NBM
Nordic Balancing Model

SVENSKA KRAFTNÄT ENERGINET FINGRID Statnett

Evaluation Report

The Nordic aFRR and mFRR capacity markets

25 09 2026

Contents

Summary 3
1 Introduction 4
2 Forecasted vs. Actual market values of cross-zonal capacity (5a) 5
2.1 SDAC spread errors 5
2.1.1 Frequency of non-zero SDAC spread errors 6
2.1.2 Average SDAC spread errors 7
2.2 Markup 8
2.3 CZC forecast error 10
2.3.1 CZC forecast error distribution 10
2.4 Comments 13
3 Increase above the 10% NTC limits (5b) 13
4 Impacts on economic surplus (5c) 16
4.1 SDAC impact 16
4.1.1 Approximate Calculation Method 16
4.1.2 Simulation Facility 20
4.1.3 Comparing the two methods 21
4.2 Capacity market benefits 22
4.2.1 Results by component 23
4.2.2 Results by bidding zone 23
4.2.3 Avoided under-procurement and trade benefit 23
4.2.4 Monthly profile 24
4.3 Total economic surplus SDAC and capacity markets 24
5 APPENDIX A 26
6 APPENDIX B 29

Summary

This report evaluates the Nordic capacity markets for 2025 and is the first to cover both the aFRR and the mFRR capacity market. The evaluation is broadly split into three: 1) the forecast method for cross-zonal capacity (CZC) values, 2) the 10% NTC limit for CZC, and 3) the economic surplus from the exchange of balancing capacity. The two markets clear sequentially, the aFRR CM first and the mFRR CM against the remaining capacity.

The CZC values used to clear the markets consist of a forecasted day-ahead price spread, based on the reference day D-1, and a dynamic markup derived from recent forecast errors. Compared with the actual spread in the single day-ahead coupling (SDAC), 39% of the combined border directions and hours have no forecast error, 38% have a forecasted CZC cost above the actual value and 23% below. The average absolute SDAC spread error is 7.8 EUR/MW. Forecast performance is weaker than in 2024, when 69% of border-hours had no error and the average absolute spread error was 5.5 EUR/MW, though it covered 22 border directions rather than 26.

In most cases, the 10% NTC limit is sufficient for an efficient allocation of reserves. Average utilization is 15% in the aFRR CM and 40% in the mFRR CM. No border exceeded the limit in the aFRR CM, while in the mFRR CM six borders reserved above 10% and up to the maximum of 20% of NTC, NO4->NO3 in 11% of the hours; since NO3 and NO4 form an isolated area, scarcity there can only be relieved in this way. The estimated loss in SDAC from these reservations is 0.71 mill. EUR, 82% of it on that border.

For 2025 the estimated reduction in SDAC surplus is 80.1 mill. EUR, 16.4 mill. EUR from aFRR and 63.8 mill. EUR from mFRR, an average of 219'573 EUR per day. The SE3->SE4 and SE2->SE3 border directions account for 61% of the loss. The aFRR loss is 28% lower than the 22.85 mill. EUR reported for 2024. The SDAC Simulation Facility gives around 85 mill. EUR, placing the loss in the range 80-85 mill. EUR.

The benefit in the capacity markets is 1'702.6 mill. EUR, 224.0 mill. EUR in the aFRR CM and 1'478.6 mill. EUR in the mFRR CM. Following the method change announced for 2025, demand that cannot be covered locally is now valued rather than set to zero, and 1'265.1 mill. EUR of the total comes from such avoided under-procurement, 1'118.7 mill. EUR of it in SE4, which without exchange could not have covered its upward mFRR demand in any hour. This is the value of security of supply in SE4 rather than a trading gain, and rests on reference prices for capacity never procured. Excluding it leaves a trade benefit of 437.5 mill. EUR, the gain from procuring the same volume more cheaply.

Setting the capacity market benefit against the loss in the SDAC, the total economic surplus for 2025 is 1'622.5 mill. EUR, an average of 4.4 mill. EUR per day, with the benefit around 21 times the SDAC loss. On the trade benefit alone, the surplus is 357.3 mill. EUR, or 978'946 EUR per day, still 5.5 times the SDAC loss. For the aFRR CM alone, on a basis comparable with earlier reports, the surplus is 207.6 mill. EUR against 200.3 mill. EUR for 2024, an increase of 4%.

1 Introduction

In ACER Decision 22-2020 on Nordic CCR market-based allocation process methodology Annex I regarding "Methodology for the market-based allocation process of cross-zonal capacity for the exchange of balancing capacity for the Nordic CCR", it is requested in "Article 12 – Publication of information" that:

> 5. The TSOs shall monitor the efficiency of the forecasting methodology and shall, by three months after the go-live of the market-based allocation process and subsequently at least once a year, submit a report to the relevant regulatory authorities. This report shall include at least:
>
> a) a comparison of the forecasted and actual market values of cross-zonal capacity for the exchange of energy;
> b) assessment of occurred increases of the limits for the maximum volume of cross-zonal capacity allocated for the exchange of balancing capacity in accordance with Article 5(1)(b), including statistics on the amount of incidents, increased volumes and percentages, reasons for the incidents and an analysis of the economic surplus effects on the SDAC;
> c) assessment of impacts on the economic surplus of the SDAC and economic surplus from the exchange of balancing capacity from the application of the market-based allocation process and the specific impact following an increase of a default limit for the maximum volume of cross-zonal capacity allocated for the exchange of balancing capacity pursuant to the process described in Article 5(1)(c); and
> d) where necessary, proposals to improve the accuracy of the forecasted market values, including a different limit for the maximum volume of cross zonal capacity pursuant to Article 5(1) or different mark-up values per bidding zone border pursuant to Article 6(2).

The above points will be addressed one by one in this report, where point a) evaluates the performance of the forecast method (Chapter 2), point b) evaluates the limit of 10% cross-zonal capacity for the use of exchange of reserves (Chapter 3), and point c) calculates the economic effects of the common Nordic capacity markets, including both the Nordic aFRR CM and the trilateral and Norwegian mFRR CM (Chapter 4).

2 Forecasted vs. Actual market values of cross-zonal capacity (5a)

To answer 5a) above, we will compare the forecasted CZC cost with the ex-post actual alternative cost of reserving CZC in the aFRR CM.

Forecasted	$\max(0, SDACprice_{t-24,r'} - SDACprice_{t-24,r}) + markup_{t,r,r'}$
- Actual	$\max(0, SDACprice_{t,r'} - SDACprice_{t,r})$
=Forecast Error	$forecasted - actual$

Cross-zonal capacity (CZC) on a line reserved for the aFRR and mFRR CM is made unavailable for the day-ahead market (SDAC) auction, which is cleared later that day. Therefore, the value of this reserved capacity can be estimated as its alternative or opportunity value in the SDAC. The (marginal) alternative value is then equal to the difference (spread) in SDAC prices on each side of the border in question.

The cost of reserving CZC in the aFRR/mFRR market clearing is calculated based on this alternative value. However, since the SDAC is cleared after the aFRR CM, a forecast alternative value is used, based on the SDAC prices from the previous day (24 hours prior). In addition, a dynamic markup is added to the forecasted value of CZC, which is a number between 1 and 9999 EUR, depending on the size of the forecast error for the previous (rolling) 30 days.

$$CZCcostForecast_{t,r,r'} = SDACspread_{t-24,r,r'} + markup_{t,r,r'}$$

Where t is the delivery hour, r is the export ("from") price area and r' is the import ("to") price area. This value is used as the cost of reserving CZC in the clearing algorithm.

The analysis is structured by first analyzing the SDAC spread, then the markup, and finally combining both to find the forecast errors.

2.1 SDAC spread errors

To reiterate, the method to forecast the *SDAC spread* uses SDAC prices from the day before (D-1):

$$SDACspread_{t-24,r,r'} = \max(0, SDACprice_{t-24,r'} - SDACprice_{t-24,r})$$

In this equation, the SDAC spread is defined as the price in the importing region (r') minus the price in the exporting region (r). If the price in the exporting region (r) exceeds that in the importing region (r'), resulting in a negative spread, the forecasted value is set to zero.

The SDAC spread calculated for hour $t - 24$ is then used to determine the Capacity Zone Cost (CZC) for hour t. For instance, for the border from NO1 to SE3 in hour 6 on December 8, the SDAC spread component of the CZC cost is calculated as the greater of zero or the SDAC price for hour 6 on December 7 for SE3 minus the SDAC price for hour 6 on December 7 for NO1.

In the subsequent analysis, we will examine the errors in the SDAC spread that arise from using the SDAC spread from 24 hours prior as a forecast for hour t. The SDAC spread error is quantified as the difference between the SDAC spread for $t - 24$ and the actual SDAC spread for hour t for each border.

It is important to note that we refer to SDAC spreads and SDAC spread errors in €/MW rather than €/MWh. This distinction is made because these markets operate on a capacity basis (MW), and CZC costs are calculated in €/MW.

2.1.1 Frequency of non-zero SDAC spread errors

The graph below illustrates SDAC spread errors categorized into three groups:

- **No Difference**: No error observed
- **Positive Difference**: Forecast is higher than actual
- **Negative Difference**: Forecast is lower than actual

This analysis encompasses all borders and border directions utilized for aFRR and/or mFRR capacity exchange during 2025. The seven national borders are displayed on the left, while the six borders connecting bidding zones in different countries are shown on the right. All hours are included, even those where border capacities were set to zero.

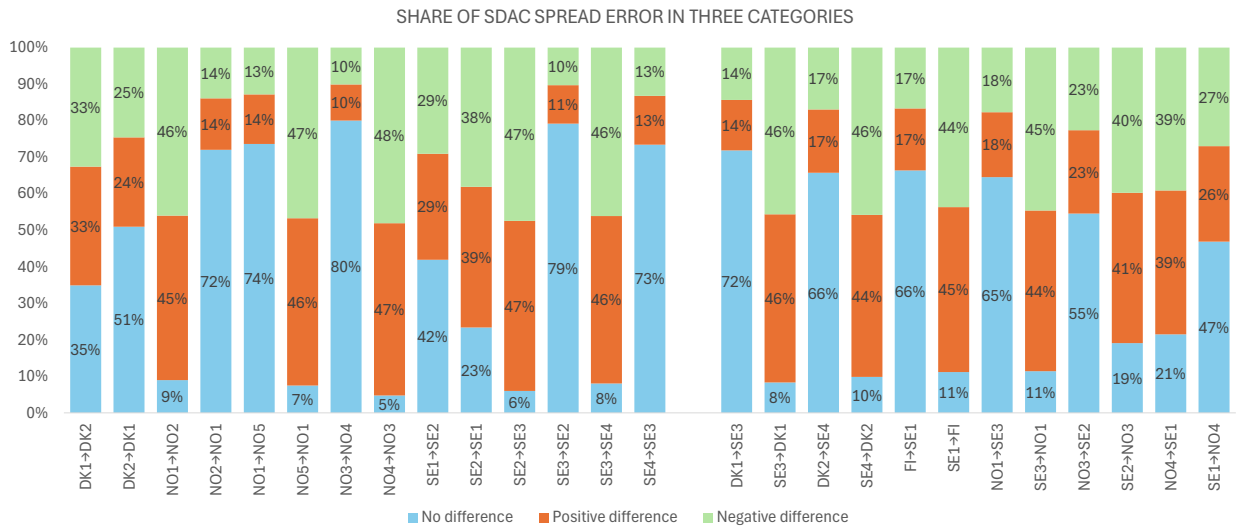


Figure 1 – SDAC spread error in three categories [<0, 0, >0].

Six borders (NO2-NO1, NO1-NO5, NO3-NO4, SE3-SE2, SE4-SE3 and DK1-SE3) show "No difference" (no error) in more than 70% of the hours in one direction. Conversely, the opposite direction on the same borders typically shows no-error hours in less than 10% of cases. The reason for this is that these borders have a dominant flow direction. Because SDAC spreads are set to 0 if the price spread is negative, the spread in the dominant direction frequently remains 0 across consecutive days, minimizing error frequency.

Only the DK1-DK2 border shows a high frequency of "No difference" (>35%) in *both* directions. This suggests strong price correlation; even when prices fluctuate, they often move in tandem, keeping the spread at zero.

Borders like SE2-SE1 and NO4-SE1, unlike the "dominant flow" borders, have a very low percentage of "No difference" hours (mostly below 25%). These borders are highly volatile. The price spread is rarely 0 and rarely stays the same day-to-day. This suggests these areas frequently flip between being an exporter and an importer, making both directions difficult to forecast accurately.

For most borders, the frequency of positive and negative errors is relatively balanced, though the total volume of errors varies significantly by region.

2.1.2 Average SDAC spread errors

Figure 2 shows the average SDAC spread error for each border.

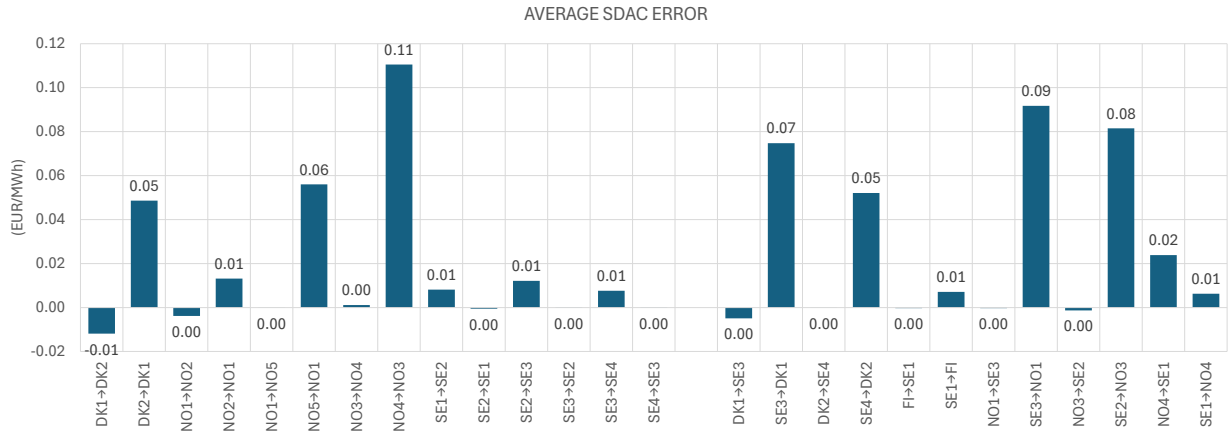


Figure 2 – Average SDAC spread error (EUR/MW).

As expected, by taking a whole year of data, capturing all the seasonal variations, the average SDAC spread errors are close to zero for all borders. Averaging all borders all hours, the SDAC spread error of zero essentially means that negative errors are balanced out by positive errors. Only one border directions have an average error > 0.1 EUR/MW: NO4->NO3 (0.11 €/MW). A positive number means that by using the D-1 spread to forecast we overestimate the actual spread. A negative number means that the forecasted spread (D-1) is underestimated compared to the actual spread.

Examining the absolute SDAC spread errors[1] in Figure 3, gives us better insights into the real errors of the forecast. On average, over all border directions, the absolute error is 7.8 EUR/MW. However, these vary significantly from border to border, with seven border directions having mean absolute SDAC spread errors in excess of 10 €/MW.

[1] The absolute value is $|x| = \begin{cases} x, if\ x \geq 0 \\ -x. if\ x \leq 0 \end{cases}$. So basically, converting all the negative SDAC spread errors to positive values.

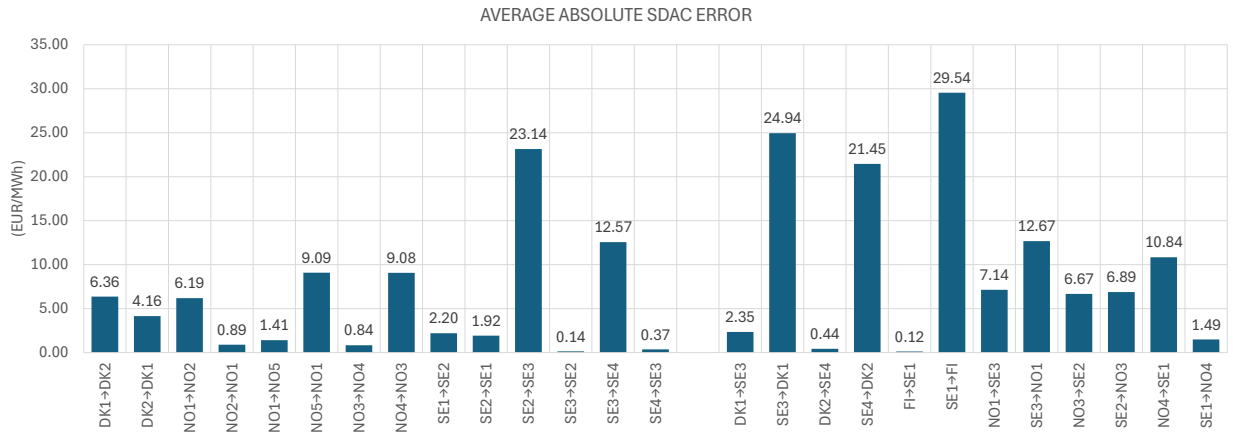


Figure 3 – Absolute average DAM spread error (EUR/MW).

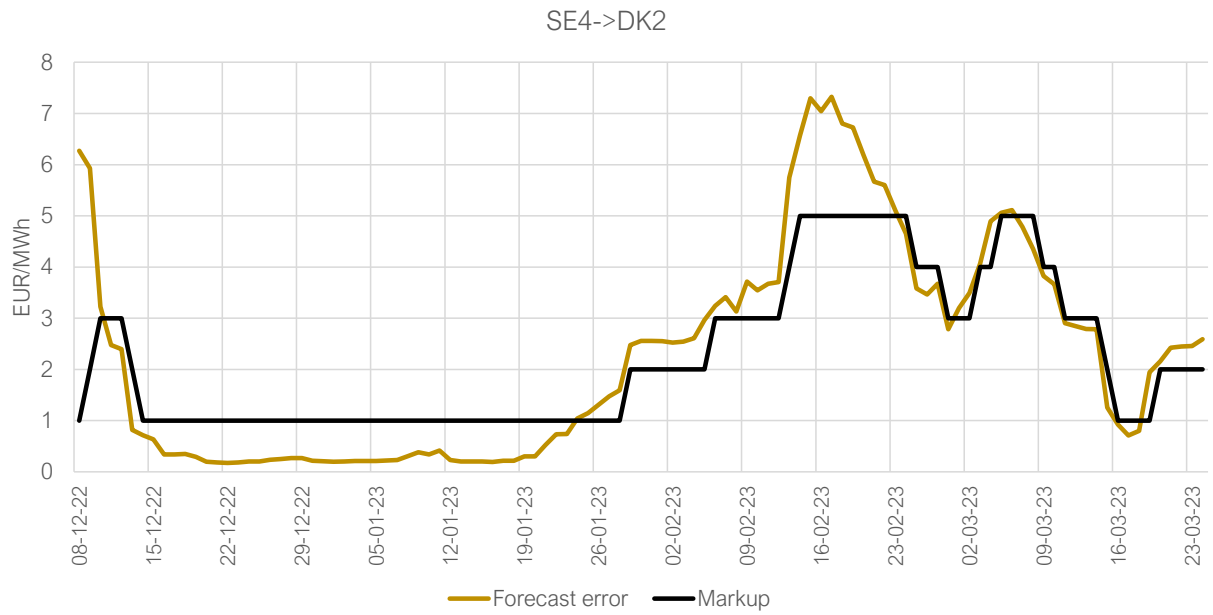
The driver of high errors are price differences and the volatility in these on either side of the border, and not surprisingly, the cross-national borders tend to have a higher absolute error than the national borders. The Swedish borders connecting the north with the south SE2->SE3 and SE3->SE4 are exceptions to this.

2.2 Markup

Recall that the cost of reserving CZC consists of two components, the *SDAC spread* and a *dynamic markup*. The dynamic markup is calculated based on the average forecast error of the last 30 days and set to a value between 1 and 9999 EUR/MW (in 1 EUR/MW steps), depending on the size of the average forecast error. The method only uses positive errors and excludes the top 5% of error values.

The markup is a daily value for each border direction and is added to the hourly SDAC spread for each hour. If the forecast SDAC spread for an hour is zero, the markup is set to 0.1 for that hour. In general, and by design, markup is correlated with recently observed errors in the CZC cost forecast. This means that if the error in the CZC cost forecast on a border (based on SDAC spread D-1) for the last 30 days is high, the markup is high, and if it's low, the markup is low.

As an example, we can see how the markup changes with the 30-day historical forecast error for the SE4->DK2 border in the figure below. This markup value in the graph is the value used if the SDAC spread is positive and non-zero. When the SDAC spread is negative or zero, markup is automatically set to 0.1.



We see how the markup follows the rolling horizon forecast error. When the difference between the forecast error and the markup for the previous day exceeds the markup value from the previous day, the markup value increases by one. The opposite effect will be seen when this difference drops below the markup.

The average markups over all hours for each border are shown in Figure 4.

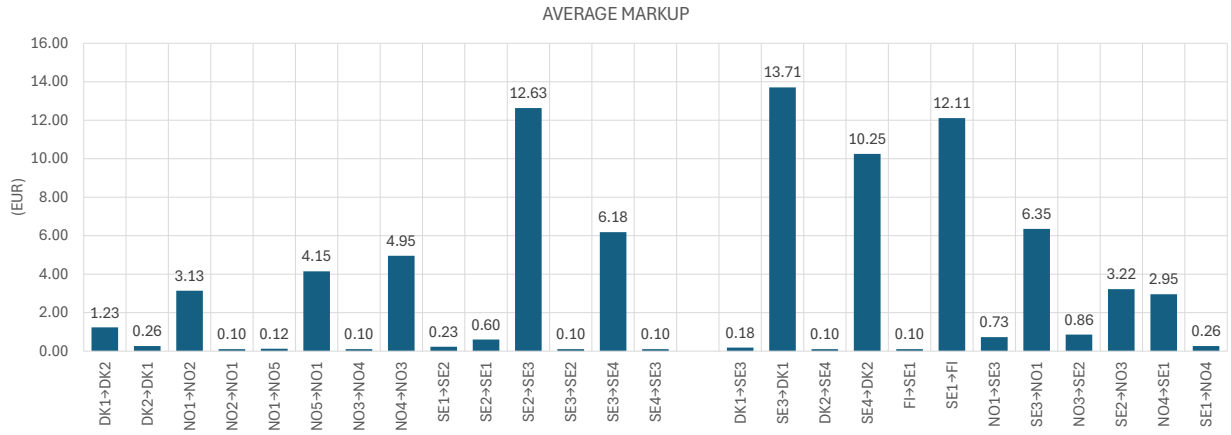


Figure 4 – Average markup (EUR/MW).

As noted above, the border directions with a high absolute SDAC spread error also have a high average markup. This is to be expected since a high number of errors drives higher markups. Around half (14 out of 26) of the border directions have a low average markup (<1 €/MW). The 12 borders with markup exceeding 1.0€/MW have an average markup of 6.74 EUR/MW. Four border directions (SE2->SE3, SE3->DK1, SE4->DK2 and SE1->FI) have an average markup larger than 10EUR/MW. Graphs showing markup per day for these four borders are available in Appendix B.

In the graph below, we see how the seven different markup possibilities are distributed across all hours for each border and direction. Markups above 5 are grouped together in the graph for illustrative purposes.

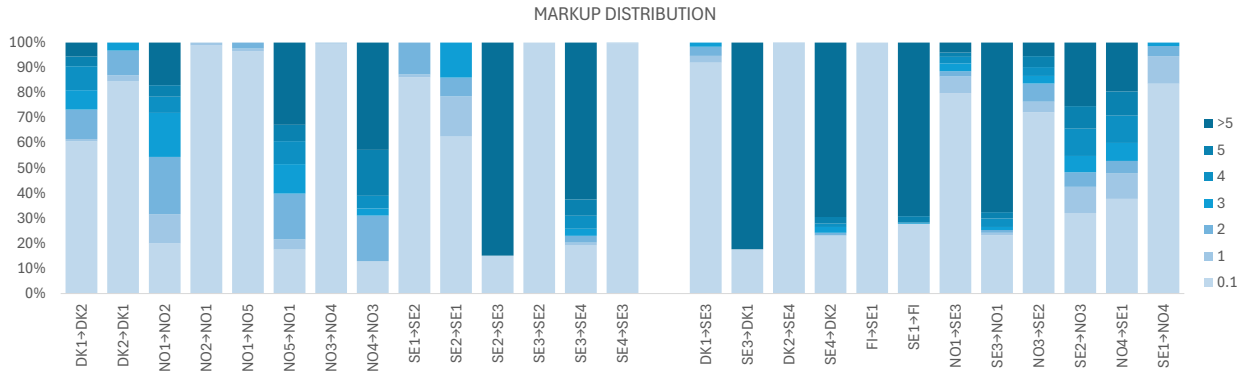


Figure 5 – Markup distribution (%).

Borders with high mean absolute SDAC spread errors have markups either at 0.1 or >= 5 EUR/MW. This indicates that whenever the D-1 forecast is > 0, the markup is high driven by large historical errors and when the forecast is 0, the markup is automatically set to 0.1. SE1->FI reached 34 EUR/MW in markup, whilst both SE2->SE3 and SE3->DK1 reached peaks of 29 EUR/MW in 2025.

2.3 CZC forecast error

Combining the forecast SDAC spread and the markup for each border results in the forecast CZC cost used in the aFRR/mFRR CM clearing algorithm. Table 1 summarizes the SDAC spread errors and average mark-up level, and the total CZC forecast error (both average error and average absolute error) for each border.

	DK1→DK2	DK2→DK1	NO1→NO2	NO2→NO1	NO1→NO5	NO5→NO1	NO3→NO4	NO4→NO3	SE1→SE2	SE2→SE1	SE2→SE3	SE3→SE2	SE3→SE4	SE4→SE3	DK1→SE3	SE3→DK1	DK2→SE4	SE4→DK2	FI→SE1	SE1→FI	NO1→SE3	SE3→NO1	NO3→SE2	SE2→NO3	NO4→SE1	SE1→NO4
Average Spread Error	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0
Absolute Spread Error	6.4	4.2	6.2	0.9	1.4	9.1	0.8	9.1	2.2	1.9	23.1	0.1	12.6	0.4	2.4	24.9	0.4	21.5	0.1	29.5	7.1	12.7	6.7	6.9	10.8	1.5
Average Markup	1.2	0.3	3.1	0.1	0.1	4.1	0.1	5.0	0.2	0.6	12.6	0.1	6.2	0.1	0.2	13.7	0.1	10.3	0.1	12.1	0.7	6.4	0.9	3.2	3.0	0.3
Average Forecast Error	**1.2**	**0.3**	**3.1**	**0.1**	**0.1**	**4.2**	**0.1**	**5.1**	**0.2**	**0.6**	**12.6**	**0.1**	**6.2**	**0.1**	**0.2**	**13.8**	**0.1**	**10.3**	**0.1**	**12.1**	**0.7**	**6.4**	**0.9**	**3.3**	**3.0**	**0.3**
Absolute Forecast Error	**7.0**	**4.3**	**7.5**	**1.0**	**1.5**	**10.7**	**0.9**	**10.8**	**2.3**	**2.2**	**27.5**	**0.2**	**15.0**	**0.5**	**2.5**	**29.3**	**0.5**	**25.2**	**0.2**	**35.3**	**7.5**	**15.0**	**7.1**	**8.2**	**12.2**	**1.6**

Table 1 – CZC forecast error summary.

For 2025, the borders with the highest CZC forecast errors were the cross-country borders SE3->DK1, SE4->DK2 and SE1->FI, as well as the border connecting northern and southern Sweden (SE2->SE3). Other borders with high forecast errors include SE3->SE4, SE3->NO1 and NO4->SE1.

Adding the markup to the SDAC spread results in a higher absolute CZC forecast error than the SDAC spread alone for all borders. Overall, there are nine borders with absolute CZC forecast errors in excess of 10€/MW.

2.3.1 CZC forecast error distribution

The distribution duration curve for the CZC forecast errors for all hours and borders is shown in Figure 6. Similar graphs for each border are available in Appendix A.

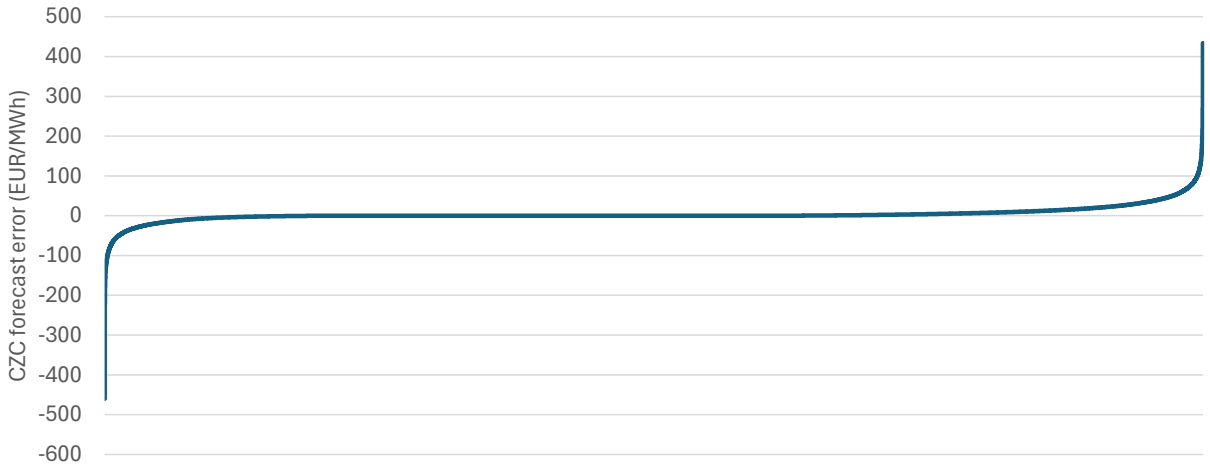


Figure 6 – Forecast error duration curve (EUR/MW).

Approximately 39% of the combined borders and hours have no errors. 38% have a forecasted CZC cost greater than the actual value, and 23% are below the actual value. The main reason for this skewness is the markup (note that all markups >= 0.1), introducing a bias for positive CZC forecast errors.

Table 2 shows how errors for each border are distributed in predefined ranges.

	[inf, -100>	[-100, -50>	[-50, -10>	[-10, -5>	[-5, -2>	[-2, -1>	[-1, 0.1>	0.1	<0.1, 1]	<1, 2]	<2, 5]	<5, 10]	<10, 50]	<50, 100]	<100, inf]
DK1→DK2	0%	1%	7%	4%	4%	2%	10%	34%	3%	4%	11%	7%	10%	1%	0%
DK1→SE3	0%	0%	3%	2%	3%	2%	4%	72%	2%	3%	4%	2%	3%	0%	0%
DK2→DK1	0%	1%	5%	2%	2%	1%	14%	50%	9%	5%	4%	2%	5%	1%	0%
DK2→SE4	0%	0%	0%	1%	2%	2%	12%	66%	12%	2%	2%	1%	0%	0%	0%
FI→SE1	0%	0%	0%	0%	1%	1%	15%	66%	15%	1%	1%	0%	0%	0%	0%
NO1→NO2	0%	0%	6%	4%	6%	4%	6%	9%	4%	8%	24%	13%	13%	1%	0%
NO1→NO5	0%	0%	2%	2%	3%	2%	4%	74%	3%	2%	4%	3%	2%	0%	0%
NO2→NO1	0%	0%	1%	1%	2%	2%	9%	72%	8%	3%	2%	1%	1%	0%	0%
NO3→NO4	0%	0%	1%	1%	3%	2%	4%	80%	3%	2%	3%	1%	1%	0%	0%
NO4→NO3	0%	1%	8%	6%	7%	3%	4%	5%	3%	4%	13%	20%	26%	1%	0%
NO5→NO1	0%	1%	8%	5%	7%	4%	5%	7%	3%	4%	17%	17%	20%	2%	0%
SE1→FI	3%	6%	10%	4%	3%	1%	6%	11%	0%	0%	2%	8%	30%	11%	5%
SE1→SE2	0%	0%	2%	3%	5%	3%	14%	42%	10%	8%	7%	3%	3%	0%	0%
SE2→SE1	0%	0%	2%	3%	6%	5%	16%	23%	13%	12%	13%	6%	2%	0%	0%
SE2→SE3	1%	3%	15%	4%	3%	1%	3%	6%	1%	1%	3%	8%	42%	8%	2%
SE3→DK1	1%	3%	16%	4%	3%	1%	2%	8%	1%	1%	2%	5%	38%	13%	2%
SE3→SE2	0%	0%	0%	0%	1%	2%	8%	79%	8%	2%	1%	0%	0%	0%	0%
SE3→SE4	0%	1%	14%	5%	4%	2%	4%	8%	1%	1%	8%	16%	33%	2%	0%
SE4→DK2	0%	4%	14%	4%	4%	2%	4%	10%	1%	1%	3%	7%	35%	10%	1%
SE4→SE3	0%	0%	0%	0%	1%	1%	11%	73%	10%	2%	1%	0%	0%	0%	0%
NO1→SE3	0%	2%	7%	3%	2%	1%	2%	65%	1%	1%	3%	3%	9%	2%	0%
NO3→SE2	0%	1%	6%	3%	4%	2%	3%	55%	1%	2%	6%	6%	8%	1%	0%
NO4→SE1	1%	2%	8%	5%	6%	3%	5%	21%	2%	3%	11%	13%	17%	2%	1%
SE1→NO4	0%	0%	1%	2%	6%	5%	10%	47%	8%	8%	8%	3%	2%	0%	0%
SE2→NO3	0%	0%	9%	6%	7%	3%	4%	19%	2%	3%	10%	15%	21%	0%	0%
SE3→NO1	0%	0%	16%	6%	4%	2%	2%	11%	1%	2%	5%	12%	37%	2%	0%
All borders	**0%**	**1%**	**6%**	**3%**	**4%**	**2%**	**7%**	**39%**	**5%**	**3%**	**6%**	**7%**	**14%**	**2%**	**1%**

Table 2 – Distribution of forecast errors (percent of hours in error ranges).

The forecast for NO3->NO4, SE3->SE2, NO1->NO5, SE4->SE3, DK1->SE3, DK2->SE4, FI->SE1, DK2->DK1 and NO2->NO1 are the most stable borders and show very high reliability with more than 70% of hours having no more than +/- 1 EUR/MWh error. These border directions have on average less than +/- 1 EUR/MWh error for 87% of the hours. The main reason for this, however, is that the price difference is negative for most hours resulting in a stable 0.1 EUR/MWh forecast giving low mean absolute errors. Looking at the same borders, but opposite direction, most of them have a high share of hours with a large error (more than 10 EUR/MWh). The largest share falls in the positive valued errors (over estimating) due to the markups.

Overall, and over all border directions, about 10% of the hours have forecast errors below -5 EUR/MWh and about 24% of the hours have forecast errors higher than 5 EUR/MWh. We also see that, for most borders, the errors are most often in the 10-50 EUR/MW range (in absolute terms).

2.4 Comments

The difference between forecasted and actual CZC value for the 26 border directions in the aFRR/mFRR CM varies significantly from border to border, both in error size and error frequency. The drivers behind large errors are:

- different DAM prices on both sides of the border
- changes in DAM prices from one day to the next

The D-1 approach to forecast CZC values used can also be referred to as a naïve forecast (a technique in which the last period's actuals are used as this period's forecast). In well-functioning markets, the market price at any time represents the summation of all information (e.g. market participants' assessment of their costs) available to the market. It can be thought of as an aggregate market "view" of what the price is, given such "underlying" information. For the next period, assuming relatively moderate changes in the underlying information, we may reasonably expect relatively moderate changes in market prices. In such a case, the naive forecast can be a fairly good short-term predictor. As we have seen, the naïve forecast gives no errors in 39% of the cases (hours + border directions) and in 34% of cases an (absolute) error greater than 5 €/MW. These larger errors are caused by changes in the spread from one day to the next. Drivers of such volatility can be hypothesized to include changes in weather conditions, change from business day to non-business day (and vice versa), and plant and grid unavailability.

It is difficult to quantify the economic effect of these errors, without having access to the full SDAC and aFRR/mFRR bids for each price area. In theory, a correct CZC cost will allow an optimal economic trade-off between the capacity and SDAC markets. Deviating from this will result in one market "winning" and the other "losing"; however, the relative sizes of the "win" and "loss" will depend on the bid curves (including the use of complex bids). It is also important to mention that having forecast errors is not equal to reservations for the exchange of reserve capacity, not being beneficial. If the value of reserving capacity for the exchange of reserve capacity is larger than the actual/realized value of cross-zonal capacity the reservation has still been socio-economically beneficial no matter the size of the forecast error. Hence minimizing forecast errors do not necessarily result in socio-economic welfare gains.

3 Increase above the 10% NTC limits (5b)

Up to 10 % of the transmission capacity (NTC) on a border can be reserved for aFRR and mFRR balancing capacity. The Nordic market design is set up to clear the aFRR CM first with all the 10% NTC capacity available. After the aFRR CM is cleared, the reminding capacity (not used by the aFRR CM) is available for the mFRR CM. In case of scarcity, reserved capacity can be increased until demand is satisfied. In such cases, the TSOs increase the CZC limits until demand is satisfied or up to the maximum of 20%.

The table below shows general statistics on CZC reservation for 2025. All values are average numbers over all hours, and the table shows available capacity (MW), reserved capacity (MW) and utilization (%). The numbers are specified for both capacity markets and the total reserved capacity. Note that some borders

are only used in aFRR CM (borders connecting Swedish and Norwegian bidding zones) and some borders only used in mFRR CM (DK1-DK2 and DK1-SE3).

	Available Capacity			Reserved Capacity				Average utilization (%)		
	aFRR	mFRR		aFRR	mFRR	Total		aFRR	mFRR	Total
DK1_DK2		36			30	30			84%	84%
DK1_SE3		50			43	43			85%	85%
DK2_DK1		42			14	14			34%	34%
DK2_SE4	128	118		11	74	85		8%	63%	66%
FI_SE1	90	73		17	64	80		18%	87%	89%
NO1_NO2	192	187		5	33	38		3%	17%	20%
NO1_NO5	58	18		40	14	54		68%	76%	92%
NO2_NO1	323	285		38	121	159		12%	43%	49%
NO3_NO4	36	28		8	12	21		23%	44%	57%
NO4_NO3	94	89		5	25	30		5%	28%	32%
NO5_NO1	309	274		35	36	72		11%	13%	23%
SE1_FI	55	45		10	12	22		18%	27%	40%
SE1_SE2	277	268		8	221	229		3%	82%	83%
SE2_SE1	310	295		16	1	17		5%	0%	5%
SE2_SE3	606	601		5	89	94		1%	15%	16%
SE3_DK1		32			6	6			19%	19%
SE3_SE2	718	680		38	10	48		5%	1%	7%
SE3_SE4	422	400		22	167	188		5%	42%	45%
SE4_DK2	113	96		17	23	40		15%	24%	36%
SE4_SE3	260	240		20	27	47		8%	11%	18%
NO1_SE3	137			44		44		32%		32%
NO3_SE2	58			4		4		6%		6%
NO4_SE1	49			8		8		17%		17%
SE1_NO4	45			12		12		27%		27%
SE2_NO3	70			10		10		14%		14%
SE3_NO1	46			8		8		17%		17%

Table 3 – CZC reservation overview.

From the table we can see that the average utilization of lines in the aFRR market is generally below 20%, with an average of 15%. NO1->NO5 is the only line with an average utilization above 50%, indicating that the remaining capacity for the mFRR CM might be critically low for many hours of 2025 with the average available capacity dropping from 58MW to 18MW.

In the mFRR capacity market, we see the utilization numbers are significantly higher, with six borders with an average utilization above 50%. The average over all borders in the mFRR CM is 40%. There are two obvious reasons for this. Firstly, the markets are larger in terms of reserve requirements, secondly, the available capacity is lower for mFRR driven by the fact that the available capacity for exchange is lower when and if the line has reservations in the aFRR capacity market. In total, the lines that have the highest average utilization are the DK1->DK2 and DK1->SE3 border directions, as well as the FI->SE1, NO1->NO5 and SE1->SE2 lines that are available for both markets. All of these lines have a total average utilization above 80%.

In the table below, we show the share of hours where the reserved capacity is at full capacity as well as the share of hours where the reserved capacity is above the limit (fallback situation).

	Hours at 100% capacity				Hours > 100% capacity		
	aFRR	**mFRR**	**Total**		**aFRR**	**mFRR**	**Total**
DK1_DK2		70%	70%			0%	0%
DK1_SE3		74%	74%			1%	1%
DK2_DK1		25%	25%			0%	0%
DK2_SE4	3%	22%	25%		0%	0%	0%
FI_SE1	2%	72%	74%		0%	0%	0%
NO1_NO2	0%	3%	3%		0%	2%	2%
NO1_NO5	26%	44%	67%		0%	4%	6%
NO2_NO1	0%	5%	5%		0%	0%	0%
NO3_NO4	2%	22%	24%		0%	2%	2%
NO4_NO3	0%	4%	4%		0%	11%	11%
NO5_NO1	0%	5%	5%		0%	0%	0%
SE1_FI	10%	24%	34%		0%	0%	0%
SE1_SE2	0%	33%	33%		0%	1%	1%
SE2_SE1	0%	0%	0%		0%	0%	0%
SE2_SE3	0%	0%	0%		0%	0%	0%
SE3_DK1		21%	21%			0%	0%
SE3_SE2	0%	0%	0%		0%	0%	0%
SE3_SE4	0%	0%	0%		0%	0%	0%
SE4_DK2	1%	13%	14%		0%	0%	0%
SE4_SE3	0%	0%	0%		0%	0%	0%
NO1_SE3	3%		3%		0%		0%
NO3_SE2	0%		0%		0%		0%
NO4_SE1	6%		6%		0%		0%
SE1_NO4	6%		6%		0%		0%
SE2_NO3	1%		1%		0%		0%
SE3_NO1	8%		8%		0%		0%

For maximum utilization (i.e., the highest reserved/capacity[2] ratio) in the aFRR CM, we see that only two border directions (NO1->NO5 and SE1->FI) have more than 10% of the hours a reserved capacity at the capacity limit. For mFRR, this number is 11, with three border directions (DK1->DK2, DK1->SE3 and FI->SE1) exceeding 70% of the hours at full capacity. The reasons for this are a mix of higher reserve requirements in mFRR than aFRR, driving the need for more trade of capacity and a lower capacity limit due to capacity already 'taken' by aFRR and the relatively larger size of the mFRR CM compared to aFRR CM.

The results in the table also show that for most of the borders, the 10% NTC limit is sufficient for an efficient allocation of aFRR and mFRR across the Nordics. For aFRR CM, no border used more than the limit available for cross-border exchange. For mFRR, however, six borders experienced fallback (reservation above the limit). The NO4->NO3 border is the main concern, where 11% of the hours had a CZC reservation in mFRR larger than the limit. Since NO3/NO4 is an 'isolated market' in mFRR (no exchange with other bidding zones), this indicates too low capacity in many hours which in worst case would also lead to these bidding zones not meeting their mFRR reserve requirements in some hours. The other border direction worth mentioning is NO1->NO5 with 6% of the hours above capacity limit. One reason for this is that a large part of the available capacity is already reserved for aFRR as mentioned above.

4 Impacts on economic surplus (5c)

The impact that the exchange of balancing capacity in the aFRR and mFRR capacity markets has on economic surplus can be split into two main parts: impact on the SDAC and impact on the capacity markets themselves.

Because the Nordic market design clears the aFRR CM first against the full cross-zonal capacity limit and offers only the residual capacity to the mFRR CM, the two markets do not draw on the SDAC independently. The figures below attribute the loss to each market according to the capacity it actually reserved, but the mFRR result should be read as the effect of reserving capacity that the aFRR CM had already left unused.

4.1 SDAC impact

The impact on SDAC can be calculated in several ways. In this report we include two alternative methods, 1) an approximate calculation method, and 2) analysis of the SDAC socio economic loss using simulation facility. The approximate calculation method was the method used for the headline figures in the Evaluation Reports for 2023 and 2024 and is useful to compare losses with previous years.

4.1.1 Approximate Calculation Method

To calculate the change in economic surplus for the SDAC, we follow the method outlined below:

For each border direction and each hour, the SDAC loss is the cross-zonal capacity reserved for the capacity market multiplied by the realized SDAC price spread across that border, where that spread is positive. Where the realized spread is zero or negative, the border is not congested, the reserved capacity would not have been used by the SDAC, and the loss is zero.

[2] Capacity based on 10% NTC.

Since capacity is removed from the SDAC as a consequence of the capacity market coupling, the impact on the economic surplus for the SDAC should always be negative or zero.

Following the method outlined above on 2025 data gives the results for each border direction stated in the table below. Border directions are shown for both markets; a blank indicates that the border direction was not available to that market during 2025.

Border	% hours congested	aFRR loss (EUR)	mFRR loss (EUR)	Total loss (EUR)
SE3->SE4	81%	2'812'692	21'985'571	24'798'262
SE2->SE3	85%	769'410	23'129'772	23'899'182
NO5->NO1	83%	2'759'512	3'609'469	6'368'982
SE4->DK2	77%	2'451'924	3'018'652	5'470'577
SE1->FI	73%	1'695'701	1'123'596	2'819'298
SE1->SE2	40%	84'278	2'724'377	2'808'655
NO4->NO3	87%	433'770	2'270'261	2'704'031
NO1->SE3	23%	2'412'398		2'412'398
NO1->NO2	80%	163'547	1'986'537	2'150'084
SE3->DK1	83%		1'248'197	1'248'197
DK1->DK2	46%		1'170'055	1'170'055
SE3->NO1	77%	806'142		806'142
NO2->NO1	18%	175'590	484'176	659'765
SE2->NO3	68%	447'367		447'367
NO4->SE1	63%	442'294		442'294
NO1->NO5	17%	317'292	111'017	428'309
DK1->SE3	19%		402'261	402'261
SE2->SE1	58%	174'237	23'201	197'438
DK2->DK1	33%		189'518	189'518
DK2->SE4	21%	32'776	151'505	184'281
NO3->SE2	32%	137'917		137'917
SE1->NO4	37%	125'007		125'007
NO3->NO4	12%	31'773	76'398	108'172
SE4->SE3	16%	38'411	52'661	91'072
SE3->SE2	13%	37'969	4'332	42'301
FI->SE1	20%	10'950	21'597	32'547
Total		**16'360'958**	**63'783'152**	**80'144'111**

Table 4 – Economic impact on SDAC (EUR).

As shown, the change in total economic surplus for the SDAC is minus 80.14 M€ over the 365 days of 2025, of which 16.36 M€ arises from aFRR reservations and 63.78 M€ from mFRR reservations. This averages 219'573 EUR per day (44'825 EUR for aFRR and 174'748 EUR for mFRR).

The loss is heavily concentrated. Two border directions (SE3->SE4 and SE2->SE3) account for 48.70 mill. EUR, or 61% of the total. Both are internal Swedish borders connecting the north with the south, both were

congested in more than 80% of the hours of 2025, and on both the great majority of the loss falls on the mFRR CM rather than the aFRR CM. This is because the aFRR CM reserves relatively little capacity on these borders compared to what it reserves for the mFRR CM due to the difference in market size.

For the aFRR CM alone, the picture is closer to that of previous years. The largest contributions come from SE3->SE4 (2.81 M€), NO5->NO1 (2.76 M€), SE4->DK2 (2.45 M€) and NO1->SE3 (2.41 M€). The aFRR SDAC loss for 2025 of 16.36 M€ is 28% lower than the 22.85 M€ reported for 2024. On a per-day basis the reduction is similar, from 62'432 EUR in 2024 to 44'825 EUR in 2025.

SDAC loss for 2025 in mill. EUR by bidding zone is presented in the table below. Where a border direction connects two bidding zones, the loss on that border has been divided equally between them, following the same convention used for congestion income.

	DK1	DK2	FI	NO1	NO2	NO3	NO4	NO5	SE1	SE2	SE3	SE4	Total
aFRR	0.00	1.24	0.85	3.32	0.17	0.53	0.52	1.54	1.27	0.83	3.44	2.67	16.36
mFRR	1.51	2.26	0.57	3.10	1.24	1.17	1.17	1.86	1.95	12.94	23.41	12.60	63.78
Total	**1.51**	**3.51**	**1.43**	**6.41**	**1.40**	**1.70**	**1.69**	**3.40**	**3.21**	**13.77**	**26.85**	**15.27**	**80.14**

Table 5 – SDAC loss by bidding zone (mill. EUR).

The borders with the highest number of congested hours in SDAC combined with the largest price spread between the adjacent bidding zones contribute most to overall SDAC losses. Three bidding zones (SE3, SE4 and SE2) account for 55.89 M€, or 70% of the total. NO1 is the largest non-Swedish contributor at 6.41 M€, split roughly evenly between the two markets and driven mainly by the NO1-NO5 and NO1-SE3 borders.

The monthly profile is shown below. The loss is concentrated in the first three quarters, with March being the highest month at 10.47 mill. EUR and November and December being the lowest at 3.35 and 2.99 M€.

Before and after the go-live of the Nordic mFRR Energy Activation Market (EAM) in March 2025, TSO's increased reserve requirements for aFRR and mFRR in all Nordic bidding zones. This increased total CZC allocations in both aFRR and mFRR CM and is the driver behind the high February, March and April numbers. Looking at the low November and December losses, we see a sharp decrease in allocations on SE2->SE3 and SE3->SE4 which are the lines responsible for more than half the total loss. The main reason why allocations on these lines dropped was because the line DK2->SE4 went from nearly zero to 150 MW capacity in the beginning of November shifting some of the allocation that previously served southern Sweden from the North to the DK2->SE4 line serving southern Sweden from Denmark instead.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
aFRR	1.79	1.40	3.28	2.51	1.22	1.25	0.95	0.61	0.89	1.07	0.76	0.63
mFRR	4.59	6.64	7.19	5.91	5.04	5.27	5.20	5.28	7.66	6.06	2.59	2.36
Total	**6.38**	**8.04**	**10.47**	**8.42**	**6.26**	**6.52**	**6.15**	**5.89**	**8.55**	**7.12**	**3.35**	**2.99**

Table 6 – SDAC loss by month (mill. EUR).

It is also useful to compare the realized SDAC loss with the forecast CZC cost that was used to clear the markets, since the difference between the two is the economic consequence of the forecast errors described in Chapter 2.

	Forecasted (EUR)	Realized (EUR)	Difference
aFRR	14'052'713	16'360'958	+16%
mFRR	71'803'629	63'783'152	-11%
Total	**85'856'342**	**80'144'111**	**-7%**

Table 7 – Forecasted CZC cost vs. realized SDAC loss (EUR).

For the aFRR CM the forecast understated the value of the capacity that was reserved by 2.31 M€, meaning capacity was reserved somewhat more cheaply than it turned out to be worth to the SDAC. For the mFRR CM the forecast overstated it by 8.02 M€. Across both markets the two effects partly offset, leaving a total forecast CZC cost 7% above the realized SDAC loss.

For the extra MW reserved above the 10% NTC limit mentioned in the previous chapter, the loss is estimated using the same method as above: for each hour and border direction, the capacity reserved in excess of the limit is multiplied by the realized SDAC price spread, where that spread is positive.

In the aFRR CM the limit was not exceeded in any hour of 2025. All use of the fallback in 2025 therefore occurred in the mFRR CM.

The mFRR CM reserved capacity above the limit in 2'146 hours across 15 border directions, amounting to 95'989 MW in total and an estimated SDAC loss of 708'320 EUR. This is 0.9% of the total SDAC loss of 80.14 M€ for 2025

Border	Hours	% of hours	Excess MW	Loss (EUR)
NO4->NO3	967	11.1%	56'882	577'676
NO1->NO2	184	2.1%	6'665	65'383
NO1->NO5	499	5.7%	20'547	30'350
SE3->SE4	24	0.3%	817	10'866
DK1->SE3	66	0.8%	2'185	10'460
SE3->DK1	16	0.2%	161	6'194
SE1->SE2	109	1.3%	2'338	2'972
NO3->NO4	186	2.1%	4'536	2'651
Other (7 border directions)	95	1.1%	1'858	1'769
Total	**2'146**		**95'989**	**708'320**

Table 8 – SDAC loss from reservations above the 10% NTC limit, mFRR CM.

Almost all the 577'676 EUR loss, or 82% of the total, arises on the NO4->NO3 border, which exceeded its limit in 11% of the hours of 2025. As noted in Chapter 3, NO3 and NO4 form an isolated area in the mFRR CM with no exchange with the other bidding zones, so scarcity there can only be relieved by reserving above the limit. The next largest contributions, NO1->NO2 and NO1->NO5, are an order of magnitude smaller.

This way of estimating the impact on economic surplus for the SDAC assumes that a congested border (positive price spread) would have used all of the capacity reserved for the capacity markets were it not for the reservation. Consequently, the values calculated above may be somewhat too extreme, which means that in reality the effect on the SDAC may be lower. The assumption is more demanding in 2025 than in 2024, because the volumes involved are considerably larger: on SE2->SE3 and SE3->SE4 the method assumes the SDAC would have absorbed the full mFRR reservation in every congested hour.

4.1.2 Simulation Facility

In this section, we present the change in economic surplus for the SDAC by utilizing the simulation facility tool allowing us to conduct the analysis based on the actual DA market supply and demand curves. The simulation facility tool allows us to rerun the DA market clearing with higher capacities (original capacity + CZC reservation) to estimate the changes in economic surplus following from the aFRR and mFRR CZC allocation.

Comparison of the two scenarios *(Actual CZC allocation for the exchange of aFRR and mFRR capacity vs. no allocation of CZC for the exchange of aFRR and mFRR)* via the tool provides us with differences in aggregate consumer and producer surplus as well as the changes in DA congestion income

Consumer Surplus	Producer surplus	Congestion income
The consumer surplus is the difference between the clearing price in the market and offered (buying) bid price times the accepted volume in the market per bid.	The producer surplus is the difference between the clearing price in the market and offered (selling) bid price times the accepted volume in the market case per bid.	For each price area, the sum of reserved czc*price spread over all lines out of the price area divided by two[4].

Table 4 – The definitions of SDAC socio-economic welfare components

We ran the simulation facility using the Nordic flow-based domain data in the Nordics for both scenarios to simulate the SDAC market outcome. For the case without the aFRR and mFRR CZC reservations, RAMs were recalculated adding the impact of the aFRR and mFRR reservations back to the flow-based domain.

We used the results to calculate the differences in aggregated consumer and producer surplus, and congestion income between the actual and the alternative (no CZC allocation for the exchange of aFRR capacity) scenario.

The per month difference in socio economic welfare (SEW) loss is presented in the table below (positive numbers = loss).

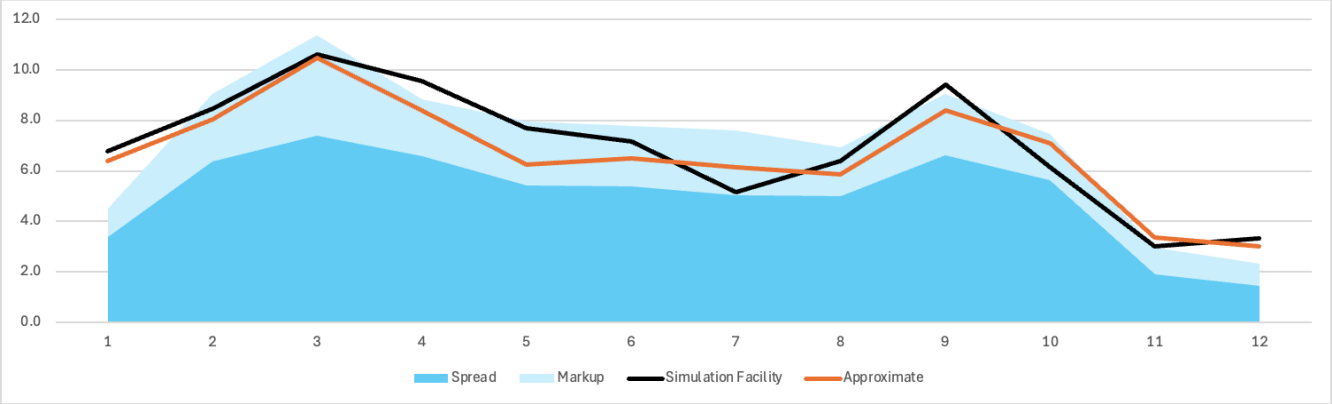
	Consumer surplus (M€)	Producer surplus (M€)	Congestion income (M€)	Total SEW (M€)
January	20.54	-5.90	-7.85	6.79
February	19.41	-12.67	1.75	8.48
March	19.03	-3.75	-4.67	10.60
April	27.74	-15.27	-2.90	9.57
May	20.54	-10.53	-2.32	7.70
June	23.38	-18.86	2.62	7.15
July	19.02	-14.63	0.77	5.15
August	12.72	-3.36	-2.98	6.38
September	24.52	-11.69	-3.43	9.41
October	8.03	-4.71	2.81	6.13
November	6.13	-1.23	-1.88	3.02
December	7.38	-2.47	-1.61	3.31
Total	208.44	-105.07	-19.69	83.69

The table shows that the effects on consumer surplus are negative each month, equaling 208 M€ on aggregate driven by higher clearing prices. Producer surplus goes the other way (higher prices benefiting the producers) ending up at a total of 105 M€ gain. Higher clearing prices also seem to increase the spread between price areas and increasing the congestion income with a total of 20 M€, though some months show a negative effect on congestion income. The sum of these effects is a total loss of 84 M€.

4.1.3 Comparing the two methods

The two methods of estimating the SDAC loss show very similar monthly and total numbers.

This gives us confidence that the estimated SDAC loss for 2025 from reserving CZC in the aFRR and mFRR capacity markets is in the region 80-85 M€.



The figure above, shows a comparison between, the realised simulated SDAC loss and the realised approximated SDAC loss. It also shows the forecasted SDAC loss, split into the actual forecast and the markup.

While the approximated realized losses are marginally lower than the forecasted losses, meaning that the forecast is conservative, we can see, that the simulation facility results return slightly higher losses, than the approximated realized losses. The conservativeness of the forecasted losses covers also this difference.

Consequently markups currently have an important role in ensuring, that the balancing capacity markets do not underestimate the value of the CZC for the exchange of balancing capacity. They adequately raise the forecasted costs to the level of the observed realized losses.

The Nordic TSOs are currently investigating, whether the forecasts can be improved to increase the benefits from balancing capacity exchange, by minimizing the share of markups in the forecasted value of CZC for the exchange of energy. A variety of forecasting models have already been evaluated, finding only marginal improvement potential in a change of the underlying forecasting model.

As part of the on-going work on the transition to the harmonized method for the reservation of CZC for exchange of balancing capacity and sharing of reserves, using flow-based parameters in the clearing of the Nordic balancing capacity markets is currently being assessed and implemented. At a later stage in the project, transitioning to 15min resolution will also be considered.

4.2 Capacity market benefits

The method for estimating the economic benefits from the coupling of price areas in the capacity markets follows the TSOs' own benefit calculations. The benefit is the difference between the actual market result and a reference case in which the market is cleared with no exchange of balancing capacity between bidding zones. The clearing and pricing algorithms used for the actual market results have also been used to clear the reference case. In the following, the actual market results are referred to as 'market' and the results without exchange as 'reference'.

When the market is cleared without exchange, only local bids can be selected. Where a bidding zone has insufficient local bids to cover its demand, the unprocured volume is priced at the higher of the bidding zone's two clearing prices, with and without exchange.

Economic surplus in the capacity markets consists of three elements: producer (BSP) surplus, consumer surplus in the form of a procurement benefit for the TSOs, and congestion income.

Component	Market	Reference
Producer (BSP) surplus	The BSP surplus in the market case, per price area.	The BSP surplus in the reference case, where only local bids can be accepted.
Consumer surplus	TSO procurement cost for the volume procured, including the cost of any unprocured volume.	TSO procurement cost in the reference case, including the cost of unprocured volume priced as described above.
Congestion income	For each price area, the reserved cross-zonal capacity multiplied by the clearing price difference across the border, divided equally between the two areas.	Zero for all price areas, since there is no exchange.

Table 9 – Producer surplus, consumer surplus and congestion income definitions.

The economic surplus from the exchange of balancing capacity is the difference in these values between the market and the reference case:

Benefit = (procurement cost in reference – procurement cost in market) + (BSP surplus in market – BSP surplus in reference) + congestion income in market

4.2.1 Results by component

The table below shows the 2025 benefit split by component for each market.

	Procurement benefit	BSP surplus	Congestion income	Total benefit
aFRR	205'808'738	10'381'347	7'781'473	223'971'559
mFRR	1'849'391'953	-485'331'673	114'566'611	1'478'626'891
Total	**2'055'200'692**	**-474'950'326**	**122'348'084**	**1'702'598'450**

Table 10 – Capacity market benefit by component (EUR).

The total benefit for 2025 is 1702.6 mill. EUR, of which 224.0 mill. EUR arises in the aFRR CM and 1478.6 mill. EUR in the mFRR CM. The aFRR figure is almost unchanged from the 223.13 mill. EUR reported for 2024.

The composition of the two results is very different. In the aFRR CM all three components are positive. In the mFRR CM the procurement benefit of 1849.4 mill. EUR is offset by a BSP surplus of minus 485.3 mill. EUR. A negative producer surplus of this size means that, across the Nordics as a whole, exchange gives BSPs access to a market in which prices are lower than they would be if each bidding zone had to clear on its own bids alone. The transfer runs from producers to TSOs, and the net of the two is still strongly positive.

4.2.2 Results by bidding zone

	DK1	DK2	FI	NO1	NO2	NO3	NO4	NO5	SE1	SE2	SE3	SE4	Total
aFRR	0.0	7.1	1.4	3.2	5.2	5.3	3.4	4.0	3.7	2.7	5.0	183.1	224.0
mFRR	16.7	36.7	7.8	12.4	5.5	2.7	2.3	3.5	80.3	47.6	63.4	1199.7	1478.6
Total	**16.7**	**43.7**	**9.2**	**15.6**	**10.7**	**8.0**	**5.7**	**7.5**	**84.0**	**50.3**	**68.3**	**1382.8**	**1702.6**

Table 11 – Capacity market benefit by bidding zone (mill. EUR).

The result is dominated by SE4, which accounts for 1382.8 mill. EUR, or 81% of the total benefit across both markets. SE3, SE1 and SE2 together add a further 202.6 mill. EUR. Every bidding zone has a positive total benefit in 2025.

4.2.3 Avoided under-procurement and trade benefit

Because the valuation of unprocured demand has a large effect on the result, the benefit is split below into the part that comes from avoiding under-procurement (the value of being able to cover demand that could not be covered locally) and the remainder, referred to here as the trade benefit, which comes from procuring the same volume more cheaply.

	Total benefit	Avoided under-procurement	Trade benefit
aFRR	223'971'559	35'069'209	188'902'349
mFRR	1'478'626'891	1'230'069'678	248'557'213
Total	**1'702'598'450**	**1'265'138'887**	**437'459'563**

Table 12 – Benefit from avoided under-procurement and from trade (EUR).

For the aFRR CM the split is 84% trade and 16% avoided under-procurement. For the mFRR CM it is the other way round: 83% of the benefit comes from avoided under-procurement, and only 248.6 mill. EUR from trade.

Almost all of the avoided under-procurement is one bidding zone in one direction. SE4 accounts for 1118.7 mill. EUR of the 1265.1 mill. EUR total, and SE4 upward mFRR capacity alone accounts for 1'019 mill. EUR. The reason is visible in the underlying data: without exchange, SE4 would have been unable to cover its upward mFRR demand in every one of the 8'760 hours of 2025, on average by 207 MW. The reference clearing price for SE4 upward mFRR averages 516 EUR/MW against 51 EUR/MW in the actual market, a factor of ten.

This figure should therefore be read as the value of security of supply in SE4 rather than as a trading gain, and it rests entirely on the reference prices being a fair valuation of capacity that was never actually procured. In practice, a persistent shortage of this size would prompt BSPs to offer more capacity locally, and the reference prices would fall. The trade benefit of 437.5 mill. EUR across the two markets is the more conservative measure and is not exposed to this assumption.

4.2.4 Monthly profile

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
aFRR	3.6	3.3	6.7	17.8	31.0	28.4	27.8	21.8	13.5	16.7	28.1	25.2
mFRR	195.9	222.9	204.2	202.4	96.9	119.0	106.1	88.9	52.9	61.2	60.3	68.1
Total	**199.4**	**226.2**	**210.9**	**220.2**	**127.9**	**147.4**	**133.9**	**110.8**	**66.4**	**78.0**	**88.3**	**93.3**

Table 13 – Capacity market benefit by month (mill. EUR).

The two markets move in opposite directions over the year. The aFRR benefit is lowest in the first quarter and highest in May and June, while the mFRR benefit is highest in the first four months and falls sharply from May onwards. The mFRR pattern follows the SE4 under-procurement valuation, which is largest in the winter and spring months.

4.3 Total economic surplus SDAC and capacity markets

When cross-zonal capacity is allocated to the exchange of balancing capacity, it is by default withdrawn from other markets. The possibility of exchanging aFRR between Nordic price areas since 8 December 2022, and mFRR since 2025, has therefore reduced the transfer capacity available to the SDAC and taken in isolation, had a negative economic effect on that market. For the capacity markets it has made cheaper resources available to the Nordics as a whole. The table below brings the two together.

	SDAC surplus	Capacity market benefit	Total surplus	Avg. daily surplus
aFRR	-16’360’958	223’971’559	207’610’600	568’796
mFRR	-63’783’152	1’478’626’891	1’414’843’739	3’876’284
Total	**-80’144’111**	**1’702’598’450**	**1’622’454’339**	**4’445’080**

Table 14 – Economic surplus summary (EUR).

In total for 2025 the economic surplus from the exchange of balancing capacity was 1622.5 mill. EUR, made up of 1702.6 mill. EUR of capacity market benefit less 80.1 mill. EUR of lost surplus in the SDAC. This is an

average daily surplus of 4'445'080 EUR. The negative effect on the SDAC is small relative to the positive effect in the capacity markets: across both markets the benefit is around 21 times the SDAC loss.

Taking the aFRR CM on its own, the total surplus is 207.6 mill. EUR against 200.3 mill. EUR reported for 2024 an increase of 4%. The daily average rises from 547'215 EUR to 568'796 EUR. The aFRR result is therefore broadly stable year on year.

As set out in section 4.2, a large part of the capacity market benefit is the valuation of demand that could not have been covered locally, and that valuation rests on reference prices for capacity that was never procured. It is therefore useful to repeat the calculation using only the trade benefit, which measures the gain from procuring the same volume more cheaply and does not depend on that assumption.

	SDAC surplus	Isolated trade benefit	Total surplus	Avg. daily surplus
aFRR	-16'360'958	188'902'349	172'541'391	472'716
mFRR	-63'783'152	248'557'213	184'774'061	506'230
Total	**-80'144'111**	**437'459'563**	**357'315'452**	**978'946**

Table 15 – Economic surplus on the trade benefit only (EUR).

The total surplus counting only isolated trade benefits for 2025 is 357.3 mill. EUR, an average of 978'946 EUR per day, and the benefit is still around 5.5 times the SDAC loss. The ratio differs sharply between the two markets: 11.5 for the aFRR CM and 3.9 for the mFRR CM. The lower mFRR ratio reflects both the larger volumes it reserves on borders that are congested most of the time and the fact that most of its measured benefit lies in avoided under-procurement rather than in trade.

The monthly profile of the combined result is shown below. Every month of 2025 has a positive total surplus on both measures.

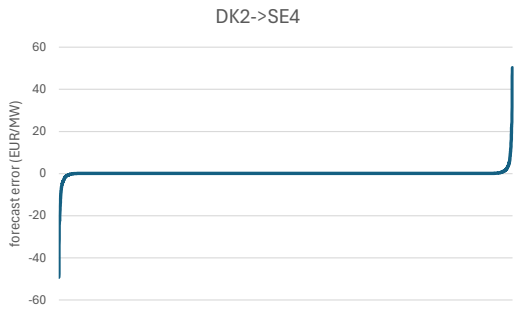
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Capacity market benefit	199.4	226.2	210.9	220.2	127.9	147.4	133.9	110.8	66.4	78.0	88.3	93.3
SDAC surplus	-6.4	-8.0	-10.5	-8.4	-6.3	-6.5	-6.2	-5.9	-8.5	-7.1	-3.3	-3.0
Total surplus	**193.0**	**218.1**	**200.4**	**211.8**	**121.7**	**140.8**	**127.8**	**104.9**	**57.9**	**70.9**	**85.0**	**90.3**

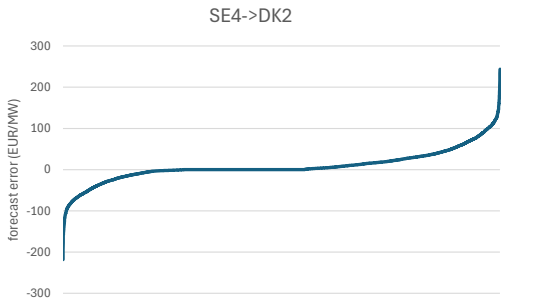
Table 16 – Total economic surplus by month (mill. EUR).

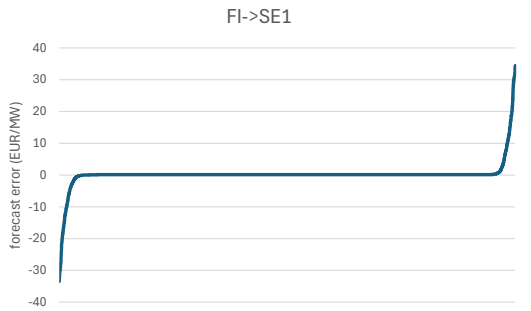
The monthly pattern is driven almost entirely by the capacity market side. The SDAC loss varies between 3.0 and 10.5 mill. EUR per month, while the benefit varies between 66 and 226 mill. EUR, so the shape of the total follows the benefit. The highest months are February and April and the lowest is September.

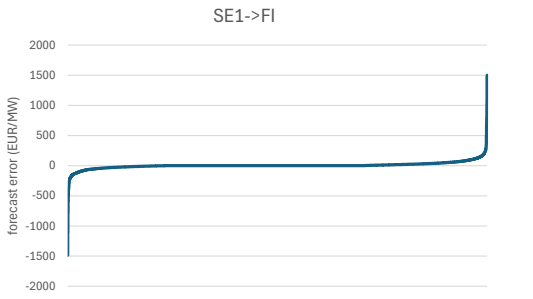
5 APPENDIX A

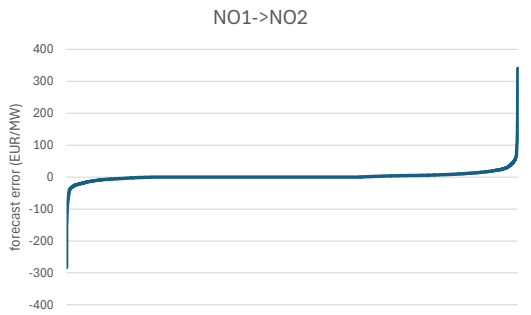
The following graphs are duration curves for the CZC forecast error for each border direction (from, to).

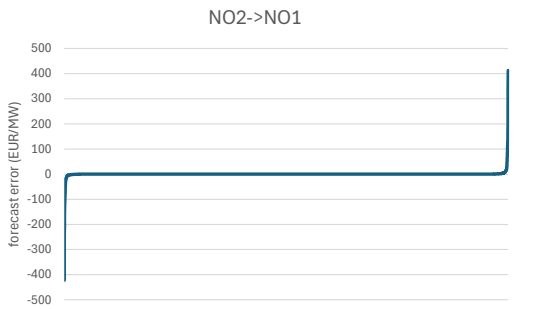


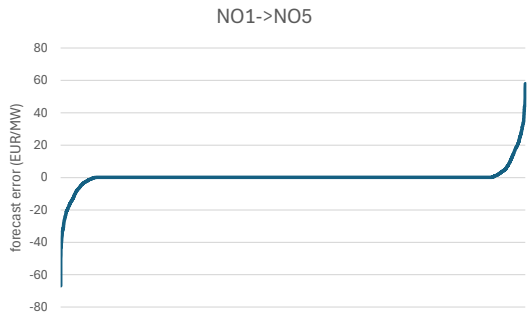


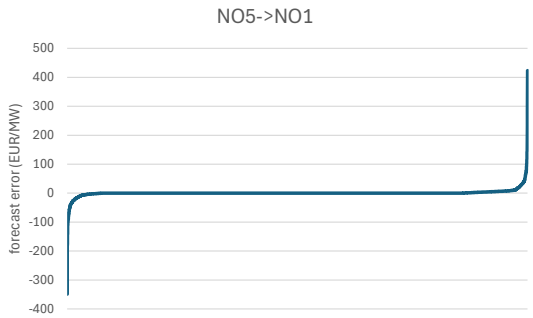


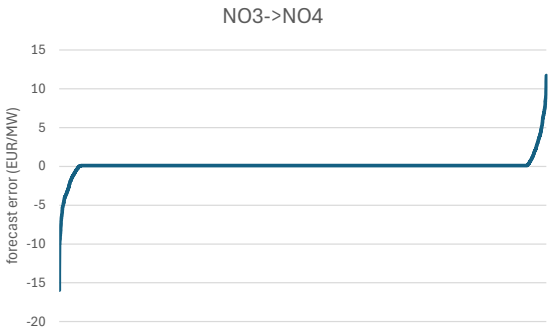


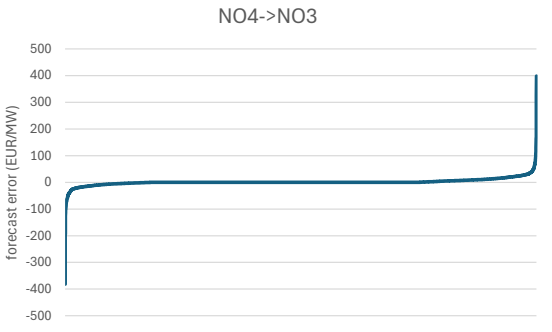


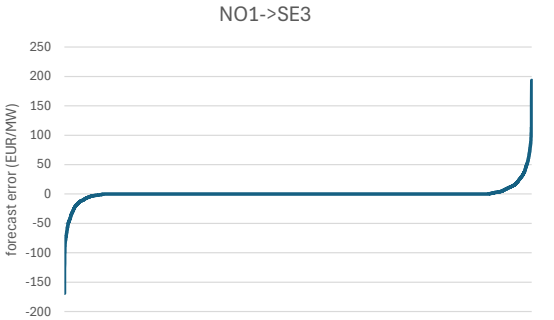


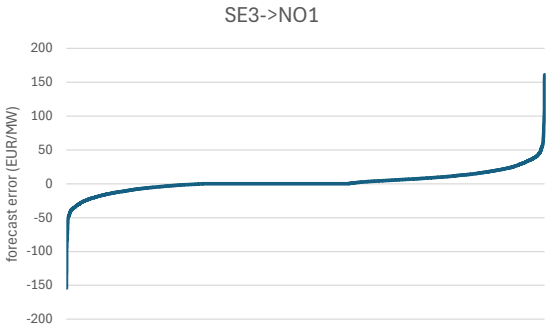


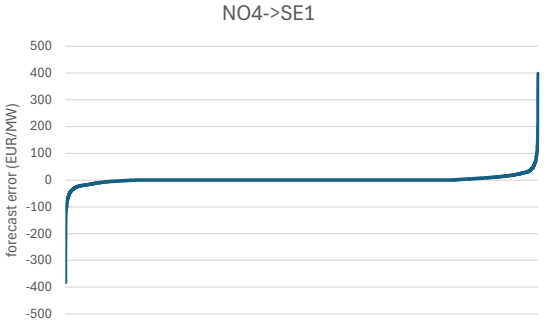


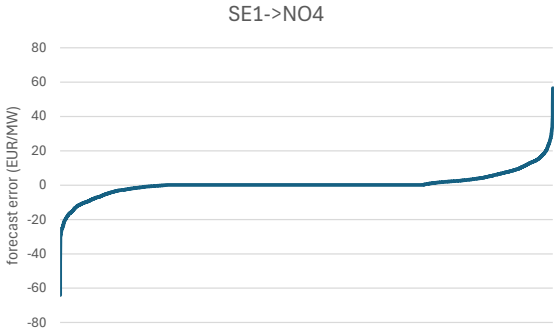

NO3->NO4
forecast error (EUR/MW)
15
10
5
0
-5
-10
-15
-20

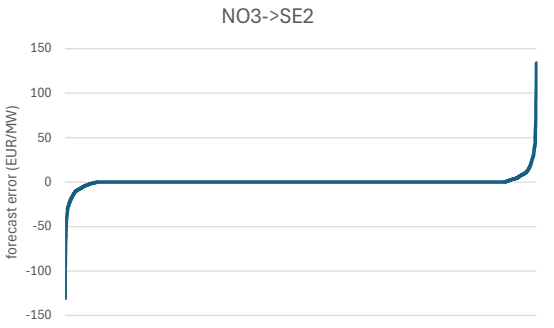

NO4->NO3
forecast error (EUR/MW)
500
400
300
200
100
0
-100
-200
-300
-400
-500

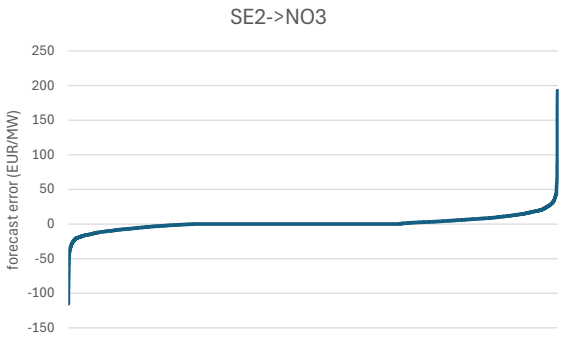

NO1->SE3
forecast error (EUR/MW)
250
200
150
100
50
0
-50
-100
-150
-200

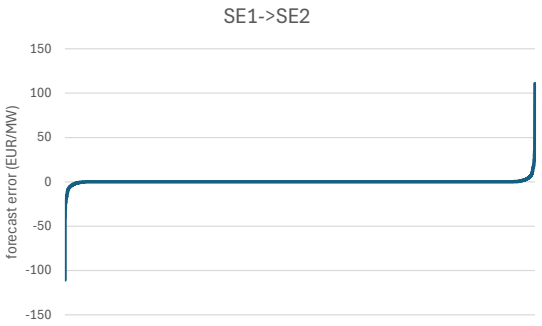

SE3->NO1
forecast error (EUR/MW)
200
150
100
50
0
-50
-100
-150
-200

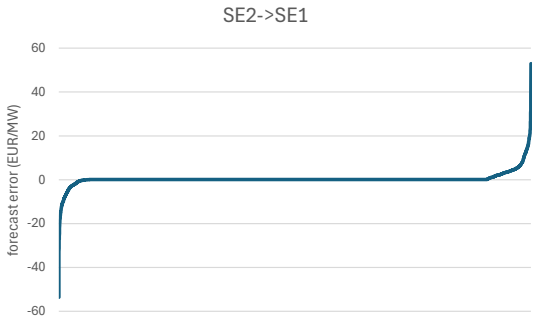

NO4->SE1
forecast error (EUR/MW)
500
400
300
200
100
0
-100
-200
-300
-400
-500

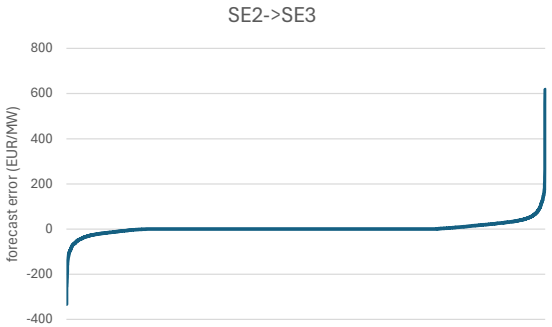

SE1->NO4
forecast error (EUR/MW)
80
60
40
20
0
-20
-40
-60
-80

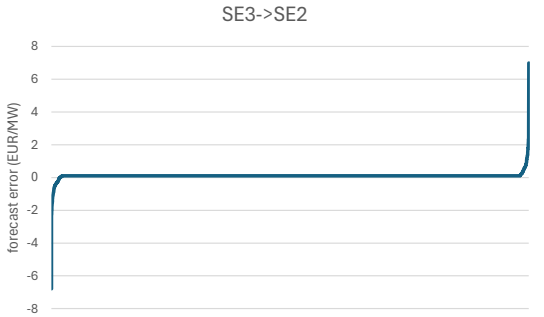

NO3->SE2
forecast error (EUR/MW)
150
100
50
0
-50
-100
-150

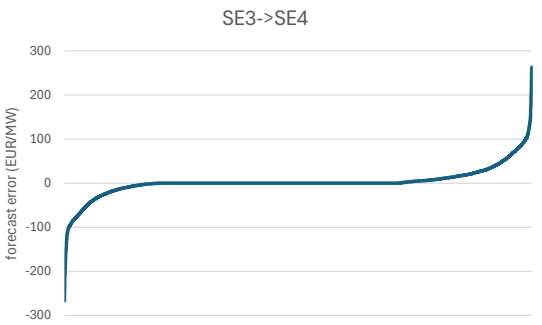

SE2->NO3
forecast error (EUR/MW)
250
200
150
100
50
0
-50
-100
-150


SE1->SE2
forecast error (EUR/MW)
150
100
50
0
-50
-100
-150


SE2->SE1
forecast error (EUR/MW)
60
40
20
0
-20
-40
-60


SE2->SE3
forecast error (EUR/MW)
800
600
400
200
0
-200
-400


SE3->SE2
forecast error (EUR/MW)
8
6
4
2
0
-2
-4
-6
-8

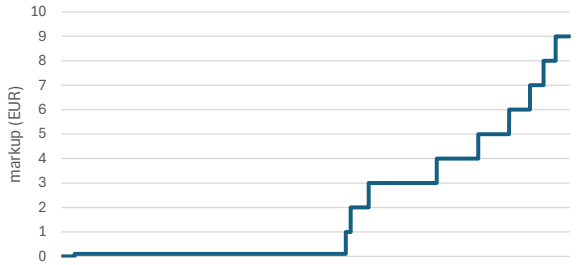

SE3->SE4
forecast error (EUR/MW)
300
200
100
0
-100
-200
-300

SE4->SE3
forecast error (EUR/MW)
80
60
40
20
0
-20
-40
-60
-80

6 APPENDIX B

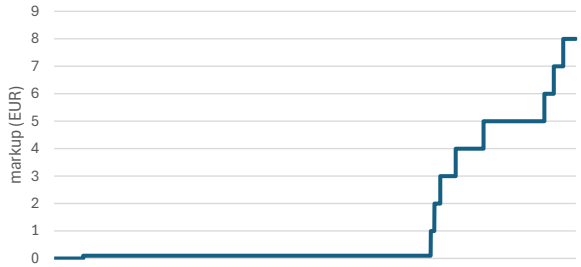
The graphs below show duration curves for markups for the eight borders with the highest average markups.

NO1->NO2

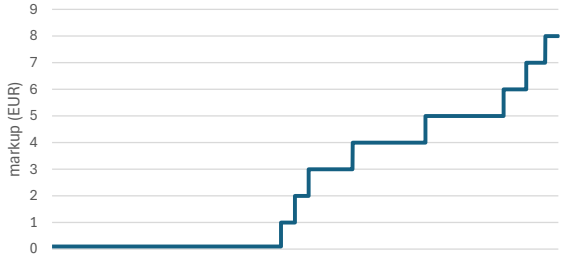


SE2->SE3

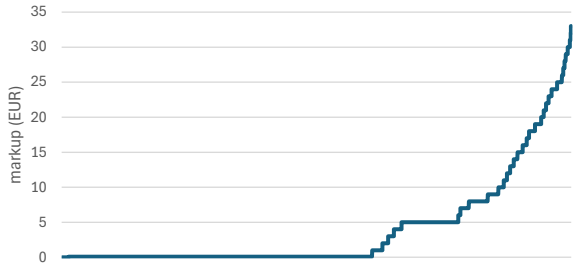
NO4->NO3



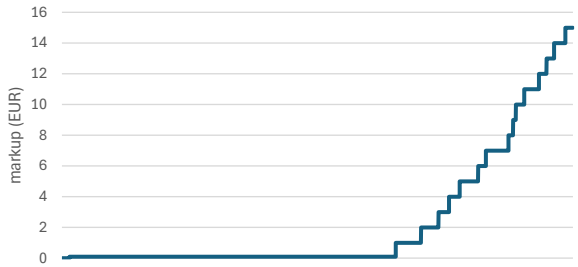
SE3->NO1



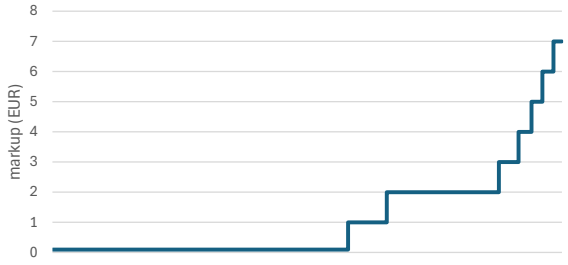
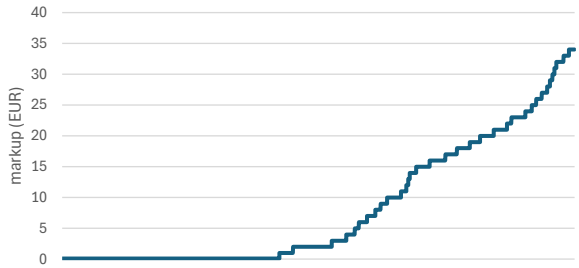
SE1->FI



SE3->SE4



SE2->NO3



SE4->DK2