Nordic Power System

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NORDIC PERSPECTIVES ON MID-TERM ADEQUACY FORECAST 2017

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1. Introduction

Fingrid, Svenska kraftnät, Statnett and Energinet are transmission system operators (TSOs) for the Nordic power system, and each play a crucial role in ensuring security of supply for society. Through three core activities: Electricity system operation, infrastructure management, and market facilitation, the TSOs ensure reliable transmission of electricity both now and in the future.

The Nordic TSOs are currently developing a common platform for assessing long-term generation adequacy. This centres on identifying and quantifying risks to the future delivery of power to consumers. To this end, a probabilistic approach is employed, which captures the uncertainties related to variable generation, plant and interconnector outages, and the effect of weather conditions on demand. This assessment is conducted using the BID[1] market model and is based on the input data used for ENTSO-E's annual Mid-Term Adequacy evaluation[2]. To give a relevant regional focus, we have modelled specific sensitivity analyses of Nordic interest.

[1] Better Investment Decisions (prepared by Pöyry Management Consulting).
[2] The ENTSO-E Mid-term Adequacy Forecast 2017 in public consultation can be found here..

For each scenario, we have used stochastic modelling, including the possibility of outages of power plants and interconnectors. The methodology takes its point of departure in the normal operating scenario, including some market measures such as exchange on interconnectors and demand responses. Hence, risks associated with power system operation in times of stress and mitigation measures used here are not included in the evaluation.

The results can be read as a demonstration of the sensitivity of different price areas to changes in underlying factors. Also, the absolute level of adequacy correlates with other input data assumptions.

In this study, LOLE/ENS measures are model results from the day-ahead market and not expected non-delivered power to end-users. If there is not enough production capacity to meet the demand in the day-ahead markets, strategic reserves and system reserves can be activated before controlled curtailment of demand is needed. Even in this case, controlled curtailment of demand does not mean a nationwide blackout.

ENS (Energy Not Served) (MWh/year) indicates unserved energy per year, including the risk of blackout, i.e. the total energy consumption need which cannot be met by production in the day-ahead market.

LOLE (Loss Of Load Expectation) (hours/year) indicates the number of hours with a power shortage irrespective of the extent of the shortage in the day-ahead market.

A high LOLE does not mean that we expect a high number of hours with a power shortage, but there is a risk of shortage in a number of hours.

Results are presented in a similar way throughout the report. The figure below explains the bar chart used.

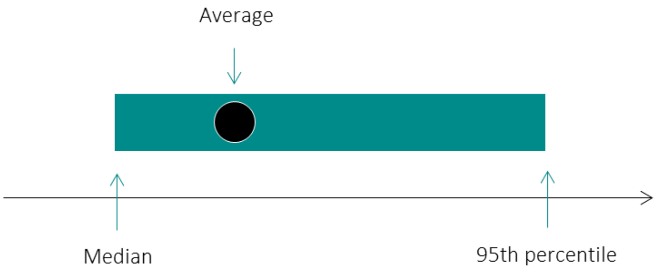

Figure 1-1 Explanation of bar charts with results.

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2. Nordic perspectives on Mid-term Adequacy Forecast 2017

Since the publication of the Mid-term Adequacy Forecast (MAF) 2016 report, activities have been consolidated, improved and standardised. New trends have emerged, and the prospective database has been updated with the support of national TSOs. In addition, modelling features have been added and improved, especially within the demand side response field, thermal plants' forced-outage modelling, and the extension of climatic conditions samples. Therefore, the new results correspond to an updated and improved best estimate of future adequacy conditions.

The MAF satisfies the need for a Pan-European adequacy assessment for the coming decade. Still, it should be noted that both the present pan-European and Nordic assessments inevitably face limitations. Nordic perspectives focus on sensitivities especially relevant for the Nordic TSOs, and include developments in thermal capacity, Russian exchange, weather patterns, location of wind and grid constraints.

The MAF results show the expected development of the adequacy situation in the Nordic countries. In the Danish case, both the national risk assessment and the MAF show that expected adequacy differs for the two price zones in Denmark. For Western Denmark, there is almost no increase in lack of power adequacy until 2025, while Eastern Denmark has a greater risk of adequacy issues.

The Finnish adequacy level has tightened during recent years, and this trend is set to continue if more power plants are decommissioned in the future. However, the simulated loss of load level in the MAF 2017 report for 2025 is considerably higher than Fingrid's projections, due to an increased simulated number of power plant failures. Also, both MAF 2017 and the Nordic perspective simulations for 2025 do not include strategic reserves for Finland. Finland currently has a 729 MW strategic reserve, operational until 2020, with an option to uphold this reserve after 2020. The strategic reserves are illustrated in table 1.

In the Norwegian case, simulations do not indicate any adequacy issues in the following years.

Swedish adequacy levels do not show any risk for loss of load in 2025, but the risk may be underestimated due to assumptions of availability on the interconnectors. Furthermore, the strategic reserve is included in the model, which means that the result doesn't show how many hours the reserve may have been activated. An activated reserve indicates a tight capacity balance even if an actual shortage situation has not occurred. Adequacy in both MAF 2017 and the Nordic perspectives is significantly higher than that presented in the Swedish system development plan 2018-2027. This is due to different assumptions about internal grid constraints where MAF and the Nordic perspectives assume 100 % availability on AC lines and a defined outage rate on HVDC connections, while the Swedish system development plan uses historical availability. Both MAF 2017 and the Nordic perspectives include power plants that are currently in the strategic reserve in Sweden. The strategic reserve is seen as a temporary solution, expected to be phased out by 2025, but if there are adequacy concerns, the strategic reserve may be prolonged.

The Nordic TSOs continuously monitor the capacity situation, and consider different mitigating actions to strengthen adequacy. Also, market signals will provide actors with price signals to ensure that periods of inadequacy do not appear often over time. Producers have a strong interest in generating at high prices and thus reducing them, while consumers are encouraged to lower their demand.

Table 1 Strategic reserves (MW)

	Included in base case	Not included in base case
Sweden	750	
Finland		729

3. Interpretation of results

The results in this report give an indication of the capacity tightness that can be expected in 2025, but should not be regarded as a prediction of load loss. The reason for this is due to limitations of the model and methodology of the analyses.

The analysis is based on the data used by the Nordic TSOs to simulate the day-ahead market. During the operational hour all TSOs have access to ancillary services that can be activated. There is a total of 5300 (1300 FI + 1400 SE + 1700 NO + 900 DK) MW of reserves in the Nordic system which were not modelled in the simulations.

Furthermore, the analysis is based on a model of the market, and models are always simplified to some extent, in this case mostly concerning grid and hydropower. The grid inside the price areas is not modelled and thus assumed to be without limitations. In addition, modelling of the hydropower is simplified, which means that energy shortage during dry years is not affecting the adequacy level satisfactory.

There are also market dynamics to take into account. If the adequacy level starts to deteriorate, it will affect the price level, which in turn could incentivise new investments, bring mothballed plants back into operation or growth in demand response activities.

Finally, it can be noted that some of the sensitivity scenarios are somewhat extreme. For these scenarios there are no historical data on which to base the analysis, so the model results do not necessarily represent the system satisfactory in such events.

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4. The Nordic base case in 2025

The Nordic base case is based on the 2025 "best estimate" from the Mid-term Adequacy Forecast 2017.[3] Data is provided by each TSO and should reflect all national and European regulations in place. Also, it should not conflict with the bottom-up 2030 "Sustainable Transition" in TYNDP 2018 Scenario Report.[4]

The Nordic base case represents the best estimate of the Nordic TSOs on Nordic power system development. Adequacy levels are highly dependent on the assumptions related to these parameters. The risk of resource inadequacy for Finland is lower in the base case in this report because this study assumes lower forced outage rates for Finnish thermal power plants than what was used in MAF 2017. This study assumes a 2 % forced outage rate for Finnish nuclear power plants and a 4 % forced outage rate for other thermal power plants.

The lower outage rate has improved the results for Finland significantly compared to the results of MAF 2017 which estimated an average 24 hours of loss of load for Finland in 2025. The current result of three hours matches results from Fingrid's national studies.

The model showed a loss of load for Finland during peak load hours when unfavorable weather conditions occurred simultaneously with at least two large power plant or an interconnector outages in Finland. From an adequacy perspective, unfavorable weather conditions are cold, non-windy winter days with high demand and low wind power production. Also, the model assumed no import capacity from Russia during the peak load hours due to current capacity payments in the Russian electricity markets.

[3] The assumptions for MAF 2017 can be found here.
[4] You can read the draft edition of the TYNDP 2018 Scenario Report here.

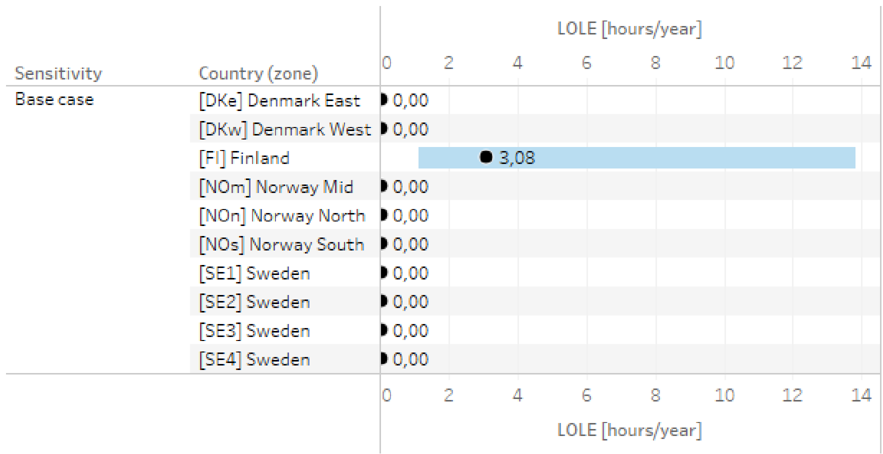

Figure 4-1 LOLE results for the base case.

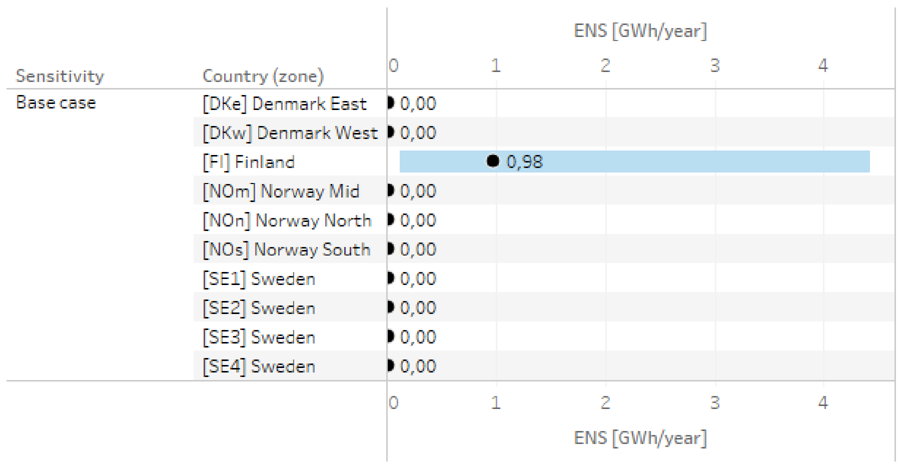

Figure 4-2 ENS results for the base case.

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5. Location of wind – northern and southern distribution

The geographical distribution of future wind power is a great source of uncertainty in the Nordic system. The placement depends on both the outcome of local permission processes, financing and political decisions regarding national subsidies (e.g. subsidies for offshore wind). The location of wind turbines in the system is seen as important for generation adequacy for two reasons:

- Risk of power confinement
- Risk of too similar production patterns

Two additional sensitivity cases were performed on the future of wind localisation. The base case was adjusted with an emphasis on a northern and a southern development in the Nordic system, extreme north and extreme south.

In the extreme north scenario, all of the expected development in wind power between 2017 and 2025 is constructed north of the border between SE2 and SE3 in Sweden and north of the border between NO3 and NO4 in Norway. The expected capacity growth in the base case sums this up to about 3100 MW in Sweden and 1300 MW in Norway. This gives an average offset to the north/south energy balance of about 6 TWh in Sweden and 1.5 TWh in Norway, if compared to the base case.

In the extreme south scenario, offshore wind is expected to be subsidised, and all the expected development in wind power between 2017 and 2025 is developed outside SE4 and NO2, i.e. the southern parts of the Nordic system. This gives an average offset to the north/south energy balance of about 11 TWh in Sweden and 2.5 TWh in Norway compared to the base case.

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Table 2 Installed wind power capacity in 2025 in the different scenarios (MW)

	Base	Extreme North	Extreme South
DKe	2053	2053	2053
DKw	5635	5635	5635
FI	2700	2700	2700
NOm	1479,3	1479,3	1479,3
NOn	1106	1407	590
NOs	515	214	1031
SE1	1010	1378	512
SE2	3860	4677	2220
SE3	2550	1733	4190
SE4	1620	1252	2118

As it turns out, neither scenario has any effect on generation adequacy in any of the Nordic areas compared with the base case, see Figure 3-1 and Figure 3 2. This might seem a bit puzzling at first but the results show two things: wind generation does not contribute that much during the tightest situations, and the flexibility provided by interconnections is great enough to cope with all scenarios. It turns out that the most critical situation for the south is strongly correlated with low wind production, and therefore, it does not matter if wind is found in the north or the south, as the south is dependent on imports during these hours either way.

This will probably not be the case when more of the Swedish nuclear plants are decommissioned, and the energy balance in the southern parts of the Nordic area becomes increasingly strained. Relying more heavily on imports consumes some of the flexibility, that interconnectors can provide, and adding nuclear decommissioning to the extreme north will probably saturate that flexibility.

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6. Weather patterns – extreme heat and extreme storm

Lack of generation adequacy in the Nordic system can be a consequence of unfortunate weather and climate. In this sensitivity example, we wanted to see how the results would change if we adjusted important weather input to the model. Using the base case as a starting point, two sensitivity tests were performed:

Extreme heat

Increased non-Nordic demand by 10%. Decreased Nordic (excl. Danish) demand by 5%. Decreased Nordic hydro inflow by 40%.

Extreme storm

Zero capacity on Skagerrak 1 and 2 cables, DK1-Germany, NordLink and 25% reduced capacity on SE2-SE3. Increased Nordic hydro inflow by 20%. No PV production, but increased wind production by 10%. Increased non-Nordic demand by 5%.

Table 3 Changes in demand and hydrological inflow for the sensitivity extreme heat

	Demand	Hydro inflow
Norway, Sweden and Finland	-5%	-40%
The rest of Europe including Denmark	+10%	

Table 4 Changes in demand, hydro inflow and generation capacities for the sensitivity extreme storm

	Demand	Hydro inflow	Photovoltaic	Wind
Norway, Sweden and Finland		+20%	-100%	+10%
The rest of Europe including Denmark	+5%			

Table 5 Changes in net transfer capacity for the sensitivity extreme storm

	Net transfer capacity
Skagerrak 1 and 2	-100%
DK1-Germany	-100%
NordLink	-100%
SE2-SE3	-25%

These sensitivity examples are not meant to be highly realistic, but to show how the system might react to very unlikely events.

The model results still do not show any changes to Norwegian and Swedish ENS or LOLE in both cases. Even in sensitivity example A with low hydro inflow, which should impact these countries the most, we see no loss of load. But power prices are much higher, and the system is strained. This means higher probability of loss of load, also in Denmark and Finland.

The Finnish loss of load is double, mainly due to low inflows, while the Danish loss of load emerges with tight continental balance. Sensitivity example B has increased hydro inflow. Still, this sensitivity simulation shows extensive loss of load due to the low interconnection between areas in combination with smaller contributions from Nordic generation and continental imports. The simulated loss of load happens on cold winter days in most weather years for case B, where imports and generation do not meet the demand.

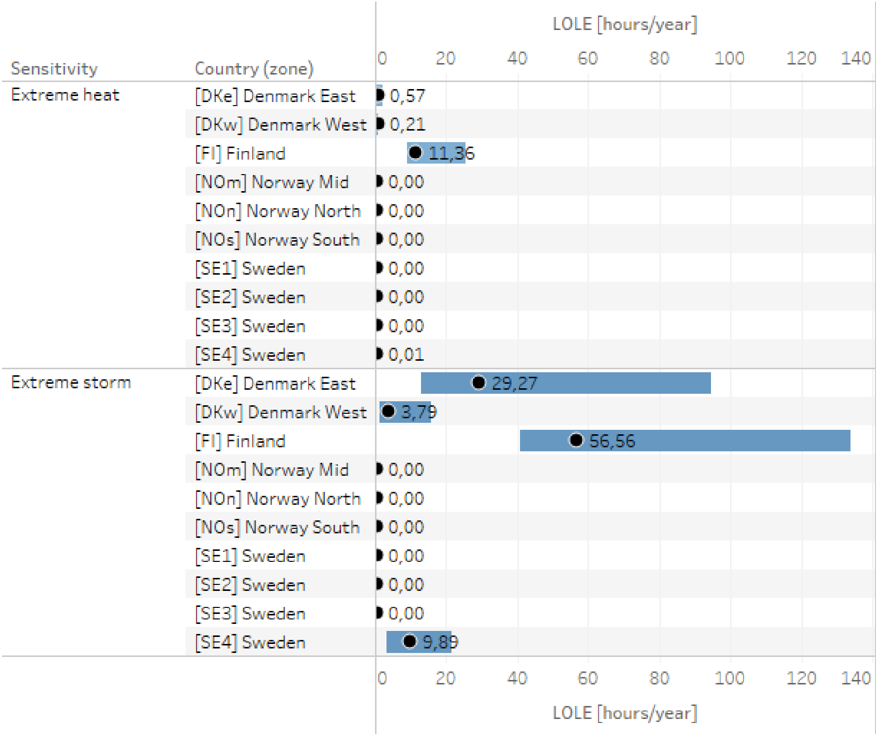

Figure 6-1 LOLE results for weather pattern sensitivity

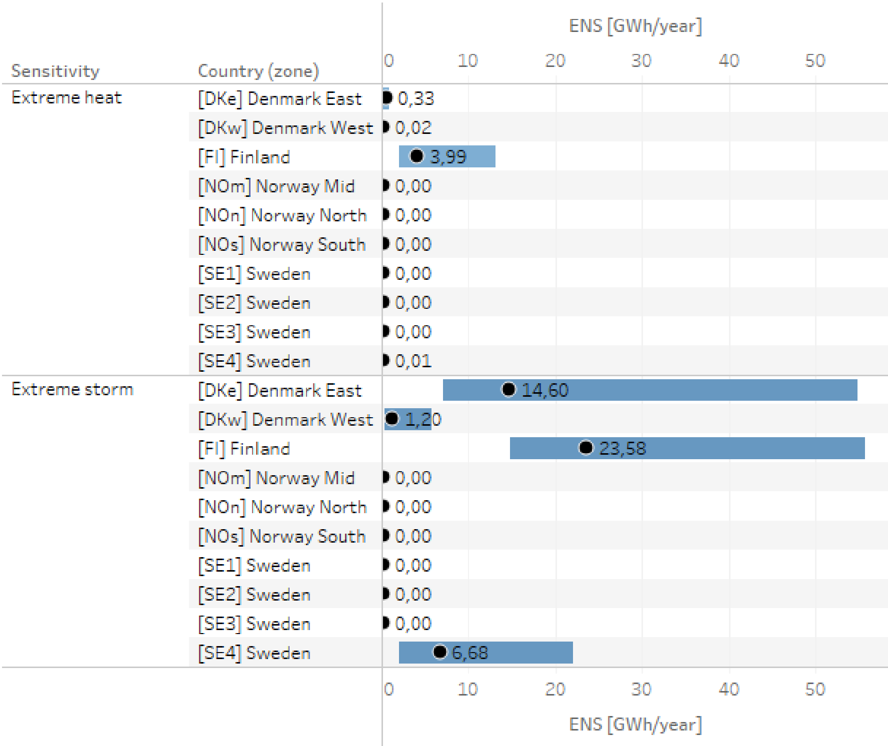

Figure 6-2 ENS for weather pattern sensitivity

7. No Russian cross-border exchange

The next four sensitivity cases relate to assumptions regarding Russian cross-border exchange, thermal capacity and nuclear capacity in the Nordic area. In each sensitivity case, all assumptions, other than the changes specifically explained, were identical to the base case scenario. This allows us to look at the magnitude of the effect of each factor separately on the risk of resource adequacy in each price area in the Nordic system.

The Russian cross-border exchange sensitivity case assumes that there is no cross-border exchange between Finland and Russia in 2025. As depicted in Figure 7-1, Russian exchange does not have a notable effect on other price areas than Finland. Results indicate high resource adequacy for the other price areas in the Nordic system but an increased risk of resource inadequacy for Finland (6.7 h/year) which is about double compared to the base case level.

Table 6 Fixed flow between Russia and Finland (TWh)

	Base case	Sensitivity
FI export	0.25	0
FI import	27.15	0

The model showed a loss of load when unfavourable weather conditions occur simultaneously with an outage of a large power plant, an interconnector or multiple medium-sized power plants in Finland.

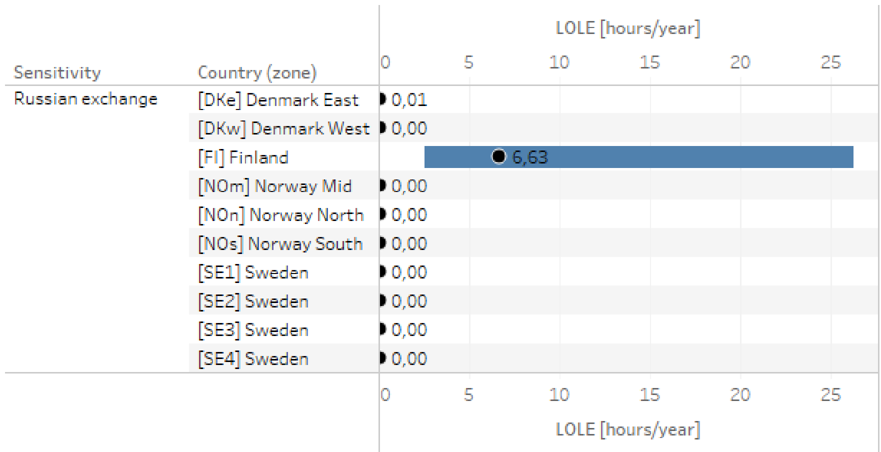

Figure 7-1 LOLE results for Russian exchange sensitivity.

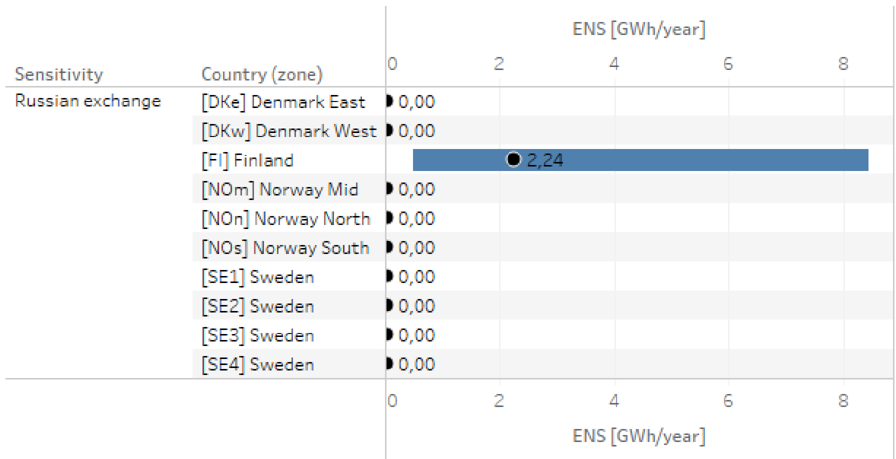

Figure 7-2 ENS results for Russian exchange sensitivity.

8. Reduction in CHP capacity

The low CHP sensitivity case assumes continued low wholesale market prices, resulting in even lower profitability of thermal power plants in Denmark, Sweden and Finland. With the current views of the TSOs, low market prices could result in a decrease of eight percent of the non-nuclear thermal capacity in total in the Nordic system by 2025. This could be a result of reduced new investments or decommissioning of unprofitable thermal plants. These plants are additional to the base case scenario where the Finnish peak load capacity is already decommissioned by 2025. In this sensitivity simulation, low wholesale market prices do not influence nuclear capacity in Sweden or in Finland.

Table 7 Non-nuclear thermal capacity (MW)

	Capacity
Base case	7,179
Sensitivity	5,851

This sensitivity case produced somewhat similar results as the cross-border exchange sensitivity case. Reduced thermal capacity did not have a significant effect on the risk of resource adequacy in other price areas in the Nordic area besides Finland. However, the risk of resource inadequacy in Finland increased three-fold compared to the base case estimate. This indicates that unprofitability of thermal plants would have a more severe effect in Finland than the Russian cross-border exchange.

The model showed a loss of load during peak load hours when an outage occurs in a large power plant unit, interconnector or multiple medium-sized units in the Finnish system simultaneously during unfavourable weather conditions. These unfavourable weather conditions are cold winter days when there is low wind power production. Also, characteristic for loss of load hours was that they occurred during weekdays when Russian import capacity was assumed zero due to Russian capacity payments, and when unavailability of energy limited the import capacity through Estlink.

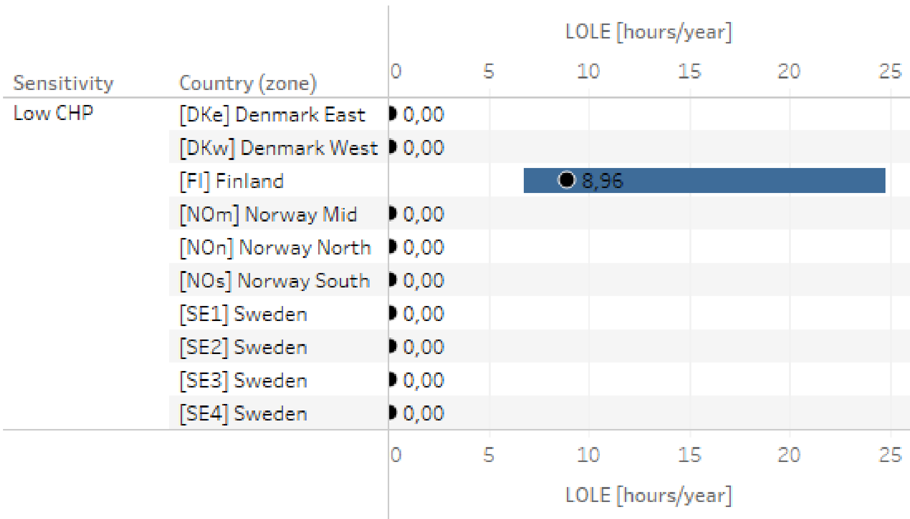

Figure 8-1 LOLE results for low CHP sensitivity.

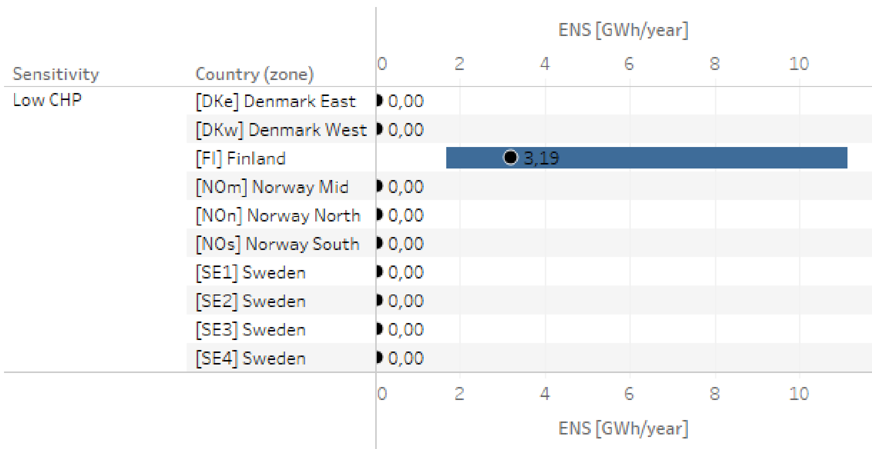

Figure 8-2 ENS results for low CHP sensitivity.

9. Reduction in nuclear capacity

The low nuclear capacity sensitivity case assumed that nuclear capacity would be lower than estimated in 2025. Sweden had three nuclear power plants in operation instead of six and Finland had five instead of six, equalling a decrease of almost 30 % compared to the base case estimate of total nuclear capacity in Sweden and in Finland.

Table 8 Nuclear generation capacity (MW)

	Base case	Sensitivity
Finland	5,565	4,363
Sweden	6,852	3,271

As shown in Figure 9-1, decreased nuclear capacity would result in a low risk of resource inadequacy for the price areas Denmark East, Denmark West and Sweden SE4 (less than 0.15 h/year), but a very severe risk for Finland (56 h/year). This level is more than tenfold compared to the base case for Finland and clearly indicates, that resource adequacy is very sensitive to nuclear capacity changes in the Nordic area.

In due time, a full phase-out of Swedish nuclear capacity is expected, and therefore, the next sensitivity looks into a scenario where all Swedish nuclear capacity is decommissioned and the remaining strategic reserve taken out.

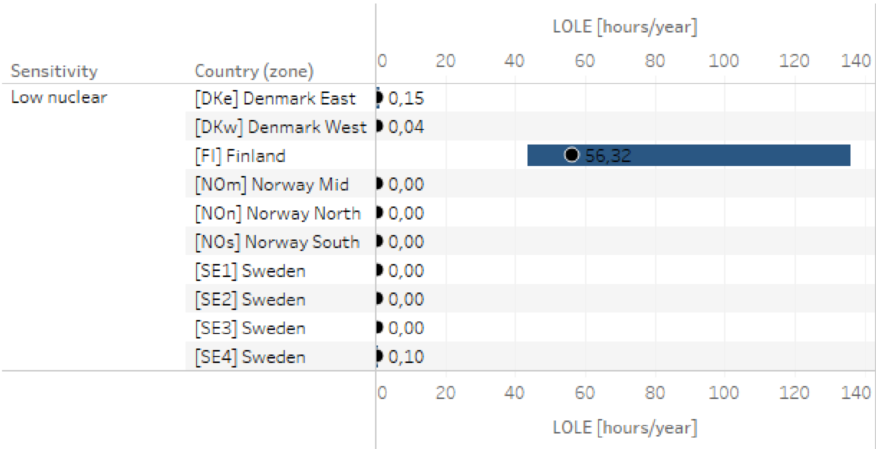

Figure 9-1 LOLE results for low nuclear sensitivity.

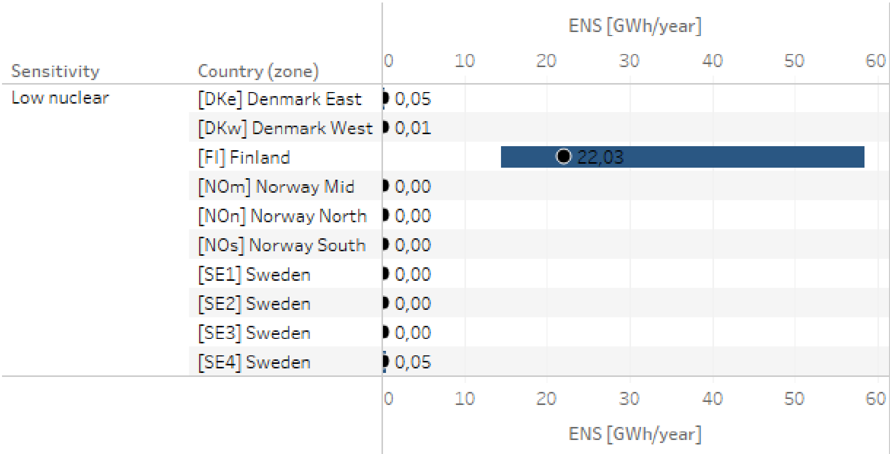

Figure 9-2 ENS results for low nuclear sensitivity.

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11. Phase-out of Swedish nuclear

The phase-out of Swedish nuclear capacity sensitivity case assumes a full decommissioning of nuclear power in Sweden by 2025. On top of that, it assumes that the remainder of the Swedish strategic reserve, available in the base case, is phased out by 2020, and that there are five nuclear reactors in operation in Finland in 2025. This creates quite an extreme scenario where the Nordic area, more specifically SE3 and SE4, lose more than 7000 MW production capacity compared to the base case.

Table 9 Nuclear generation capacity (MW)

	Base case	Sensitivity
Sweden	6,852	0
Finland	5,565	4,365

Table 10 Strategic reserve (MW)

	Base case	Sensitivity
Sweden	410	0

Losing this amount of nuclear production would have a great impact on the Nordic power system and its security of supply. The risk of inadequacy in Finland, the most vulnerable part of the system, would rise to about 75 h/year which is more than twentyfold compared to the base case.

Moreover, the level in Sweden would rise from 0 h/year to about 20 h/year divided between SE3 and SE4. This is still significantly lower than the figures presented in the Swedish system development plan 2018-2027 which indicates that extra flexibility of 400 h/year on average will be needed in Sweden alone, when nuclear capacity is phased out by 2040. In MAF 2017, missing flexibility is compensated for by considerably increased availability on interconnectors, both AC and HVDC, than what is assumed in the Swedish system development plan. Even so, the risk level still highlights the fact that decreased nuclear capacity would result in elevated wholesale market prices, which again would make other investments profitable or increase the amount of demand side response to ensure an increased security of supply in Finland and Sweden.

Decommissioning of nuclear and strategic reserve in Sweden reduces the extra margin at which Sweden and its neighbouring Nordic price areas can handle extreme weather conditions. The model showed a risk of loss of load for the price areas that are dependent on import capacity in peak demand situations. These situations occurred most frequently in the Sweden SE3, Sweden SE4 and Finland price areas during cold winter days with low wind power production. This differs from earlier sensitivity cases since the loss of load occurred without major outages in power production units or interconnectors in the region.

Loss of load also occurred in the Denmark east and Denmark west price areas, when a cold and non-windy winter day occurred in Denmark in addition to the neighbouring price areas of Denmark. This resulted in a situation where loss of load occurred in a large region, and there was not enough excess energy to be transmitted through interconnectors from neighbouring areas, even though there was plenty of capacity.

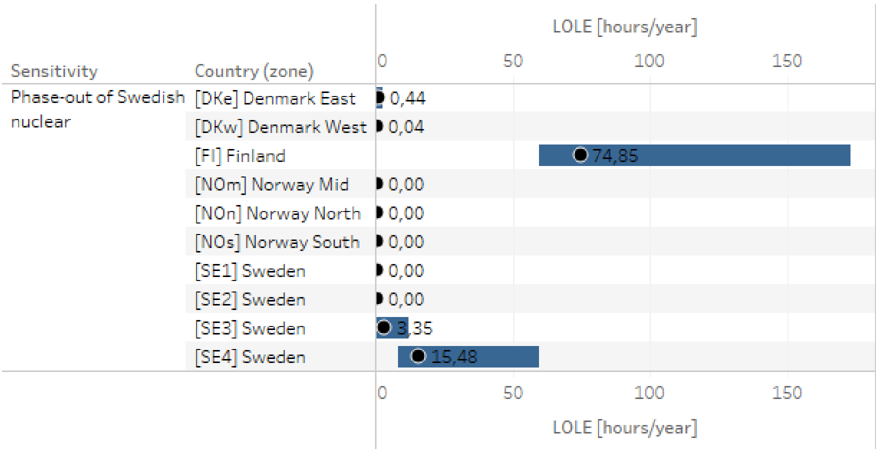

Figure 11-1 LOLE results for phase-out of Swedish nuclear sensitivity.

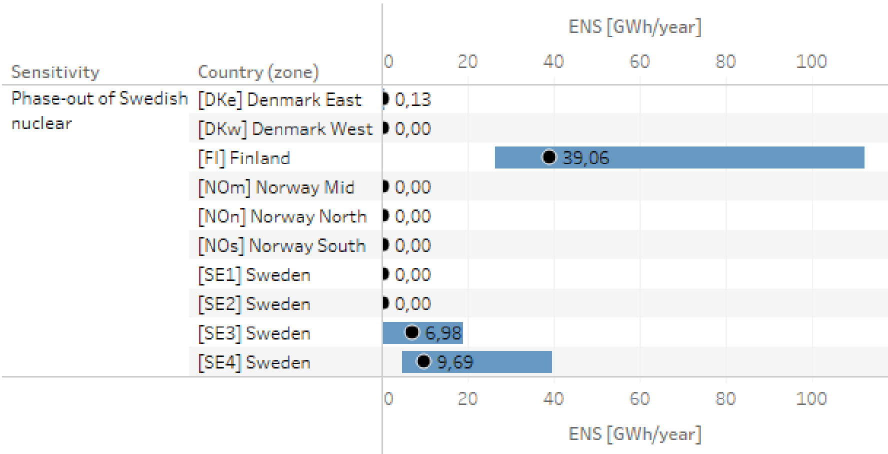

Figure 11-2 ENS results for phase-out of Swedish nuclear sensitivity.

12. Grid constraints on the Danish-German border

Grid constraints are seen on the border of Western Denmark. The model does not model the internal grid.

The constraints implemented in the model occur:

1. In situations with lots of wind and/or solar production in Germany combined with low demand
2. Only on the export capacity from Western Denmark to Germany.

When assessing the adequacy situation, an analysis is performed of hours when demand cannot be met by supply. Hence, situations in which constraints are applied on the border between Denmark and Germany are not hours where the adequacy situation is challenged in the Nordic countries. As constraints only apply to export capacity, it does not affect the opportunity to import from Germany in hours where loss of load is seen in Denmark or the other Nordic countries. Thus, constraints are not an issue when assessing adequacy situations in the Nordic countries.

Figure 12-1   Illustration of the modelled grid constraints between Denmark west and Germany.

13. Conclusions

Overall results from the Nordic perspectives are broadly in line with the conclusions from MAF 2017 for the Nordic area. Nordic perspectives confirm the known tightness in the Finnish system but indicate that the results in MAF 2017 overestimate the problem by setting high outage rates for Finnish nuclear and thermal power plants. The base case also confirms that there is not a strong indication for a need for concern in the Nordic areas, if the power system develops in line with national projections. However this will not be the case if the assumptions do not last.

The six sensitivity analyses performed were chosen to deal with uncertain factors believed to have an impact on generation adequacy. With the exception of extreme storms and the phase-out of Swedish nuclear[5], the sensitivity cases all show that resource adequacy remains high in the Nordic power system except for Finland in 2025. The results of all six sensitivity cases clearly show an increased risk of scarcity situations in Finland, where nuclear phase-out and extreme heat severely elevate the risk of resource scarcity, low CHP has a high impact and the lack of cross-border exchange to Russia has a low impact.

The most severe, but still realistic, cases studied as part of the Nordic perspectives are the sensitivity cases involving low nuclear capacity. Swedish nuclear capacity is expected to be fully phased out by 2040, and the situation with only three reactors running is expected to be a reality already by 2035. Phasing out nuclear capacity earlier might lead to a severe risk of loss of load in Finland and Sweden SE4. This would also result in a low risk of resource inadequacy for the price areas Denmark East, Denmark West and Sweden SE3. Furthermore, losing a base production such as nuclear power would make the Nordic area more dependent on imports, consuming some of the flexibility observed in other sensitivity cases.

[5] Which can be considered very extreme in 2025.

14. Comparison of results

Figure 14-1 LOLE results for base case and all sensitivities.

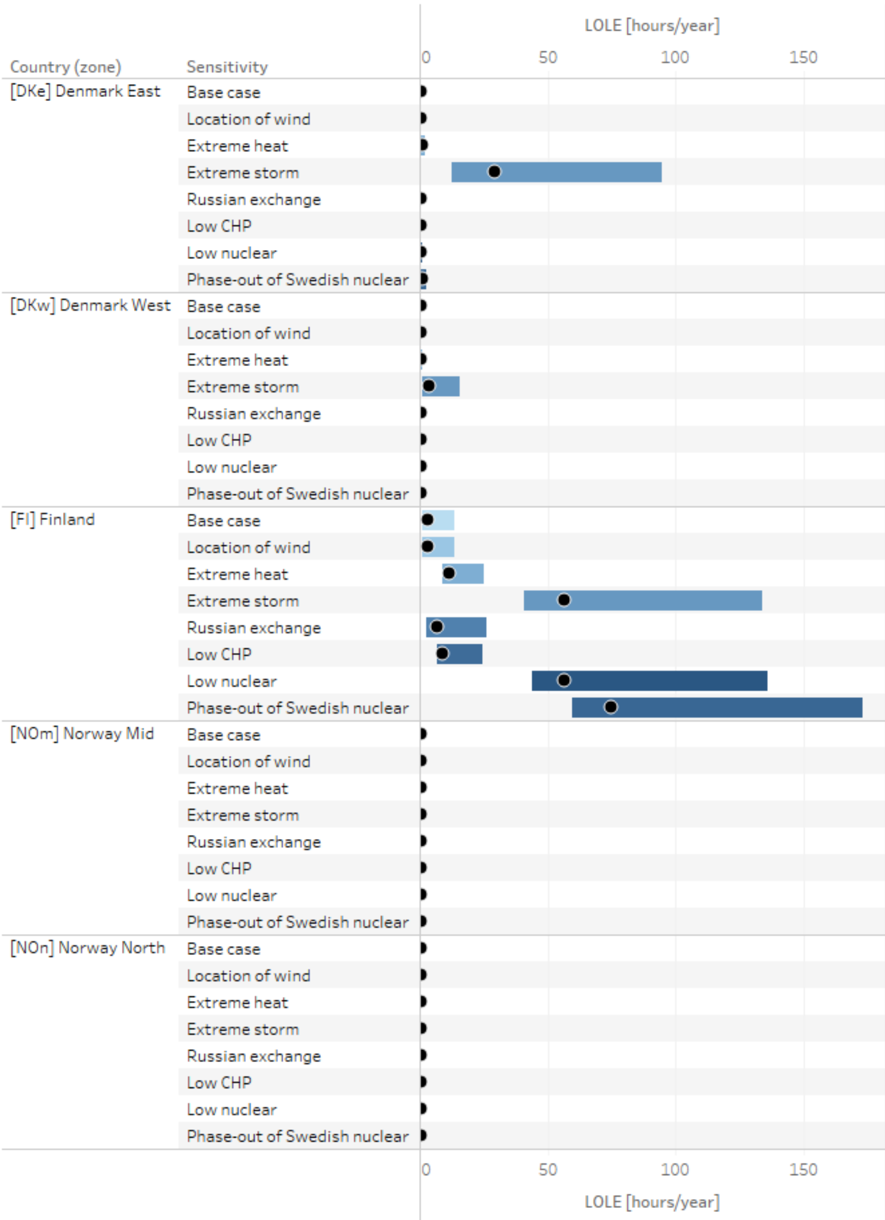

Figure 14-2 LOLE results for base case and all sensitivities.

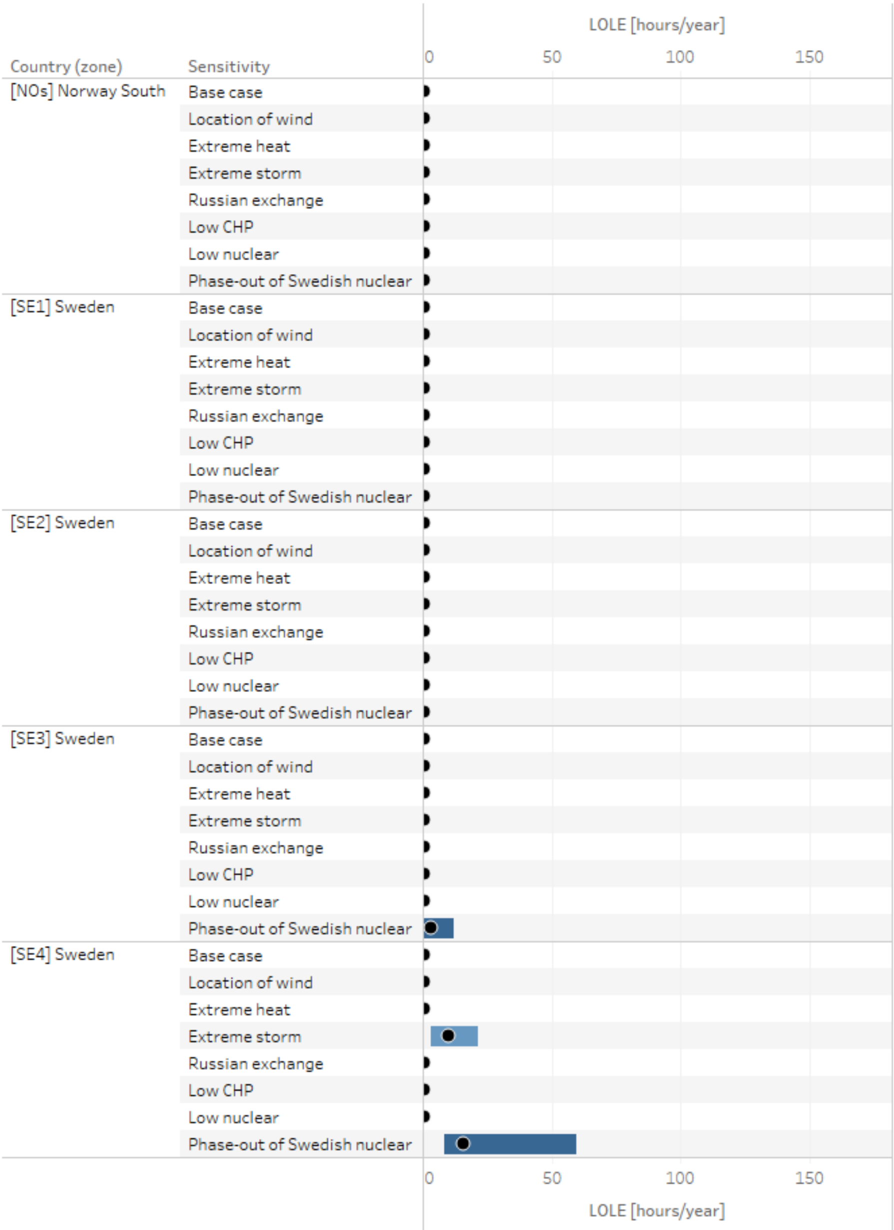

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Figure 14-3 LOLE values for base case and all sensitivities.

Country (zo..	Sensitivity	Average	Median	P95
[DKe] Denmark East	Base case	0,00	0,0	0,0
	Location of wind	0,00	0,0	0,0
	Extreme heat	0,57	0,0	1,9
	Extreme storm	29,27	12,8	94,5
	Russian exchange	0,01	0,0	0,0
	Low CHP	0,00	0,0	0,0
	Low nuclear	0,15	0,0	1,1
	Phase-out of Swedish nuclear	0,44	0,0	2,4
[DKw] Denmark West	Base case	0,00	0,0	0,0
	Location of wind	0,00	0,0	0,0
	Extreme heat	0,21	0,0	0,8
	Extreme storm	3,79	1,3	15,6
	Russian exchange	0,00	0,0	0,0
	Low CHP	0,00	0,0	0,0
	Low nuclear	0,04	0,0	0,1
	Phase-out of Swedish nuclear	0,04	0,0	0,3
[FI] Finland	Base case	3,08	1,1	13,8
	Location of wind	3,08	1,1	13,8
	Extreme heat	11,36	8,8	25,3
	Extreme storm	56,56	41,0	134,1
	Russian exchange	6,63	2,5	26,3
	Low CHP	8,96	6,8	24,8
	Low nuclear	56,32	43,8	136,2
	Phase-out of Swedish nuclear	74,85	59,4	173,3
[NOm] Norway Mid	Base case	0,00	0,0	0,0
	Location of wind	0,00	0,0	0,0
	Extreme heat	0,00	0,0	0,0
	Extreme storm	0,00	0,0	0,0
	Russian exchange	0,00	0,0	0,0
	Low CHP	0,00	0,0	0,0
	Low nuclear	0,00	0,0	0,0
	Phase-out of Swedish nuclear	0,00	0,0	0,0
[NOn] Norway North	Base case	0,00	0,0	0,0
	Location of wind	0,00	0,0	0,0
	Extreme heat	0,00	0,0	0,0
	Extreme storm	0,00	0,0	0,0
	Russian exchange	0,00	0,0	0,0
	Low CHP	0,00	0,0	0,0
	Low nuclear	0,00	0,0	0,0
	Phase-out of Swedish nuclear	0,00	0,0	0,0

Figure 14-4 LOLE values for base case and all sensitivities.

Country (zo..	Sensitivity	Average	Median	P95
[NOs] Norway South	Base case	0,00	0,00	0,00
	Location of wind	0,00	0,00	0,00
	Extreme heat	0,00	0,00	0,00
	Extreme storm	0,00	0,00	0,00
	Russian exchange	0,00	0,00	0,00
	Low CHP	0,00	0,00	0,00
	Low nuclear	0,00	0,00	0,00
	Phase-out of Swedish nuclear	0,00	0,00	0,00
[SE1] Sweden	Base case	0,00	0,00	0,00
	Location of wind	0,00	0,00	0,00
	Extreme heat	0,00	0,00	0,00
	Extreme storm	0,00	0,00	0,00
	Russian exchange	0,00	0,00	0,00
	Low CHP	0,00	0,00	0,00
	Low nuclear	0,00	0,00	0,00
	Phase-out of Swedish nuclear	0,00	0,00	0,00
[SE2] Sweden	Base case	0,00	0,00	0,00
	Location of wind	0,00	0,00	0,00
	Extreme heat	0,00	0,00	0,00
	Extreme storm	0,00	0,00	0,00
	Russian exchange	0,00	0,00	0,00
	Low CHP	0,00	0,00	0,00
	Low nuclear	0,00	0,00	0,00
	Phase-out of Swedish nuclear	0,00	0,00	0,00
[SE3] Sweden	Base case	0,00	0,00	0,00
	Location of wind	0,00	0,00	0,00
	Extreme heat	0,00	0,00	0,00
	Extreme storm	0,00	0,00	0,00
	Russian exchange	0,00	0,00	0,00
	Low CHP	0,00	0,00	0,00
	Low nuclear	0,00	0,00	0,00
	Phase-out of Swedish nuclear	3,35	0,00	11,92
[SE4] Sweden	Base case	0,00	0,00	0,00
	Location of wind	0,00	0,00	0,00
	Extreme heat	0,01	0,00	0,00
	Extreme storm	9,89	3,25	21,51
	Russian exchange	0,00	0,00	0,00
	Low CHP	0,00	0,00	0,00
	Low nuclear	0,10	0,00	0,67
	Phase-out of Swedish nuclear	15,48	8,13	59,71

Figure 14-5 ENS results for base case and all sensitivities.

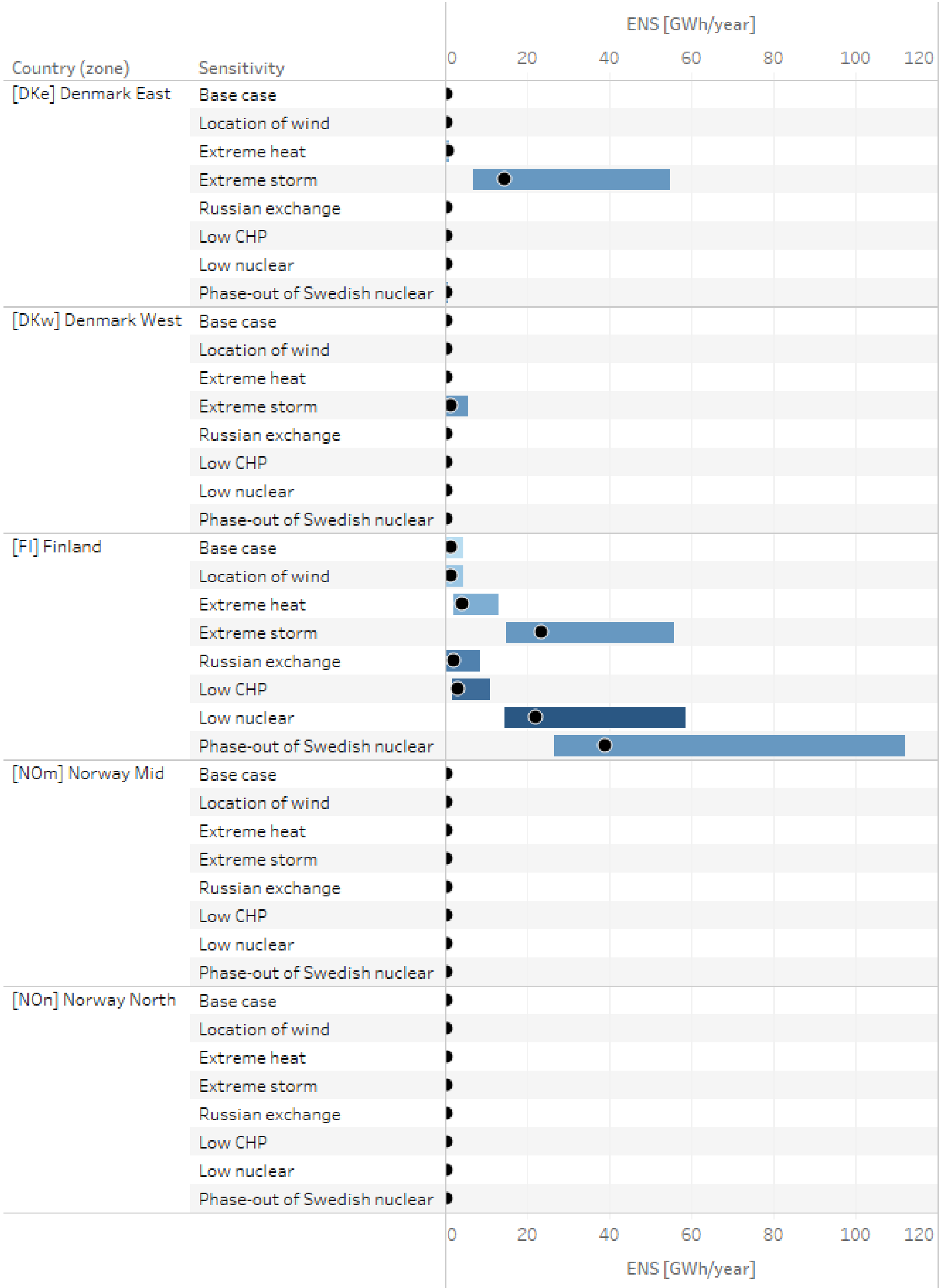

Figure 14-6 ENS results for base case and all sensitivities.

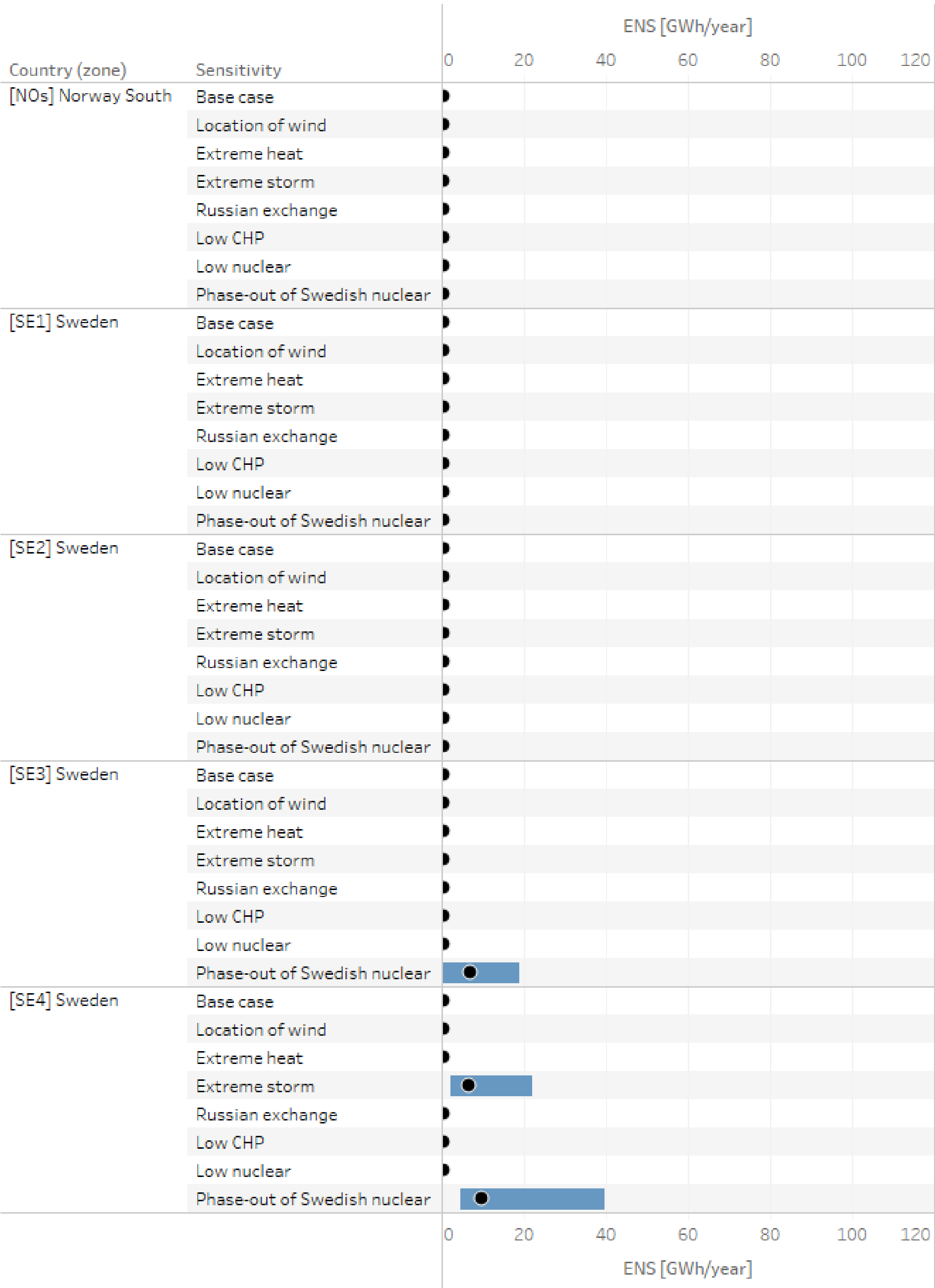

Figure 14-7 ENS values for base case and all sensitivities.

Country (zone)	Sensitivity	Average	Median	P95
[DKe] Denmark East	Base case	0,00	0,0	0,0
	Location of wind	0,00	0,0	0,0
	Extreme heat	0,33	0,0	0,9
	Extreme storm	14,60	7,0	54,9
	Russian exchange	0,00	0,0	0,0
	Low CHP	0,00	0,0	0,0
	Low nuclear	0,05	0,0	0,3
	Phase-out of Swedish nuclear	0,13	0,0	0,6
[DKw] Denmark West	Base case	0,00	0,0	0,0
	Location of wind	0,00	0,0	0,0
	Extreme heat	0,02	0,0	0,1
	Extreme storm	1,20	0,3	5,6
	Russian exchange	0,00	0,0	0,0
	Low CHP	0,00	0,0	0,0
	Low nuclear	0,01	0,0	0,0
	Phase-out of Swedish nuclear	0,00	0,0	0,0
[FI] Finland	Base case	0,98	0,1	4,4
	Location of wind	0,98	0,1	4,4
	Extreme heat	3,99	2,1	13,2
	Extreme storm	23,58	14,8	55,7
	Russian exchange	2,24	0,5	8,5
	Low CHP	3,19	1,7	11,2
	Low nuclear	22,03	14,4	58,5
	Phase-out of Swedish nuclear	39,06	26,5	112,2
[NOm] Norway Mid	Base case	0,00	0,0	0,0
	Location of wind	0,00	0,0	0,0
	Extreme heat	0,00	0,0	0,0
	Extreme storm	0,00	0,0	0,0
	Russian exchange	0,00	0,0	0,0
	Low CHP	0,00	0,0	0,0
	Low nuclear	0,00	0,0	0,0
	Phase-out of Swedish nuclear	0,00	0,0	0,0
[NOn] Norway North	Base case	0,00	0,0	0,0
	Location of wind	0,00	0,0	0,0
	Extreme heat	0,00	0,0	0,0
	Extreme storm	0,00	0,0	0,0
	Russian exchange	0,00	0,0	0,0
	Low CHP	0,00	0,0	0,0
	Low nuclear	0,00	0,0	0,0
	Phase-out of Swedish nuclear	0,00	0,0	0,0

Figure 14-8 ENS values for base case and all sensitivities.

Country (zone)	Sensitivity	Average	Median	P95
[NOs] Norway South	Base case	0,00	0,00	0,00
	Location of wind	0,00	0,00	0,00
	Extreme heat	0,00	0,00	0,00
	Extreme storm	0,00	0,00	0,00
	Russian exchange	0,00	0,00	0,00
	Low CHP	0,00	0,00	0,00
	Low nuclear	0,00	0,00	0,00
	Phase-out of Swedish nuclear	0,00	0,00	0,00
[SE1] Sweden	Base case	0,00	0,00	0,00
	Location of wind	0,00	0,00	0,00
	Extreme heat	0,00	0,00	0,00
	Extreme storm	0,00	0,00	0,00
	Russian exchange	0,00	0,00	0,00
	Low CHP	0,00	0,00	0,00
	Low nuclear	0,00	0,00	0,00
	Phase-out of Swedish nuclear	0,00	0,00	0,00
[SE2] Sweden	Base case	0,00	0,00	0,00
	Location of wind	0,00	0,00	0,00
	Extreme heat	0,00	0,00	0,00
	Extreme storm	0,00	0,00	0,00
	Russian exchange	0,00	0,00	0,00
	Low CHP	0,00	0,00	0,00
	Low nuclear	0,00	0,00	0,00
	Phase-out of Swedish nuclear	0,00	0,00	0,00
[SE3] Sweden	Base case	0,00	0,00	0,00
	Location of wind	0,00	0,00	0,00
	Extreme heat	0,00	0,00	0,00
	Extreme storm	0,00	0,00	0,00
	Russian exchange	0,00	0,00	0,00
	Low CHP	0,00	0,00	0,00
	Low nuclear	0,00	0,00	0,00
	Phase-out of Swedish nuclear	6,98	0,00	18,81
[SE4] Sweden	Base case	0,00	0,00	0,00
	Location of wind	0,00	0,00	0,00
	Extreme heat	0,01	0,00	0,00
	Extreme storm	6,68	1,95	21,99
	Russian exchange	0,00	0,00	0,00
	Low CHP	0,00	0,00	0,00
	Low nuclear	0,05	0,00	0,48
	Phase-out of Swedish nuclear	9,69	4,58	39,77