



DA results from the external parallel run (EPR) of Nordic flow-based

SH bi-weekly meeting
1 February 2024

Rikke Bjerregaard Jørgensen & Krishna Solberg

Contact: ccm@nordic-rcc.net



Agenda

1. Updates since last meeting & upcoming events
2. Background information on the EPR
3. Follow-up on NSL and VL from last meeting
4. EPR results: the impacts on SEW, prices, flows, net positions, constraining CNECs
5. Case studies



Publication schedule and upcoming events

- **The biweekly meetings will change to monthly meeting.**
 - Biweekly meeting on 15/2, 9-11 CET covering the results for week 1-2.
 - Monthly meeting on 14/3, 9-11 CET covering the results for week 3-6.
 - Monthly meeting on 11/4, 9-11 CET covering the results for week 7-10.
- **Market report will still be delivered on weekly basis.**



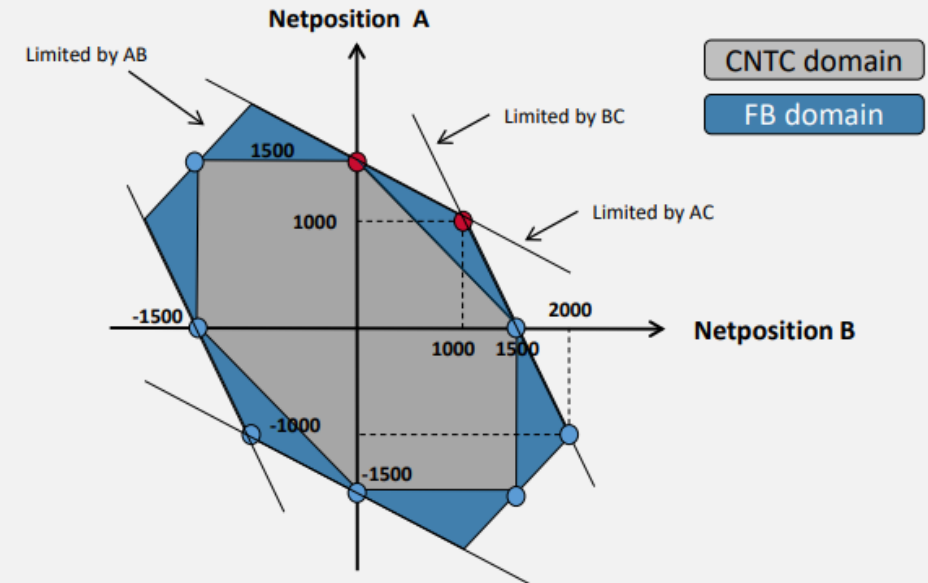
External parallel run (EPR)

- In EPR, the capacity calculation process for both FB and NTC is performed in parallel. Market results are available for:
 - NTC = actual day-ahead market coupling results, “production”
 - FB = simulated market coupling results with FB constraints
- **Goals of the EPR:**
 - 1) Ensure that the capacity calculation process works
 - 2) Show the differences between FB and NTC capacity calculation methods
 - 3) Intended for market participants to become familiar with FB capacity calculation and the impacts FB may have on the market outcome
 - 4) “Learning by doing” for TSOs



Increasing transmission capacity increases SEW

- **An increase in transmission capacity to the market will provide a higher social economic welfare.**
 - Larger domain allows for more trade, and increased opportunity for trade provides increased economic efficiency in any market.
 - SEW gain can be anywhere in the Nordics or SDAC (Europe).
- **TSOs can offer more transmission capacity to markets, e.g., by**
 - Changing the capacity calculation method
 - Building more transmission capacity between bidding zone borders
- **In FB, a larger domain than possible in NTC is provided directly to the market in the form of PTDFs, RAMs, and CNEs.**
 - This has the same effect as installing more capacity to the entire Nordic CCR. The setup, where and how much more flow is enabled, depends on forecasted flows and market bids.
 - FB development will continue after DA FB go-live.

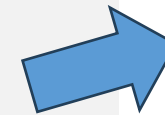




The role of TSOs and EPR

- **The role of TSOs is to provide as much transmission capacity to the markets, as operationally secure, to ensure efficiency.**
 - Other market participants are responsible for other segments of the day-ahead market; TSOs should not intervene or speculate in these.
- **Assumption in the EPR: Different capacity calculation method, but same market coupling algorithm and same order books**
 - Changing nothing else as the capacities enables a fair comparison of the two capacity calculation methods. It isolates the impacts solely from FB capacity calculation without further assumptions.
- **Why we measure the SEW impact of FB?**
 - EPR is done the way NRAs and CACM require TSOs to perform it.*
 - Higher SEW **per MTU** indicates **higher or economically more efficient flows** in the system
 - Higher SEW **over a long time** indicates a **trend of the above** in the system

- The report shall include at least the following, based on a per MTU level of granularity:
 - A calculation of DA socio-economic effects (as measured by delta in consumers' surplus, producers' surplus and congestion income) from flow-based capacity calculation compared to the current capacity calculation method in use. The geographical area for this calculation shall be the Nordic market area plus neighboring countries if possible.
 - If the accumulated DA socio-economic effect of flow-based is negative over any two-week period, the TSOs shall provide analysis and explain why this occurred.



* <https://www.fingrid.fi/globalassets/dokumentit/fi/tiedotteet/sahkomarkkinat/2020/paatos-cacm-suuntaviivojen-202-artiklan-mukaisen-nordic-kapasiteetin-laskenta-alueen-yhteisen-kapasiteetin-laskentamenetelman-muuttamisesta.pdf>



Viking Link & North Sea Link

Viking Link (VL) and North Sea Link (NSL) are interconnectors from DK1 and NO2 to UK. These borders are not included in SDAC market coupling.

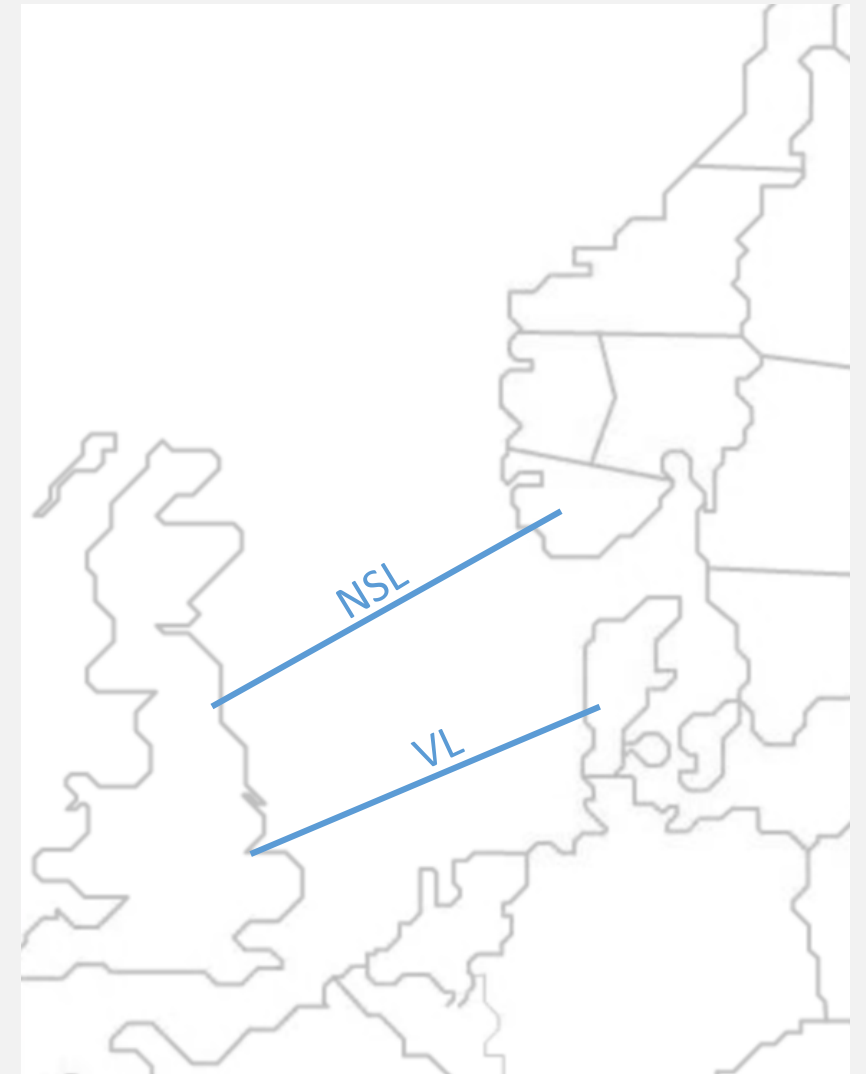
Allocation on these borders are made in separate auctions before SDAC.

The flow on these borders need to be considered in the SDAC an SDIC capacity allocation process to secure a safe domain for system operation.

Modelling in flow-based:

- The flow on VL and NSL in the FB model are modelled based on a forecast of flow because the actual auction results will not be ready in time for the FB process.
- VL and NSL are in the IGM considered as a non-flexible consumer, or a non-flexible producer depended on the flow direction.
- The expected flow on VL and NSL will be part of the F0 value and will therefor affect the RAM value available.

Note that for NSL in NTC prognosis is not part of the capacity calculation and any issues are solved during operation. This means that the NTC solution can provide a larger domain that might not be secure.





FB enables higher utilization of the grid and will result in other changes in the market

- When FB enables more capacity provided to the day-ahead market, it is likely that there will be other changes in the markets.
 - EPR enables SHs to learn how to read, analyze, and use FB domains.
 - EPR is not a forecast of future prices and flows.
- Why EPR cannot be designed to use “FB order books”?
 - No such information available from market participants.

Not presented in the stakeholder meeting on
18. January 2024. Included as extra information
(from 7 December 2023 meeting).



Hydro production in the Nordics

- **Nordic power system is dominated by hydro production and Nordic prices, especially for some BZs, are impacted by water values.**
 - However, the production mix is diverse for Nordics as a whole (together with the continent)
- **SEW is an indicator of higher grid use per MTU:**
 - It can be assumed that water values are not affected within the day by the change in the capacity calculation.
- **However, there is an effect of using more water in the north and saving water in the south over a longer period, and it has an impact on BZ prices and SEW.**
 - If there is more energy to be traded in FB day-ahead market than in NTC, it is expected that the hydro producers in the north would adjust their orders accordingly to save water.
 - Also, it is expected that hydro producers in the south would adjust their orders, so that their reservoirs wouldn't overflow.
 - The simulated FB SEW is affected by this, but the purpose of computing SEW is to indicate that capacity calculation works per MTU, not to forecast the market development

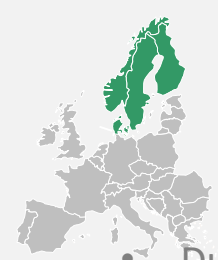
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The uncertainty of hydro on SEW does not undermine positive impacts from FB

- FB enables more objective handling of grid limitations and allocates flows where it creates highest SEW. This is especially useful for a meshed grid and is not likely only hydro utilization.
 - Enabling higher flows from FI to SE3 (Fennoskan)
 - Enabling higher flows from SE3 to NO1 and DK1
- FB enables higher grid utilization with the same level of operational security in the changing energy system.
- Enabling higher flows in the Nordic grid has been proven in the EPR.
 - Even if hydro volumes do not materialize fully as they do with NTC orderbooks, it does not remove the EPR-result, observed over various seasons and market settings, that the possibility for higher transmission exists.

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18. January 2024. Included as extra information
(from 7 December 2023 meeting).



Nordic region in W51-52 NTC

- During end last two weeks of December the temperature increased in the Nordic area together with the low consumption during Christmas this resulted in a decrease in the prices in all BZ compared to the previous weeks.
- Prices in DK, SE and NO4 are very close to each other, and slightly lower than FI. Higher prices in the Baltic countries and the continent except DE.
- The prices in NO1,NO2 & NO5 are highest, but still lower than in the previous weeks.
- Constraints in the grid:
 - Northern Norway ->Southern Norway
 - SE+DK -> Southern Norway
 - Nordic -> Continent
- During Christmas, the Nordic area was importing electricity from the continent.
- In delivery a lot of countertrading and grid splits was necessary in Southern Norway to avoid overloads on transformer station in Sauda. This indicate that the NTC-domain was not secure.

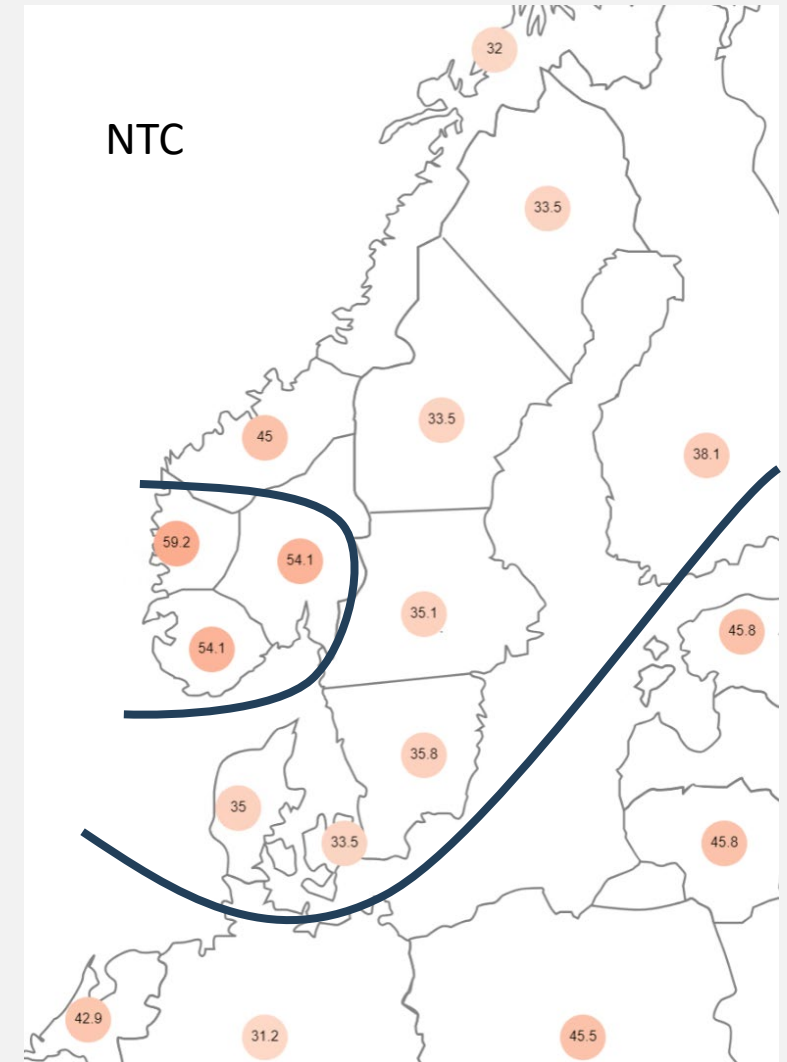


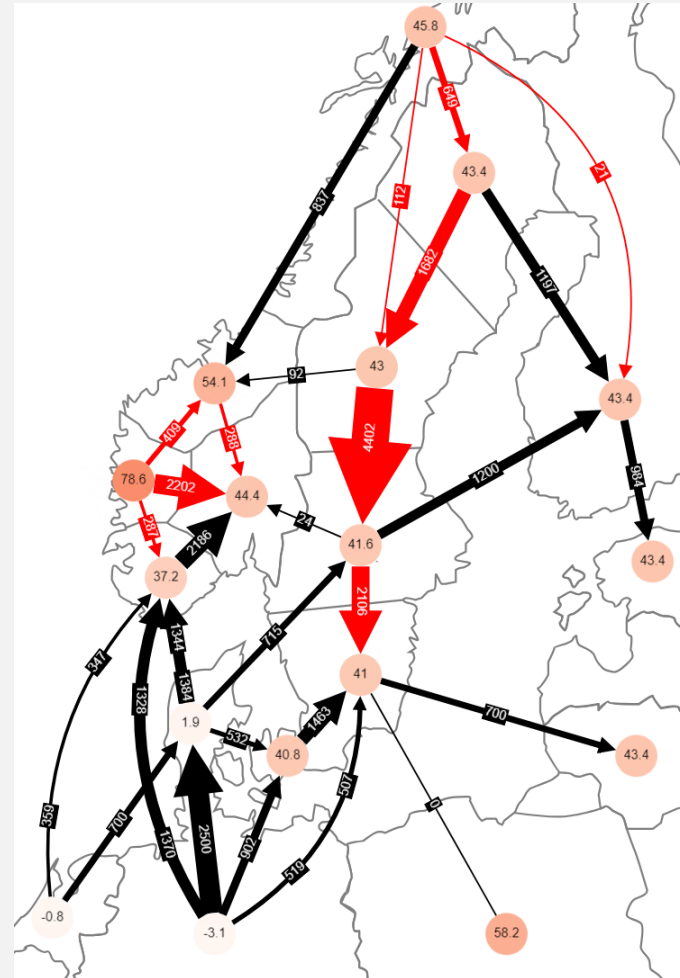
Figure: Average price in each BZ in NTC



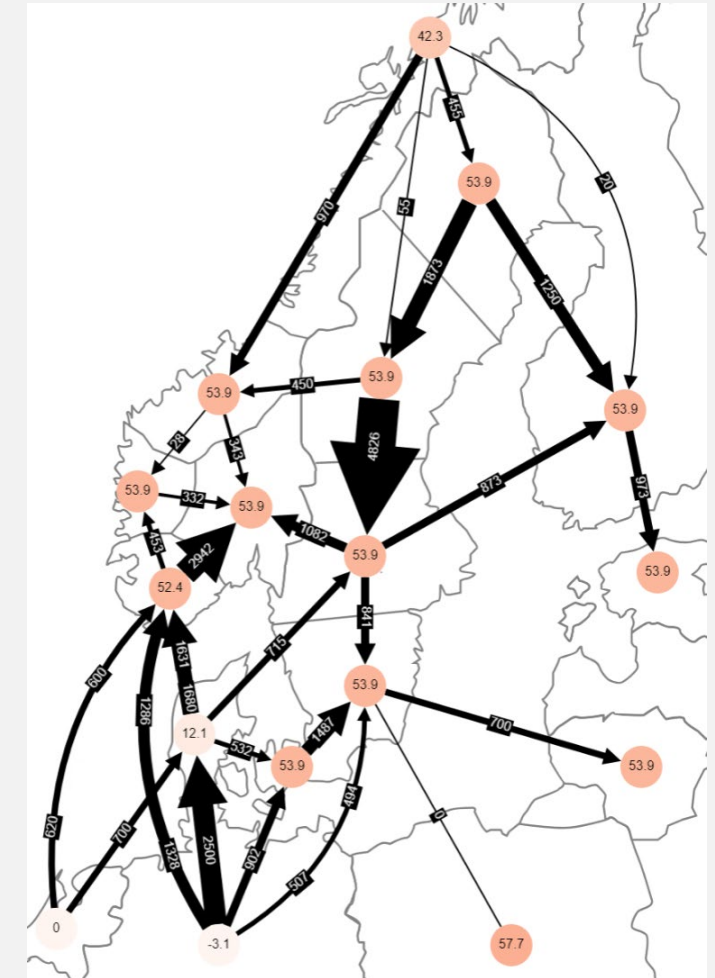
Sauda transformers

2023-12-24 MTU 10

- Sauda transformers are located in NO2
- During high import from the Continent and deficit of power in parts of NO5 and NO2, these transformers are very loaded (in both NTC and FB).
- In NTC, the operators use a lot of counter trade and grid splitting to avoid overloads.
- In flow-based, the model forces production in NO5, increasing the price, but avoiding overloads (and avoiding counter trade)
- We are still analyzing this case, but the operators seem happy with the FB solution.



Map: Price and flows from FB



Map: Prices and flows from NTC



Social welfare change W51-52

- Flow-based results in a higher SEW compared to NTC for the Nordic region, but a lower SEW for the whole market coupling region (SDAC).
 - Total Nordic SEW change 5.8 M€
 - Total SEW change in the SDAC region -2.08 M€
- Both Week 51 and 52 result in a positive Nordic SEW, while only Week 51 results in a positive SEW for the whole SDAC area.
- The second half of W51 & W52 are showing SEW losses in FB, which are caused by congestions on Souda CNECs in Southern Norway. These congestions are not shown in the NTC results, as the overloads are handled by counter trading.
 - FB finds a solution to avoid the countertrading, but is more restrictive which lowers the SEW.

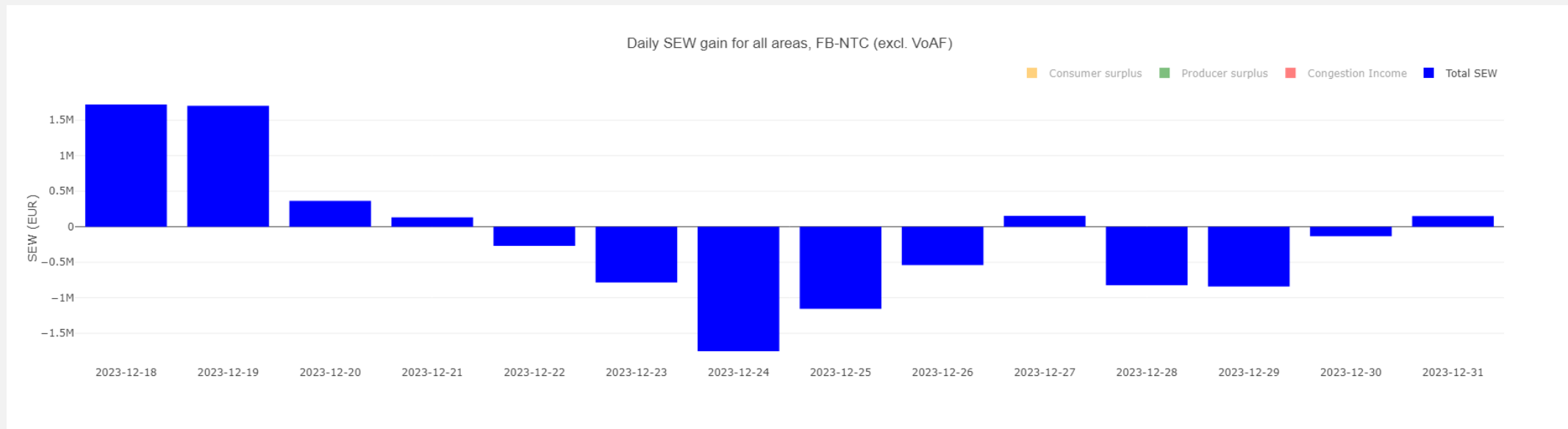


Figure: SEW change in the whole SDAC region on daily level



Constraining CNECs in FB W51-52

- The CNECs with highest shadow prices are HVDC interconnectors connecting the Nordics to the continent, and the “Sauda” CNECs in Norway.
- High shadow prices indicate that more flow would have increased the total SDAC welfare.

⌘CNEC	⌘Count of hours	⌘Average shadowprice	⌘Total shadowprice
15351_126 95% Sauda T3 Transformator P + Sauda T2 Transformator P	110	198.89	21,878.02
AC_Maximum_SE4_BC	184	23.76	4,371.22
15351_372 76% Sauda T3 Transformator P + Sauda T2 Transformator P	18	186.55	3,357.90
AC_Maximum_DK2_KO	200	16.55	3,309.86
15351_232.372 81% Sauda T3 Transformator P + Sauda T2 Transformator P	14	235.98	3,303.66
AC_Maximum_NO2_NK	139	23.69	3,293.55
35b6b0a6f4f64c0b89fe28af1a186b38	135	23.25	3,138.66
15291_10 45% 420 Nea-Klæbu + 420 Tunnsjødal-Namsos + 300 Tunnsjødal-Verdal	111	24.68	2,738.96
AC_Minimum_SE4_SP	120	20.96	2,514.70
b150def9f7b340099fa460676f66f183	193	11.52	2,223.41
9b521f09c6b246c0bb3b7933dacc7cf5	91	22.76	2,071.34
ACLineSegment ENDK DK1 E_FOU-MOSV 1 F Terminal : F	19	107.98	2,051.56
FI_PTC_FI_EL_EXPORT	82	24.98	2,048.38
AC_Minimum_DK2_KO	89	22.82	2,031.37
DK1_SV_EXP	88	21.84	1,921.52
DK1_NL_EXP	84	22.70	1,906.95
DK1_DK_EXP	178	10.47	1,863.84
AC_Minimum_NO2_ND	100	18.55	1,855.07
AC_Minimum_SE4_BC	63	28.60	1,802.02
AC_Minimum_DK1_CO	79	22.64	1,788.88
13792_325 420 Kristiansand-Arendal + 420 Kristiansand-Kvinesdal + 420 Kristiansand-Brokke + Kristia	138	12.89	1,779.16
AC_Maximum_SE4_SP	73	20.11	1,468.36
13792_325 65% 420 Namsos-Ogndal + 30% 420 Namsos-Hofstad + 300 Tunnsjødal-Verdal	57	23.30	1,327.93
AC_Maximum_NO2_ND	84	14.10	1,184.71
AC_Minimum_DK1_DE	66	16.82	1,110.17

Table: Top 25 aggregated shadow prices on CNEC level



Nordic net position impacts W51-52

- From the 21. December and for most of the remaining part of these weeks the Nordic Net Position is negative, meaning power is imported from the continent.
- In the exporting period, the export from the Nordic increased from 452 GWh in NTC to 466 GWh in FB resulting in a Nordic NP increase of 14 GWh.
- In the importing period, the import to the Nordic decreased from 902 GWh in NTC to 784 GWh in FB resulting in a Nordic NP increase of 117 GWh.

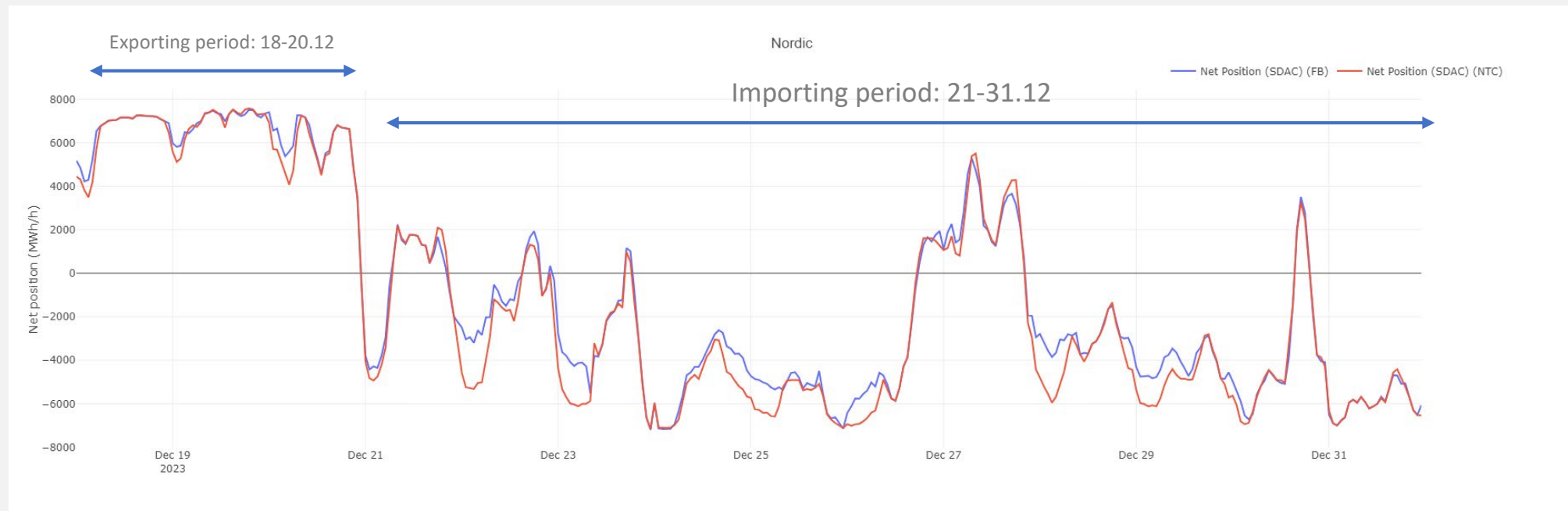


Figure: Net position in CCR Nordic (FB and NTC)

Average prices in the Nordic region W51-52



- For these weeks there are the mentioned internal constraints in Southern Norway
- Constraints between the Nordics and the continent
- The price decreases with ~2-3 EUR/MWh in NO1, NO2 and DK1 & increases ~2-4 EUR/MWh in SE, FI & Northern Norway.

To avoid the Sauda congestion:

- FB reduces the import from the Continent & DK1 to NO2 with 196 GWh
- 70 GWh more export from NO5 to NO2, and 277 GWh less from NO2 to NO1.
- 131 GWh less export from the Continent to the Nordics
- NO5 price increases due to increased production

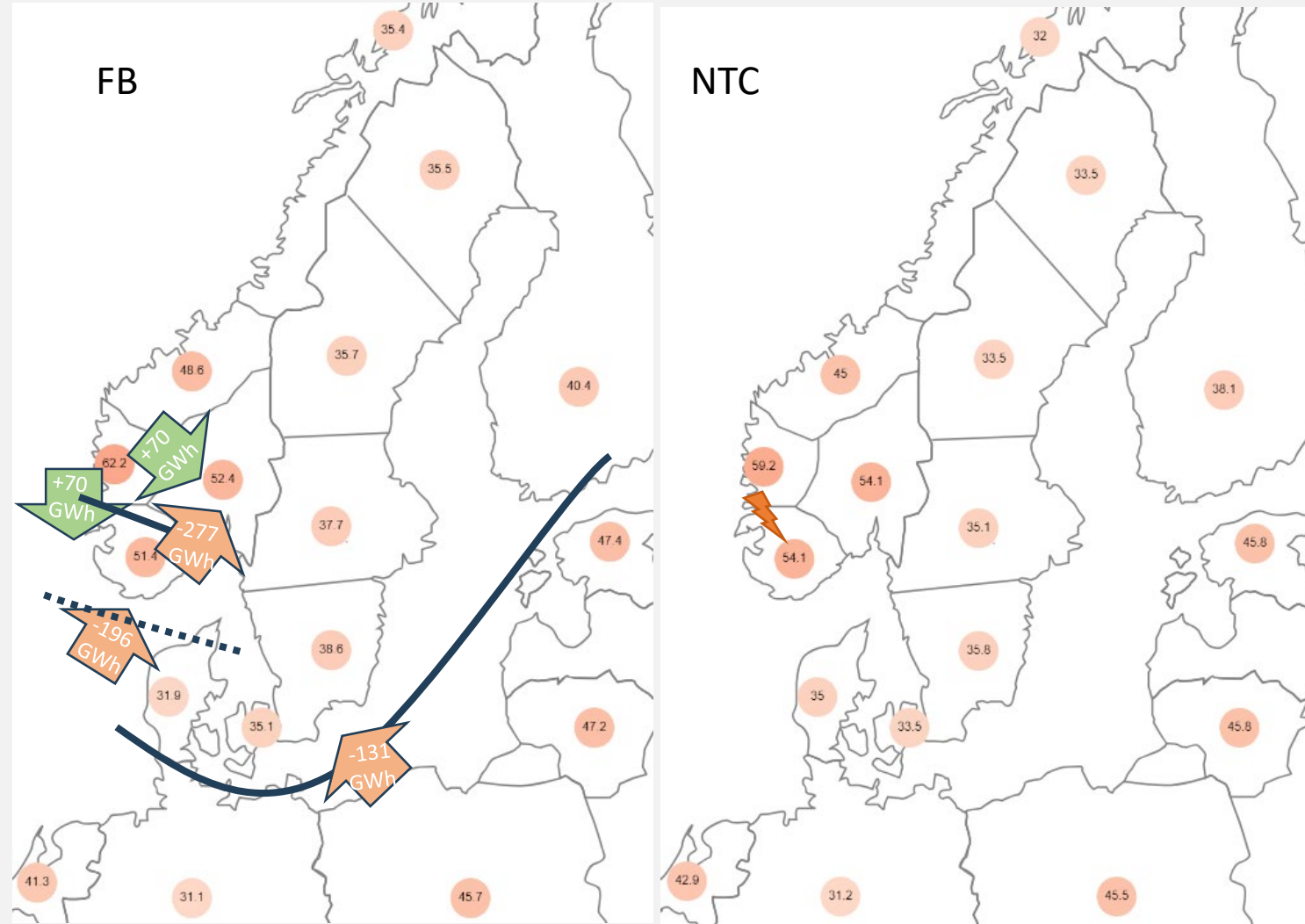


Figure: Average price in each BZ in FB and NTC. Arrows show the increased flow over constraining elements.



Prices W51-52

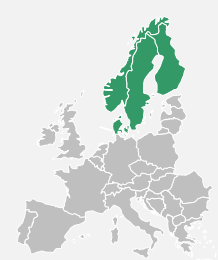
Market prices

Rounded to nearest integer. Thousands separated by comma. Example: 1,234,567

Bidding zone	Min. price		Max. price		Avg. price		
	FB	NTC	FB	NTC	FB	NTC	FB-NTC
DK1	-11	-9	102	92	32	35	-3
DK2	0	0	89	83	35	34	2
FI	6	0	114	118	40	38	2
NO1	24	0	80	80	52	54	-2
NO2	20	0	80	80	51	54	-3
NO3	8	10	83	80	49	45	4
NO4	15	10	77	78	35	32	3
NO5	31	44	85	80	62	59	3
SE1	6	0	77	80	35	33	2
SE2	5	0	78	80	36	33	2
SE3	3	0	83	80	38	35	3
SE4	1	0	90	80	39	36	3

Table: Min, max and mean prices for all bidding zones in FB and NTC

- Generally, quite similar prices in DK, SE & FI through the period, Southern Norway has higher prices.
- FB decreases the average prices in DK1, NO1 & NO2 and slightly increases them in the other bidding zones.
- The maximum prices decreased for FI, SE1 and SE2, but increases for DK, NO3, NO5, SE3 and SE4.



Total socio-economic welfare on hourly level W51-52

- Week 51 has a slightly positive total SEW with a volatility on consumer & producer surplus changes. Volatility decreases in Week 52, but FB results in a slightly negative total SEW.
- However there is a period where the changes are small and FB provides a similar market solution as NTC.

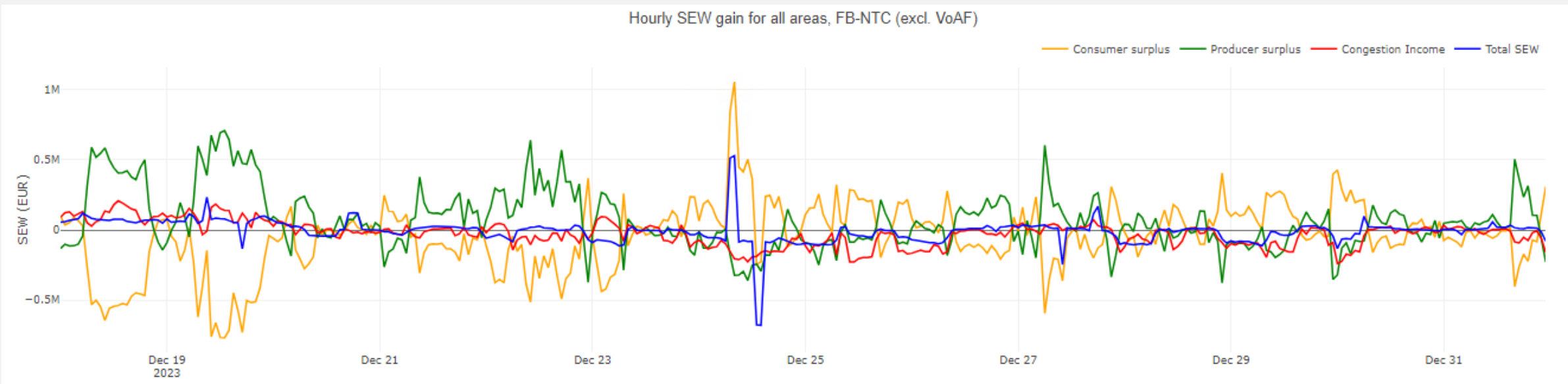
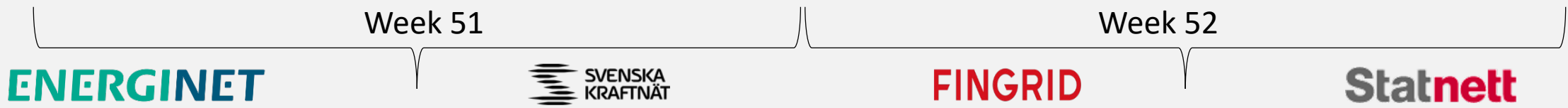


Figure: Hourly SEW change from FB to NTC for the total SDAC region.





SEW Impact on bidding zone level W51-52

- The impact on the different parts of the SEW from FB differs significantly between the Nordic bidding zones.
- Largest positive total SEW change in SE2 and NO1.
- Negative difference in SEW is observed in DK1, DK2, NO2 and SE4.
- FB results in a gain for consumers in DK1, NO1 and NO2, while the producers in SE2, SE3, FI, NO3, NO4 and NO5 experience the largest gain with FB compared to NTC.

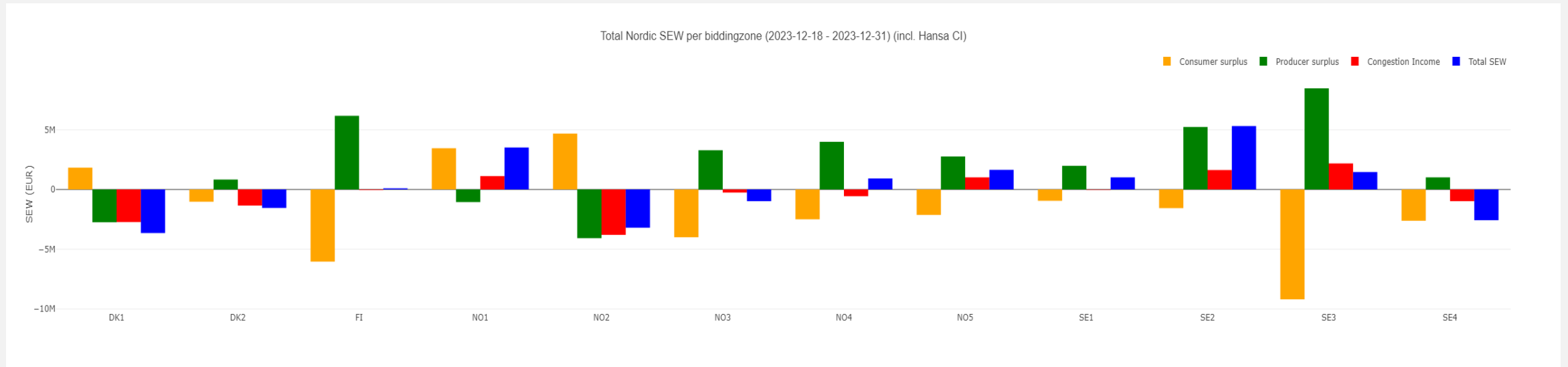


Figure: SEW change per stakeholder in CCR Nordic per BZ



Impact on buy and sell volumes (FB-NTC) W51-52

- Biggest difference of demand is noted in NO2, DK1, largest overall difference in NP is in NO2 and NO5
- Mostly the change in supply volumes that are impacting the changing net positions in the bidding zones

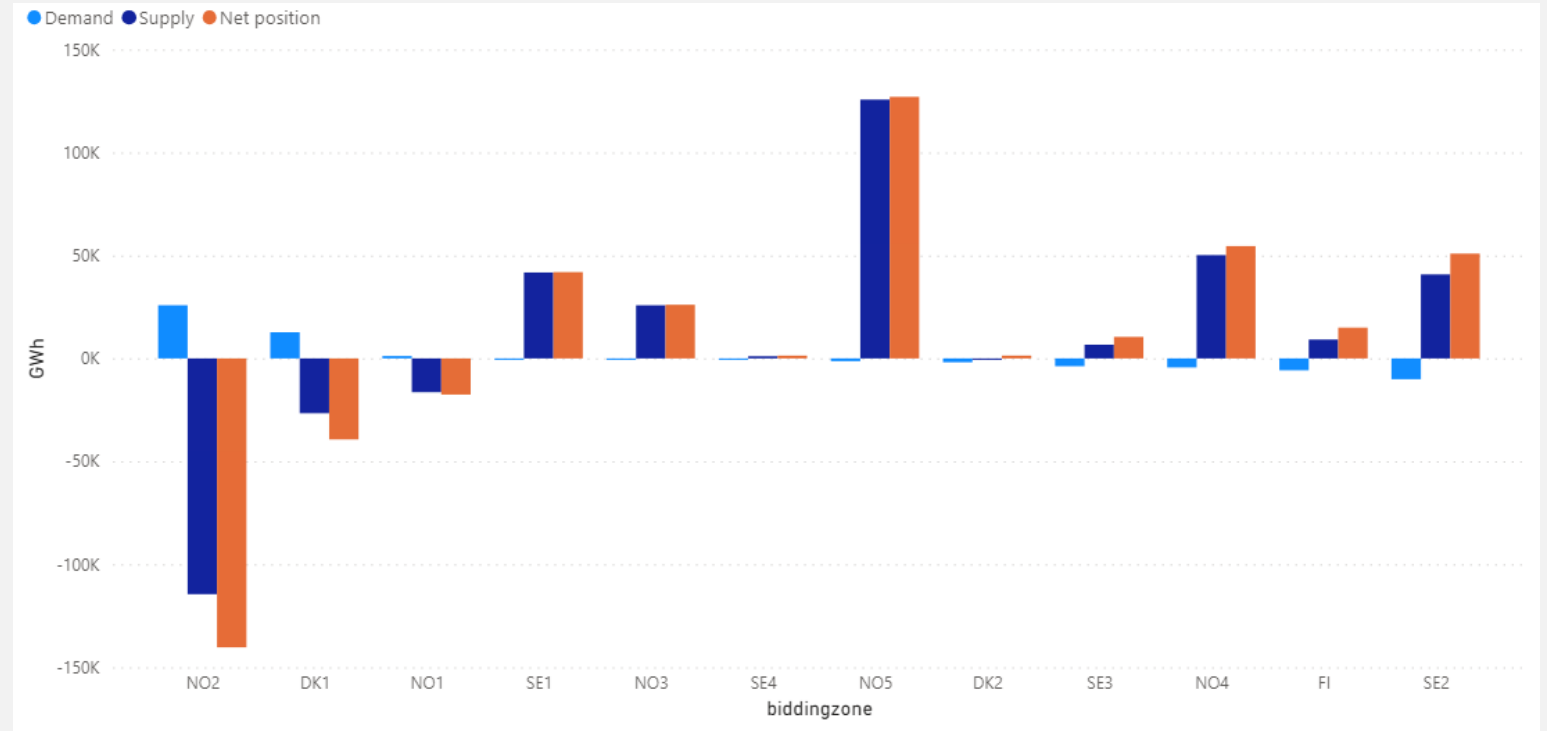


Figure: Demand and supply volumes difference (FB-NTC) and the corresponding net position change

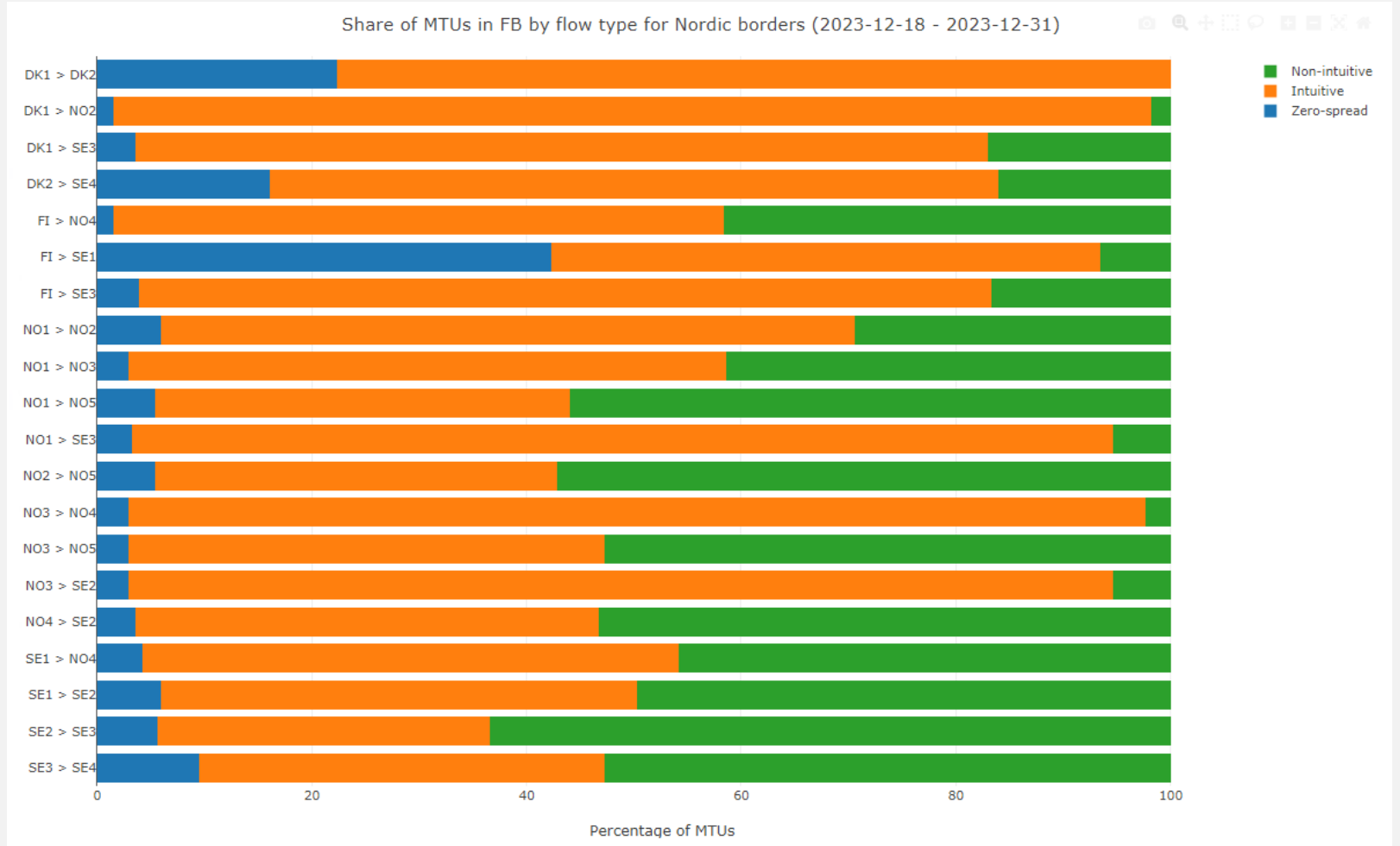


Flows W51-52

- Borders between bidding zones internally in Sweden & Norway and between Norway and Sweden have the highest share of non-intuitive flow.

	All	Intuitive	Non-intuitive
	FB	FB	FB
DK1 > DE/LU	8	13	NA
DK1 > DK2	8	10	NA
DK1 > NL	14	18	NA
DK1 > NO2	21	21	-5
DK1 > SE3	12	16	-2
DK2 > DE/LU	16	18	NA
DK2 > SE4	4	5	0
EE > FI	7	21	0
FI > NO4	5	12	-3
FI > SE1	5	10	0
FI > SE3	4	6	-3
LT > SE4	9	10	0
NL > NO2	18	23	-23
NO1 > NO2	1	2	-1
NO1 > NO3	4	11	-6
NO1 > NO5	-10	1	-18
NO1 > SE3	15	16	-4
NO2 > DE/LU	23	26	-29
NO2 > NO5	-8	5	-17
NO3 > NO4	13	14	-4
NO3 > NO5	-4	13	-18
NO3 > SE2	13	14	-6
NO4 > SE2	0	5	-4
PL > SE4	14	17	-11
SE1 > NO4	1	5	-3
SE1 > SE2	0	1	-1
SE2 > SE3	2	10	-2
SE3 > SE4	1	4	-1
SE4 > DE/LU	20	20	NA

Table: Average price spread per border with FB



Graph: Share of hours with intuitive, non-intuitive and zero-price spread per border with FB. All prices are rounded at one decimal.

Walk through specific hours and periods

18.12, 10.00-11.00

Different Net Position in the Nordic compared to the rest of the period: Export to the continent

27.12

Weather change affects Nordic Net Position

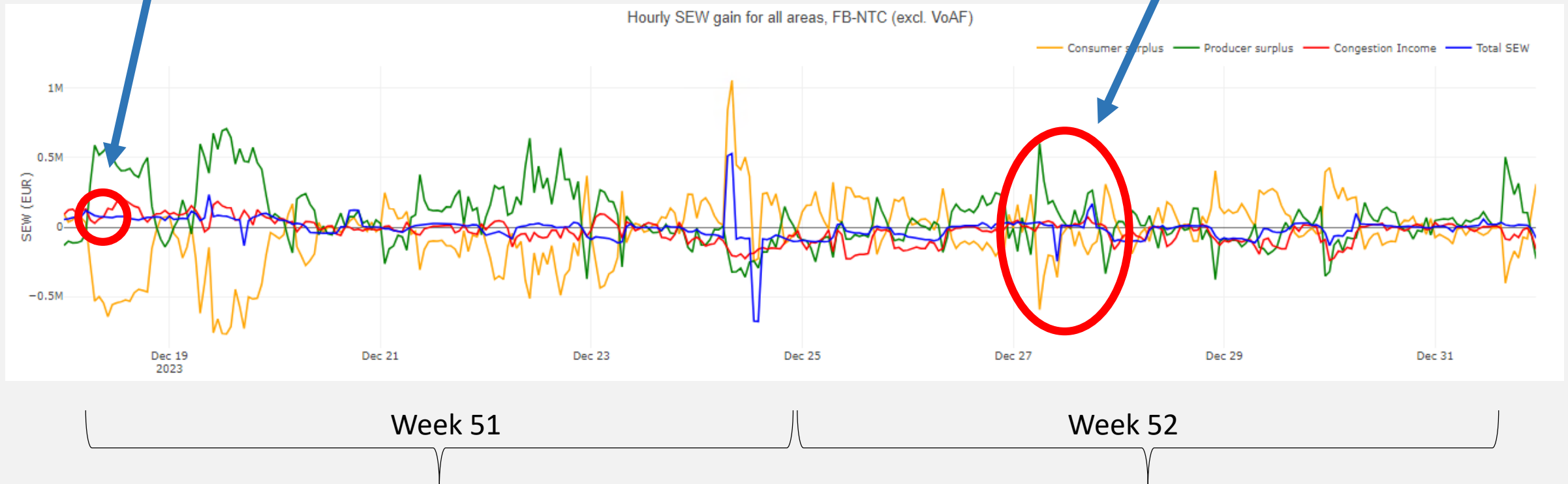
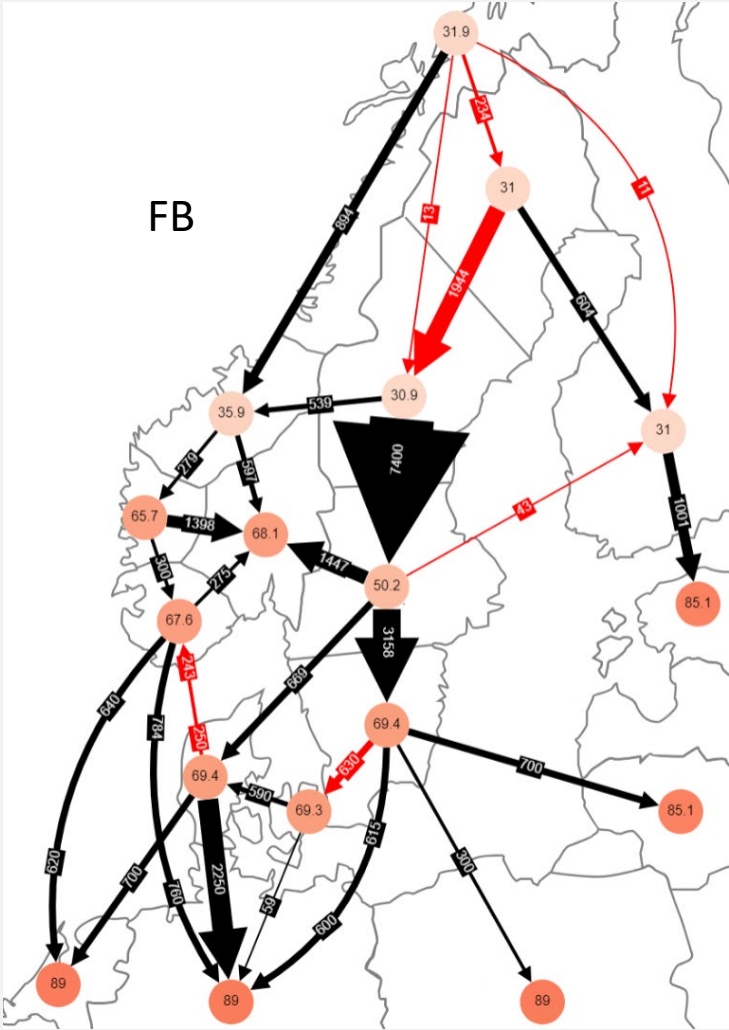


Figure: Hourly SEW change from FB to NTC for the total SDAC region.

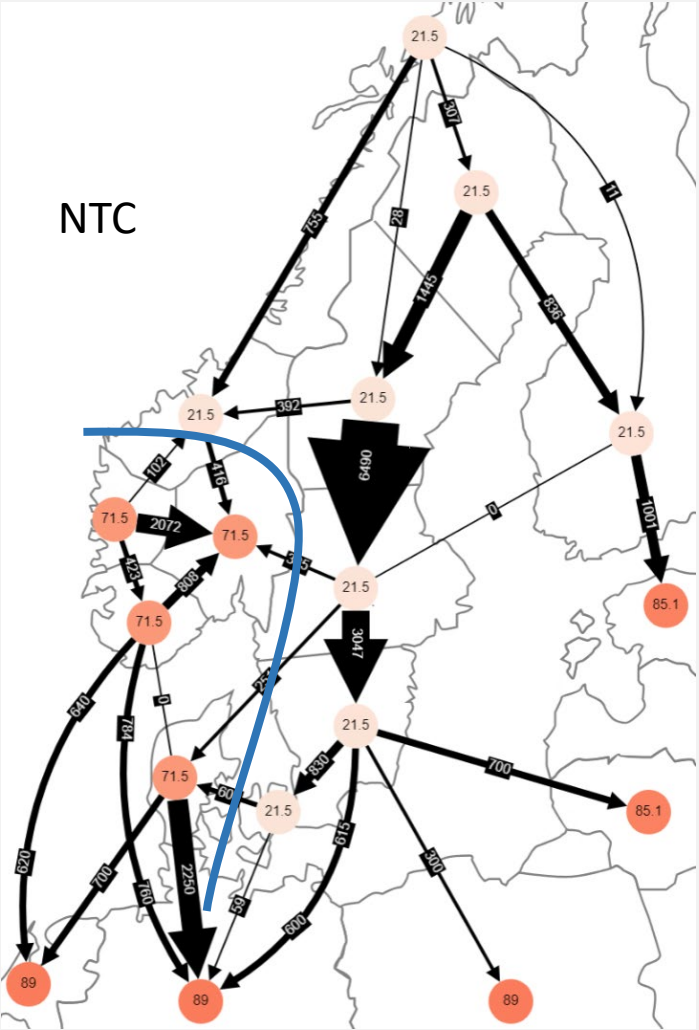


December 18th, 10:00-11:00

- Export from the Nordic to the Continent.
- No change in the flow to the Continent, but overall different compared to the rest of the period.
- The total SEW gain is 74 k€, and the Nordic SEW gain is 152 k€
 - FB utilizes the grid better and can therefore find a more socioeconomic effective solution
 - Congestion income are moved from Hansa borders to Nordic borders.
- FB increases the over the constraining elements.
 - Decreased prices in the Southern Norway and DK1 compared to NTC.
 - Increased prices in the rest of the Nordic compared to NTC.
 - The largest price increase occure in DK2, SE3 and SE4.



Map: Average price and flows from FB



Map: Average prices and flows from NTC



Net position switch on December 27th

- On the 27. December the price in DE increases for both NTC and FB due to low wind.
- For the 27. December the change in Nordic NP is positive for most of this day, while it is negative for most of the days in the period.
- For the period of import to the Nordic the hours in the nights & early morning show a negative Nordic SEW gain, except December 27th.
- Analysis has shown that the Suda CNEC is the most constraining element in this two-week period.

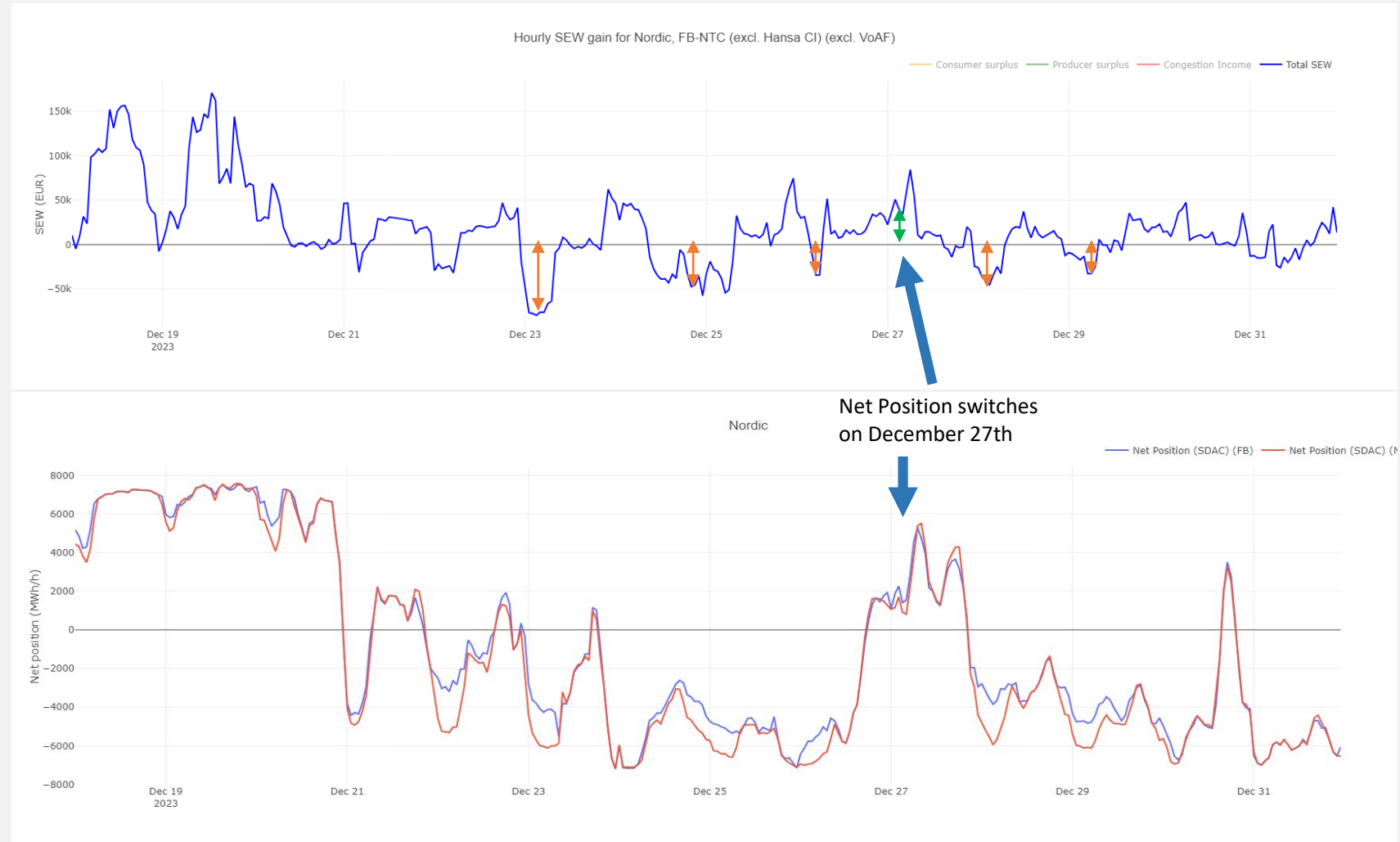


Figure: Hourly SEW gain in the Nordic & net position in CCR Nordic (FB and NTC) for week 51-52.



Net Position Switch on December 27th

- Taking a detailed look at the Sauda CNEC, it is shown that NTC results in an overload for several hours.
 - If $PTDF * NP_NTC > RAM \rightarrow$ overload in NTC.
- FB is compliant with the constraints in the grid and the need for countertrading would therefore have been avoided.
- For the hours with a positive Nordic Net Position, the Sauda constraint does not constrain the market solution and the SEW gain for FB is again positive.

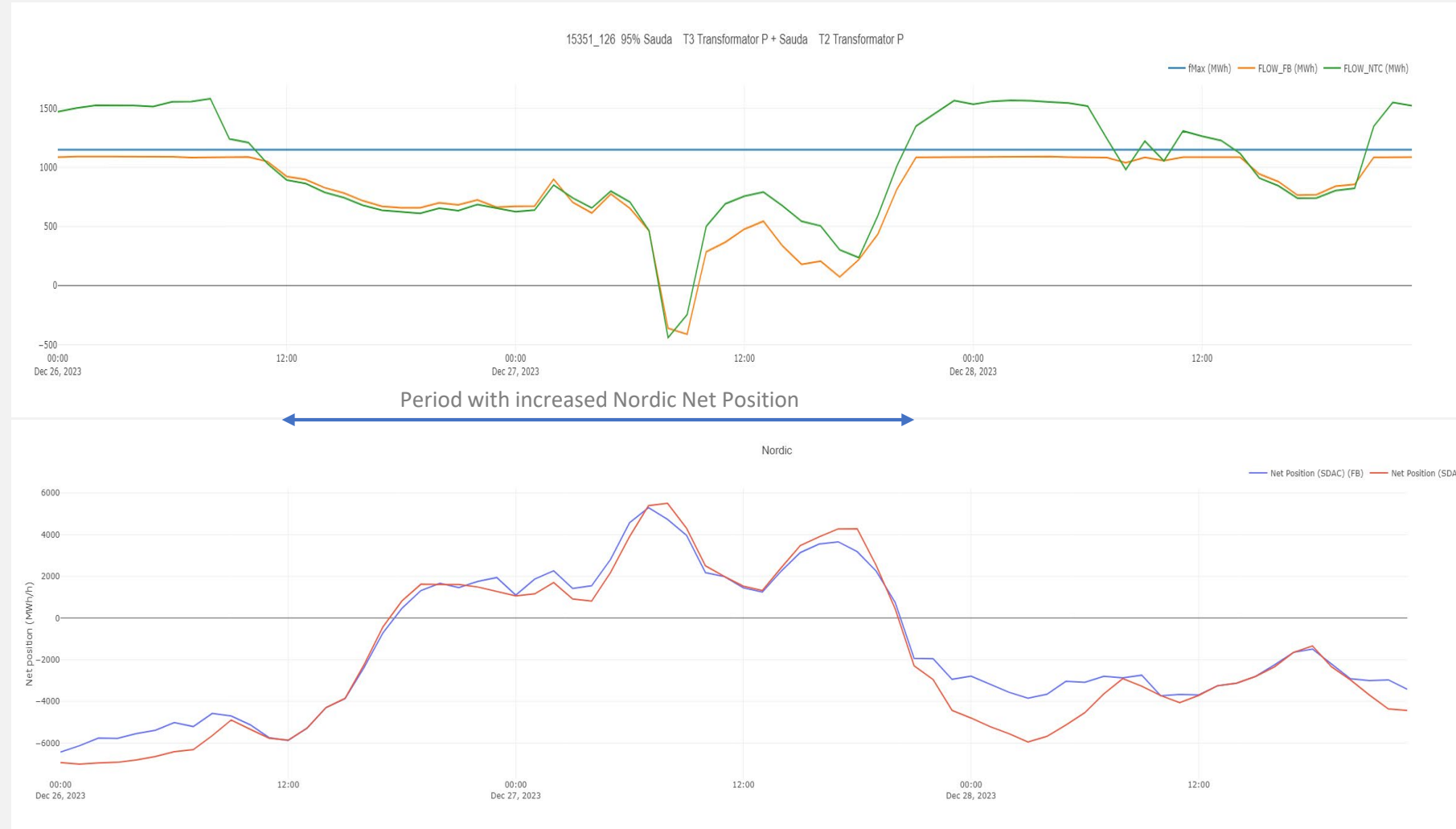


Figure: Flow and fmax of the Sauda CNEC & Net position in CCR Nordic (FB and NTC) for 26.-28. December.



Questions?

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FINGRID

Statnett



Thank you!

Contact: ccm@nordic-rcc.net

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