprofitable units. On the other hand, EVA will add new units, if they are considered profitable.

The total European effect of EVA is capacity reductions respectively 60, 67 and 40 GW for the three years. The reductions are net results of commissions, life extensions and decommissions of capacities (fig. 4). New capacities and life extensions were made for Denmark for 2030.

Decision Variable	Technology	2025	2027	2030	Most-affected countries
Economic Commissioning	Battery	0.1	0.1	0.1	MT
	DSR	3.9	4.9	7.3	SE, ES, NL, DE, DK, PT
	Gas	0.4	0.7	14	DE, DK, IE, MT
Economic Life Extension	Gas	0	0.5	4.1	DE, BE, DK
Economic Decommissioning	Coal	−9.8	−10.6	−13.2	BG, PL, RO, BA, DE
	Gas	−50.2	−57.7	−48.7	UK, DE, ES, GR, IT, NL
	Other non-RES	−4.3	−4.6	−3.2	DE, UK, HU, EE
Total		**−59.9**	**−66.7**	**−39.6**	**UK, DE, ES, IT, PL, DK**

Fig. 4 - Capacity change compared to National Estimates Scenario [GW] – Non-cumulative

The details for each country are explained in annex 4 of ERAA 2022.

The planned Danish capacity changes from 2025 to 2030 are shown for the two Danish bidding zones in fig. 5. The general trend is a reduction in dispatchable capacity and increased wind and solar power. The essential difference between DK1 and DK2 is the large increase for DK2 of wind power in 2030.

DK1	Capacity changes	2025-2027	2027-2030
		MW	MW
AF22	Dispatchable	-136	-687
	Wind power	1.844	161
	Solar power	3.281	5.249
EVA	Dispatchable	-120	4140
Total		4.868	8.863

DK2	Capacity changes	2025-2027	2027-2030
		MW	MW
AF22	Dispatchable	-35	-76
	Wind power	468	4.172
	Solar power	1.454	1.900
EVA	Dispatchable	150	1540
Total		2.038	7.535

Fig. 6 - EVA made significant changes in the Danish planning for the period 2025-2030

EVA doubles Danish dispatchable capacity

EVA tries to equalize the difference between DK1 and DK2 by adding dispatchable capacity. The total Danish dispatchable capacity in AF22 is 4345 MW in 2030 (2281 MW for DK1 and 2064 MW for DK2). After the EVA adjustment, the total Danish dispatchable capacity is more than doubled to 10,025 MW (6421 MW for DK1 and 3604 MW for DK2).

LOLE	2025	2027	2030
h/Year			
DK1	9,8	13,4	2,3
DK2	7,4	11,1	10,9
DE	10,5	13,7	20,4
SE4	2	5,1	5,5

Fig. 5 - LOLE results from ERAA Central Reference Scenario without CM

AF22 does not specify forecasted demand in MW. The max load in Denmark was 6419 MW in 2022. The estimated installed capacity in 2030 (AF22 central estimate) is:

Dispatchable capacity:	4,345 MW
Wind power:	35,839 MW
Solar power:	17,744 MW

These figures indicate the magnitude of changes (and investments) in just 8 years. The assessments of security of supply must be correspondingly uncertain for both ENTSO-E and Danish authorities. Available results should therefore be evaluated with skepticism. The matter is complicated. Nevertheless, it deserves more public attention in Denmark than up to now.

The use of EVA may be well justified, but when the results of ERAA 2022 are used for reliability evaluations, the deviation from Danish national plans should be kept in mind. The result without the intervention of EVA would probably be similar to the German (DE) in 2030 for DK1. LOLE for DK2 would probably be slightly lower as estimated for 2027.

Annex 3 of ERAA 2022 has a table 4 with capacity changes proposed by EVA for all price zones of the project. Annex 4 has additional explanations for most countries, including Denmark. Extract of the Danish comment:

These Danish developments seen in isolation would indicate increased risk of the adequacy indicators results over the ERAA 2022 time scope. However, as can be seen from the Executive Report (Section 4.2) and Annex 3 (Section 3.2), Danish adequacy indicators (both EENS and LOLE) in especially DKW1 decreases significantly between 2027 and 2030. This is, at least in part, due to the massive investments in gas CCGTs in both DKE1 (380 MW) and DKW1 (2750 MW), life extensions of gas OCGT in DKE1 (50 MW) and DKW1 (30 MW) and DSR in DKE1 (290 MW) and DKW1 (500 MW) deemed economically viable by the EVA be-

tween 2025 and 2030. The thermal investments correspond to a 66% increase of Danish installed thermal capacity between the National Estimates and the post-EVA scenario without capacity mechanisms.

Due to time constraints, the effects of capacity mechanisms have not been analyzed in ERAA 2022.

Reason to worry about Danish security of electricity supply by 2030

Denmark has a high rank in 2025 and 2027 on the top 11 list of the 37 countries considered in ERAA 2022. The results suggest that security of supply in Germany and its surrounding countries could be challenged in the future.

The Danish system operator, Energinet, has confirmed by mail that here are no plans in Denmark of additional dispatchable capacities, as proposed by EVA.

According to the ERAA results, the absence of the EVA intervention would leave Danish electricity consumers with a supply reliability among the worst in Europe by 2030.

Denmark depends more than most other countries on import of electricity during periods without wind and solar power. The ERAA 2022 results indicate that surplus electricity will be available elsewhere in Europe, but that it may be difficult to have this surplus conveyed to the shortage areas in and around Germany.

Internal bottlenecks in German and Swedish grids will probably still exist in 2030 and form essential physical barriers for long-distance transit of electricity.

For unknown reasons, the risk of energy shortage disappeared from Danish energy planning rules 10 years ago.

During international crises, there is a risk that each country will defend its own interest by limiting exchange of electricity. Therefore, most countries also analyze their degree of self-sufficiency. Limitations on international exchange would bring Denmark in a more vulnerable situation than most other countries.

Danish consumers have experienced increased cost of energy, and particularly electricity. The future cost and security of supply for electricity deserves intensified public attention in Denmark.