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

SH Monthly meeting

04 July 2024

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Agenda Dayahead

1. Upcoming events and news
2. Background information on the EPR
3. DA EPR results, weeks 19-22
   - Impacts on SEW, prices, flows, net positions, constraining CNECs
   - Specific cases walkthrough
4. ID EPR results, weeks 19-22

Upcoming events and news

- **EPR Publication during the summer break**
  - The TSOs will continue publishing the DA and ID results on a weekly basis throughout the summer break to ensure an uninterrupted publication process. Please note the following content-related details:
    - Due to resource restrictions during the summer break, the ID results and graphical reports will be automatically published without CCM project review from week 28 to week 31. The review of the ID results for these weeks will take place starting from week 32.
    - The DA results and market reports will be reviewed and published by the CCM project during the summer break.
- **Next monthly EPR meeting on Thursday August 29, 9:00 – 11:00 CET**
  - This event will cover weeks 23-30.
- **Hybrid stakeholder event, 9 September, 09:30 – 16:00 CET**
  - Location: Clarion Hotel, Copenhagen Airport, Denmark
  - You can now register to participate onsite in Copenhagen: Click here to register for onsite participation
  - This event will focus on day-ahead and intraday, as well as the CCM go-live arrangement, among other interesting topics

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 flow-based constraints
- **Simulations are done on a weekly basis after a 2-week grace period, and the market report is published ~4 weeks after production.**
- **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

The role of TSOs and EPR

- **Flow-based capacity calculation aims to enhance the use of current transmission capacities.**
  - 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.
- **EPR compares different capacity calculation methods but uses the same market coupling algorithm and same order books as in NTC.**
  - This enables a fair comparison of the two capacity calculation methods. It isolates the impacts solely from FB without further assumptions.
  - EPR is not a forecast of future prices and flows.
    - With higher capacity available, there may be other changes in the market after go-live, but these are not considered.
    - EPR is intended to show the impact if we would have used FB for any single day-ahead coupling instead of NTC.
- **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**
  - Higher SEW **over a long time** indicates **a trend of the above**

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

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Summary of weeks 19-22, 2024
6 May – 2 June

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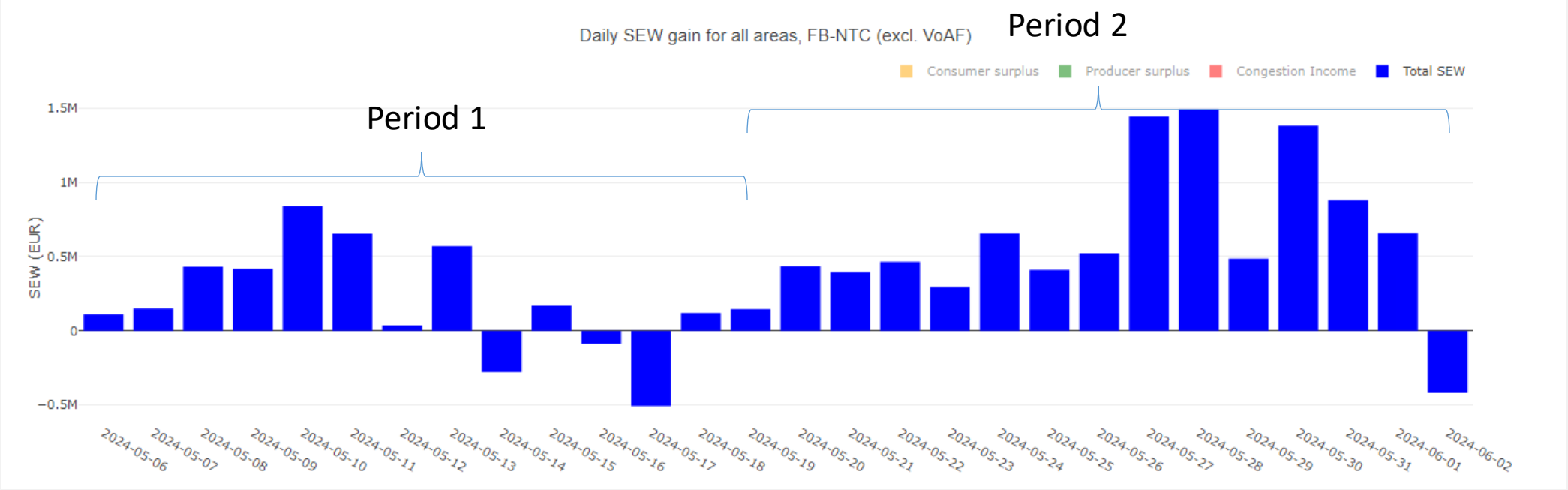
Social welfare change W19-22

- These four weeks are split into two periods:
  - **Period 1, 06/05 – 19/05:** Impacted by a volatile Net Positions and resulting in varying SEW.
  - **Period 2, 20/05 – 02/06:** The Nordics are exporting, constant SEW gains in the total SDAC area.

- Over the full 4-week period, flow-based results in a lower SEW compared to NTC for the Nordic region, but a SEW gain for the whole market coupling region (SDAC).
  - Total CCR Nordic SEW change -7.70 M€
  - Total Nordic SEW change including the Nordic share of the Hansa congestion income change +2.13 M€
  - Total SEW change in the SDAC region +11.88 M€



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Nordic Net Position W19-22

- The total cumulative Nordic net position increased with 43 GWh from 3002 GWh to 3045 GWh in FB compared to NTC
- Period 1: Variable with generally high export and for some hours during daytime high import.
  - The cumulative net position increases with 16 GWh from 1332 GWh to 1348 GWh
- Period 2: Net position less varying and more hours with export.
  - The cumulative net position increases with 27 GWh from 1671 GWh to 1698 GWh in FB.

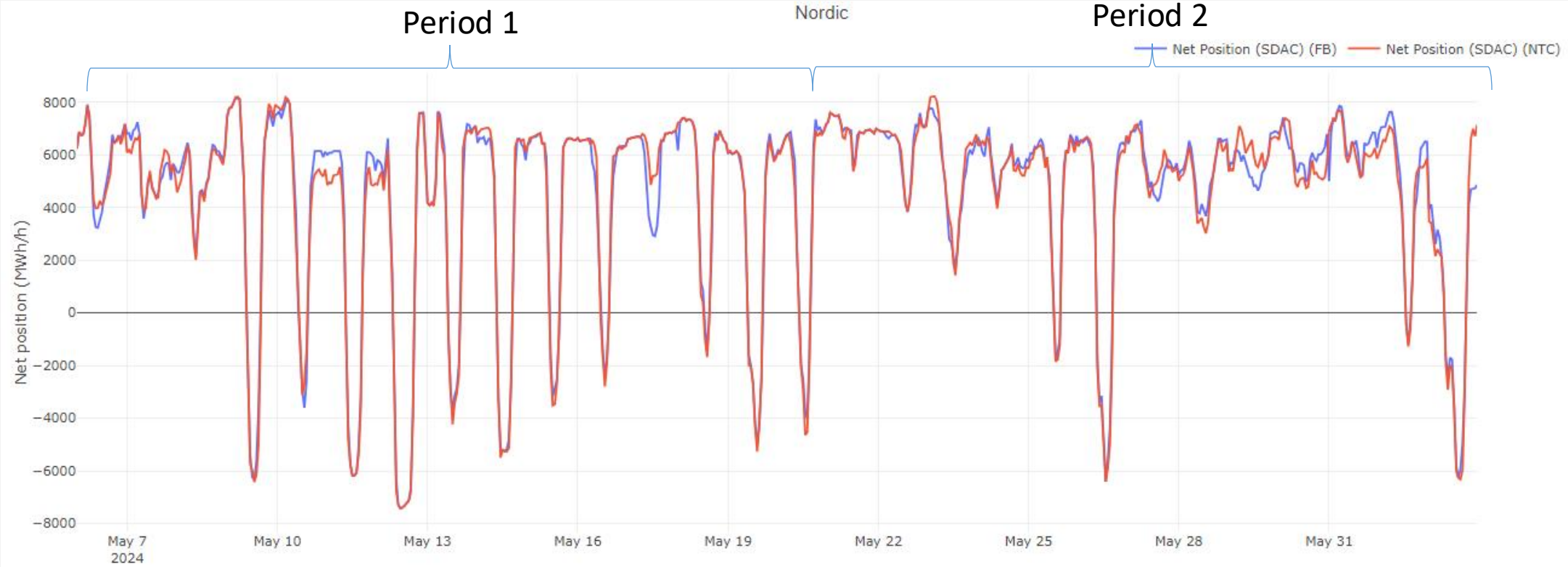

Figure: The Nordic Net Position from Week 19 until Week 22

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Nordic negative welfare change
Congestions moved to the borders of the Nordics

- In the NTC market solution the congestions are in the inter-Nordic AC-grid and on the HVDC borders to the continent.
- With FB, the flow over the constraining element is increased with 15%.
  - This results in lower price spreads inside the Nordics.
  - And leads to higher price spreads on the external borders.
  - → **Congestion income moved from inter-Nordic borders to External borders.**
  - Furthermore, we see an increased flow to the continent.
  - → **Welfare gain caused by FB in our neighbouring areas.**

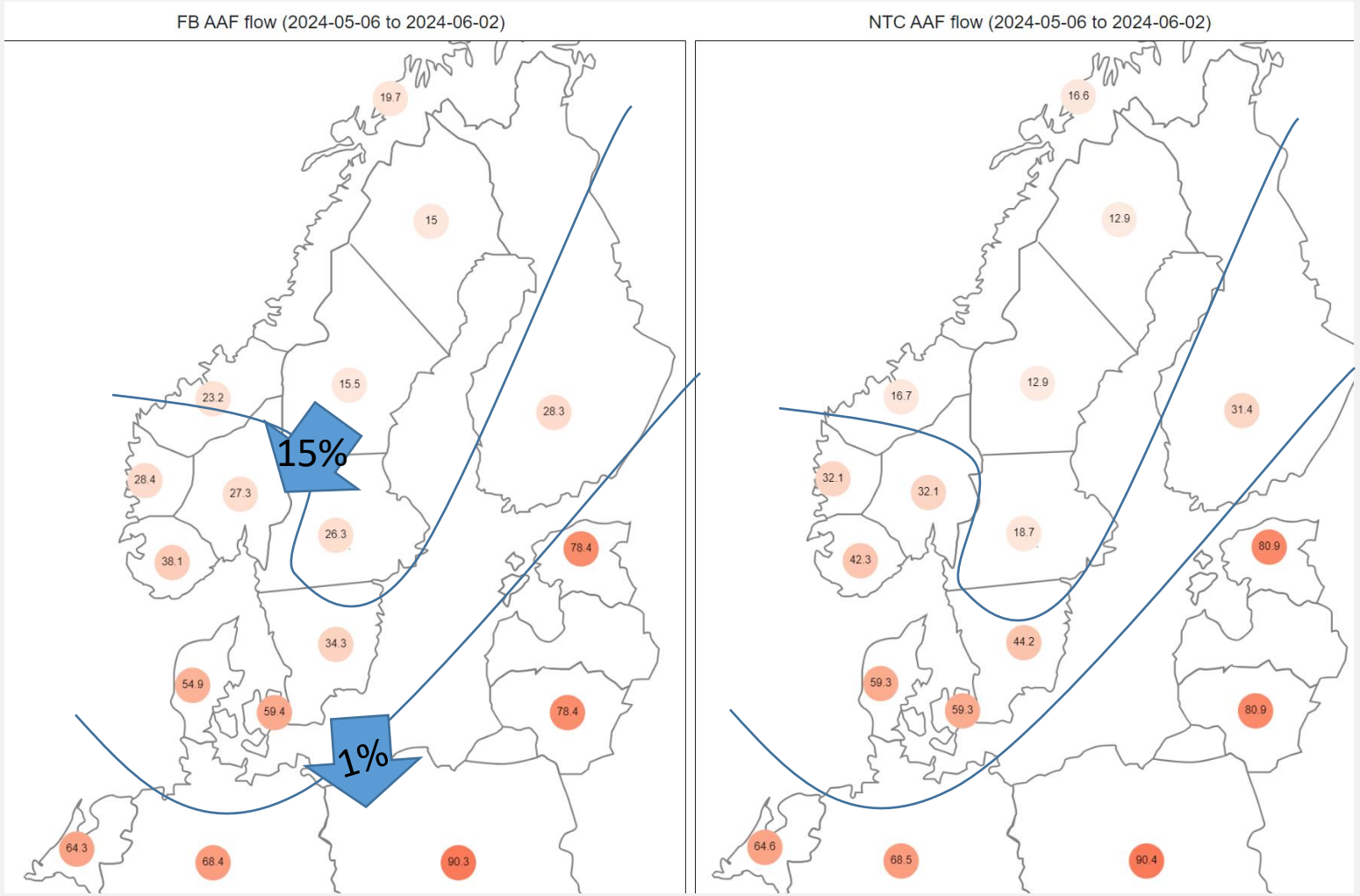

Figure: Average prices in each BZ in NTC & FB.

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Negative welfare impact - Remedial Action missing in DK1

- For weeks 20-22, there was a CNEC in DK1 that significantly constrained the results more in FB than in NTC and decreased the SEW.
- These CNECs are located on the Danish West Coast and were constrained during this period due to planned maintenance in the area and high renewable production. During this period, the NTC day-ahead capacity was not reduced, and counter trade was planned to be used if the marked outcome would result in overload on the west coast 150 kV lines.
- This means that the NTC marked clearing resulted in overloads and downregulation of renewable was activated. However, when providing the FB domain, the capacities are based on the expected topology and renewable production without counter trade.
- ENDK is currently investigating whether and how to handle these cases.

- The item has been added to the ”Operational Learning Points”-Document.

Nordic region in NTC in Period 1 (6.5 - 19.5)

- As indicated by the net position, during the first period, the Nordics are net exporting to the continent, but there are several hours with high imports to the Nordic areas as well.

- Overall constraints in the grid:
  - Nordics -> Continent & Baltics
  - Finland -> Nordics
  - Northern Sweden, NO3 & NO4 -> South Norway, South Sweden & Denmark

- The highest average prices for the first period are found in the Baltics & the continent. From a Nordic perspective, the highest prices can be seen in Denmark. The lowest prices are found in SE1 & SE2.

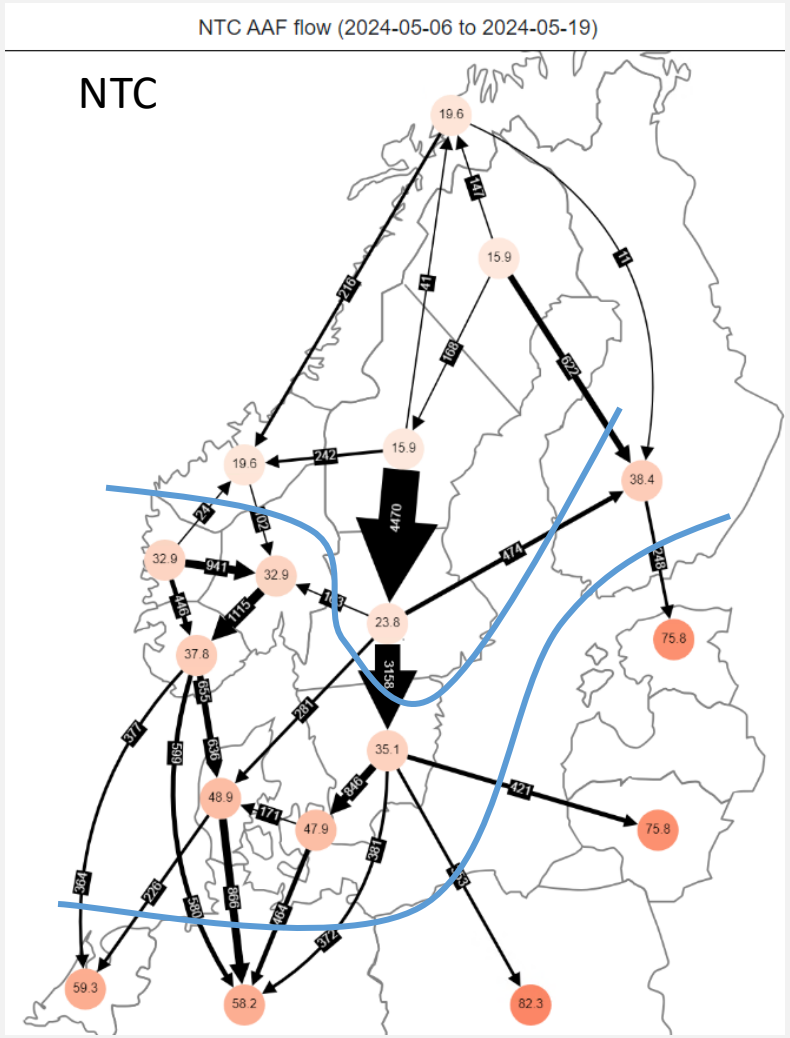

Figure: Average prices and flows in each BZ in NTC

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Average prices and flows in the Nordic region - Period 1 (6.5 – 19.5)

Overall constraints in the grid:

- Nordic -> Continent & Baltics
  - FB is increasing the flow with 15 GWh
- North -> South & Finland
  - FB is increasing the flow with 128 GWh
  - 55 GWh out of the 128 GWh are increased on the SE2-SE3 border.
- SE3 -> SE4
  - FB is decreasing the flow with 38 GWh

Prices:

- In the Northern BZ SE1, SE2 & NO4 as well as DK2, the prices are increasing with 0.3-1.5 €/MWh, while the price in NO3 & SE3 is increasing with 6-8 €/MWh.
- In all other Nordic Bidding Zones and the Baltics, the prices are decreasing with 2-6 €/MWh.

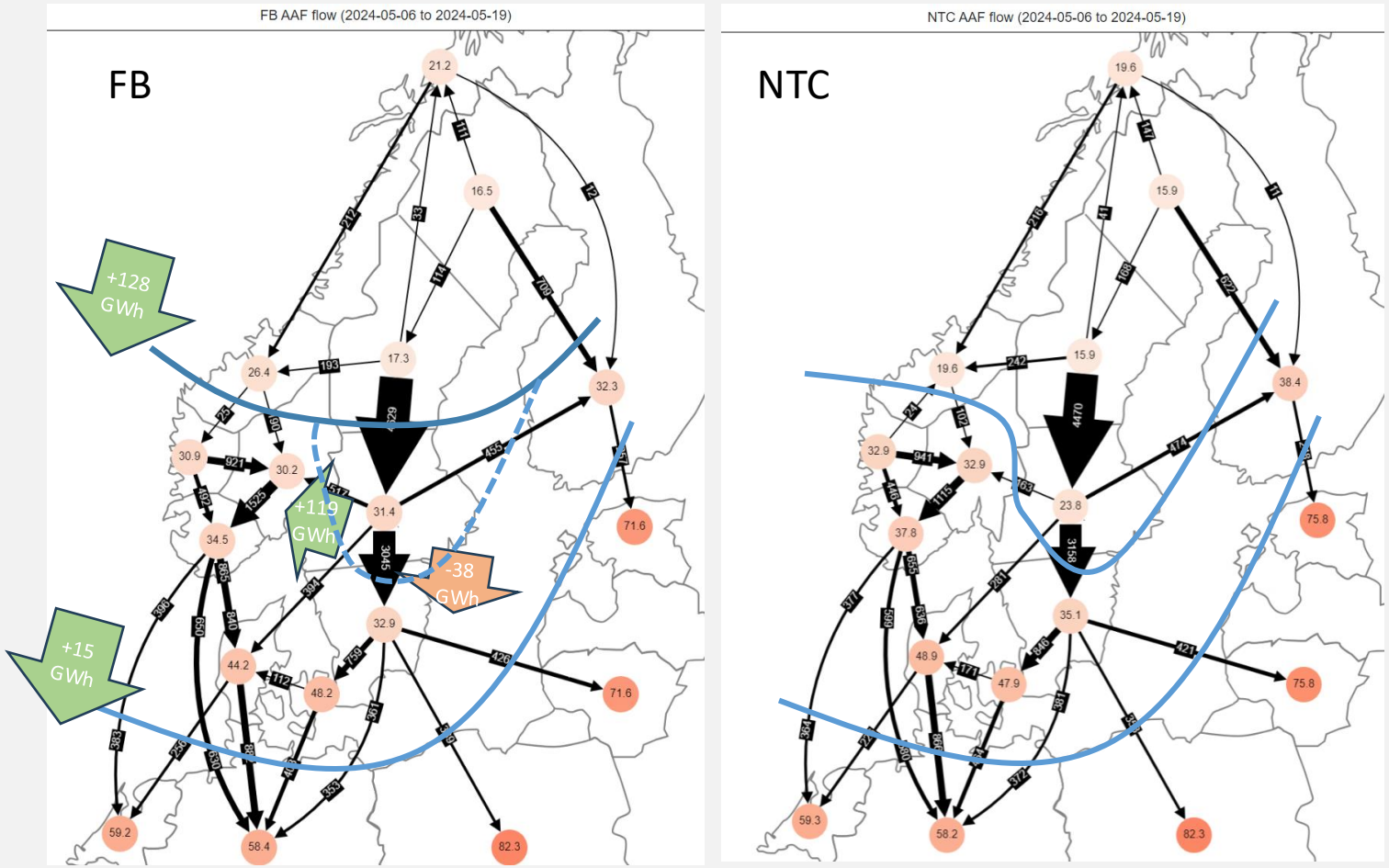

Figure: Average price in each BZ in FB and NTC. The arrows show the increased flow over constraining elements.

Impact on buy and sell volumes (FB-NTC) Period 1 (6.5 - 19.5)

- The largest changes on net positions are in DK1, NO2, SE2, SE3 and NO3.
- Except for SE3, the change in supply volumes affects the changes in net positions most.
- Biggest difference in the demand volumes is noted in DK1 and SE3.

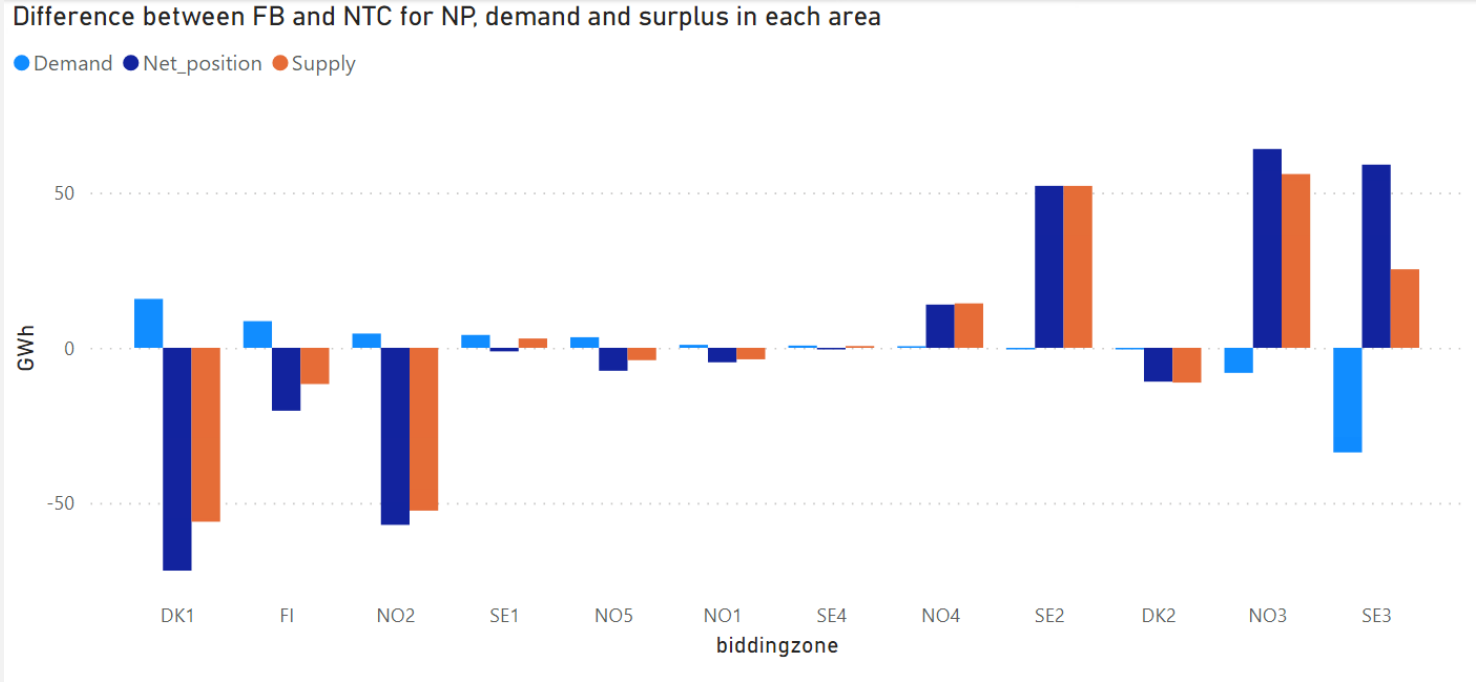

Figure: Demand and supply volumes difference (FB-NTC) and the corresponding net position change

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Prices Period 1 (6.5 - 19.5)

- The average prices decreased with 2-6 €/MWh in six bidding zones, with the biggest decreases in FI & DK1.
- While there is no change in DK2, the average price increases with 1-8 €/MWh in the other BZ.
- The BZ with decreasing average prices are the BZ with the highest average prices in NTC, and the ones with an increased average price are the once with the lowest average price in NTC.
- The maximum prices decrease in Denmark, Finland, South Norway and SE4.
  - In Finland the maximum price decreases more than 100€/MWh

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	-27	-29	149 ↓	160	44	49	↓ -5
DK2	-18	-15	152 ↓	167	48	48	= 0
FI	-16	-15	296 ↓	398	32	38	↓ -6
NO1	-22	-15	105 ↓	116	30	33	↓ -3
NO2	-19	-15	107 ↓	134	35	38	↓ -3
NO3	-3	0	86 ↑	56	26	20	↑ 7
NO4	-3	0	71 ↑	56	21	20	↑ 2
NO5	-16	-13	101 ↓	116	31	33	↓ -2
SE1	-16	-15	62 ↑	56	16	16	↑ 1
SE2	-17	-15	72 ↑	56	17	16	↑ 1
SE3	-18	-15	153 ↑	134	31	24	↑ 8
SE4	-18	-15	148 ↓	167	33	35	↓ -2

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

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Constraining CNECs in FB
Period 1 (6.5 - 19.5)

- High shadow prices indicate that more flow would have increased the total SDAC welfare.
- The most constraining CNEC is located on the Danish west coast and is typically limiting in situations with a high share of renewable energy production. In this period, the situation is impacted by planned maintenance.
  - ENDK is currently investigating this case. More about this can be found in the Operational Learning Points document.
- Beside the Danish CNECs, mainly HVDCs are the most limiting elements.
  - Here, especially border to the continent & the Baltics are constraining
- The SWL CNECs have very high shadow prices that are not representative of the actual constraint.
  - The high shadow price occur when the South-West link is out of operation. It is reoccurring that CNECs for HVDC get this level of shadow prices during outages, and why these high shadow price occur is being investigated. The incorrect shadow price does not affect the market results.
- The other Swedish CNECs that have a high shadow price can be explained by the outage between NO3-NO5 which increases the flow out of SE1 and SE2 to NO3 and NO4, and due to and internal outage in SE2.

Counts of hours with shadowprice (FB)

Thousands separated by comma and decimal separated by dot. Example: 1,234.56

CNEC	Count of hours	Average shadowprice	Total shadowprice
ACLineSegment ENDK DK1 E_KAE-LYK_3 1 N Terminal : N|165KV LINE E_KAE-LYK_2	33	793.08	26,171.58
AC_Minimum_SE4_SWL	184	113.92	20,960.67
AC_Minimum_SE3_SWL	101	206.73	20,879.59
FI_PTC_FI_EL_EXPORT	203	56.61	11,492.19
AC_Minimum_SE4_NB	198	51.66	10,229.19
AC_Minimum_NO2_ND	226	37.02	8,366.27
AC_Minimum_NO2_NK	235	32.73	7,692.57
ACLineSegment ENDK DK1 E_KAE-LYK_3 1 N Terminal : N|165KV LINE E_KAE-LYK_1	10	736.98	7,369.83
AC_Minimum_SE4_BC	179	39.62	7,091.19
43c83c43e5114e35b4ea6538e13c178e	156	44.37	6,922.34
b914dcee8db6403596c2d80ce5abc78e	32	214.03	6,848.96
DK2_SV_IMP|BASECASE	175	29.76	5,208.65
13792_325 65% 420 Rød-Grenland + 300 Rød-Porsgrunn	49	105.26	5,157.90
FI_PTC_RAC_SE1-FI	100	43.23	4,323.47
AC_Minimum_DK2_KO|BASECASE	170	24.50	4,164.18
1c0dd019549e44a2a0c5dd4fbb04f61a	126	25.90	3,262.78
2dd4eb812fe44686b6b406f74038bdf0	80	40.77	3,261.42
AC_Minimum_NO2_SK	126	25.24	3,179.97
AC_Minimum_SE4_SP	58	52.35	3,036.29
DK1_NL_EXP|BASECASE	124	24.07	2,984.30
aaec5375219241e88251875ea4183284	72	38.54	2,774.97
910127af8ca34621ac7ec34e85d520c0	104	23.77	2,472.22
AC_Minimum_FI_EL	31	63.90	1,981.05
f3fcf6c8989445baa490c2a74ac6ca97	61	31.86	1,943.33
382f78f8d7c04edf88e6d44c42d885e6	13	142.84	1,856.89

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Table: Overview about the most constraining CNECs in Period 1

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SEW impact on bidding zone level
Period 1 (6.5. - 19.5.)

- The impact on the different parts of the SEW from FB differs between the Nordic bidding zones.
- Positive total SEW change with FB compared to NTC is observed in Finland, DK2, NO1, NO2, NO4 and SE2.
  - The biggest negative impact can be seen in SE3 & SE4.
- FB results in a gain for consumers in DK1, FI, NO1, NO2, NO5 and SE4.

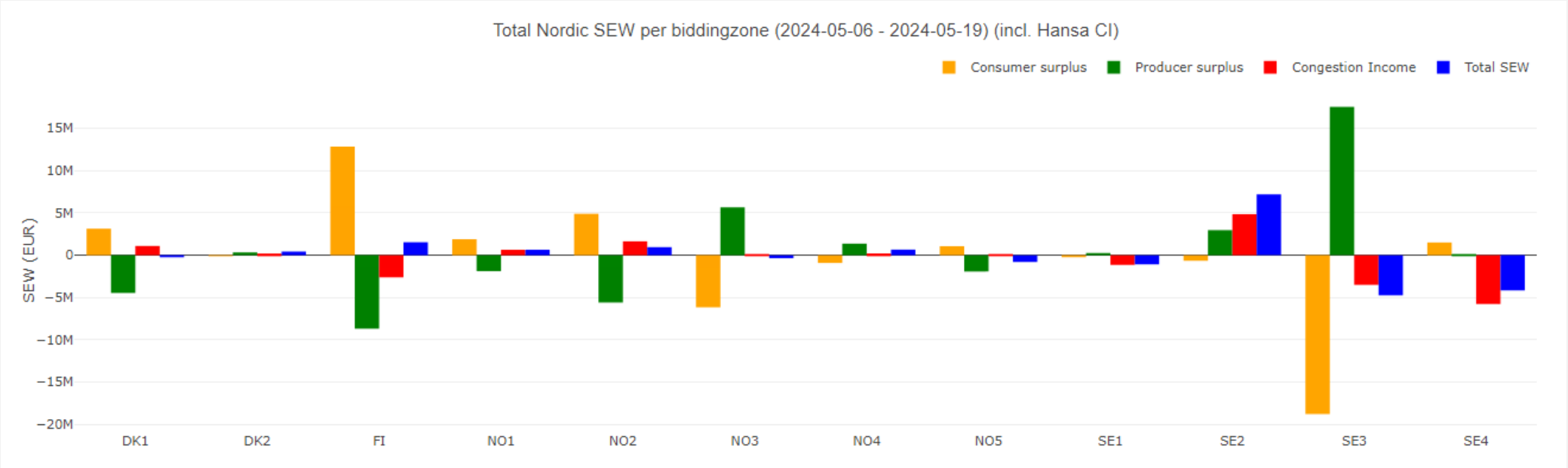

Figure: SEW change per stakeholder group in CCR Nordic, per bidding zone

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Nordic region in NTC in Period 2 (20.5. – 2.6.)

- During the second period, Nordics are exporting to the Continent except for a few MTUs
- Highest prices in the Nordics are in DK1, DK2, NO2 and SE4 areas. Compared to Period 1 the average price in FI area drop and DK1 and DK2 remain as the highest price areas in the Nordics.
- Lowest average prices are found in SE1 and SE2
- Constraints in the grid:
  - Nordics -> Continent & Baltics
  - Northern Sweden, NO3 & NO4 -> South Norway, South Sweden, Denmark

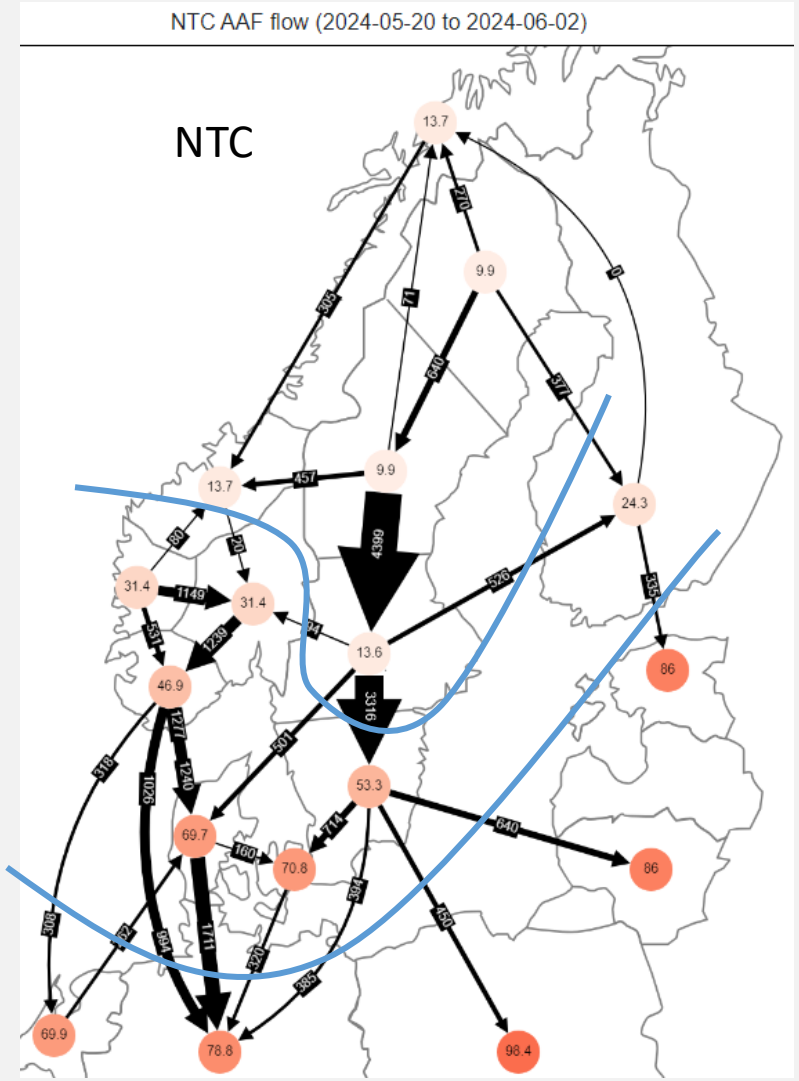

Figure: Average prices and flows in each BZ in NTC

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Average prices and flows in the Nordic region
Period 2 (20.5. - 2.6.)

For this period, there are constraints between:

- North -> South & Finland
  - The overall flow over this constraint was increased with 260 GWh.
  - Flow over SE2-SE3 border were increased even 271 GWh.
- NO1+NO5 -> NO2
  - Flow was increased with 363 GWh towards NO2 over this constraint.
- Nordic -> Denmark, Continent & Baltics
  - FB was increasing the flow 60 GWh.

Relatively small average price changes between NTC and FB:

- The average prices decrease by 18 EUR/MWh in SE4
- The average prices increase by ~4-8 EUR/MWh in NO3, NO4, SE1, SE2 and SE3.

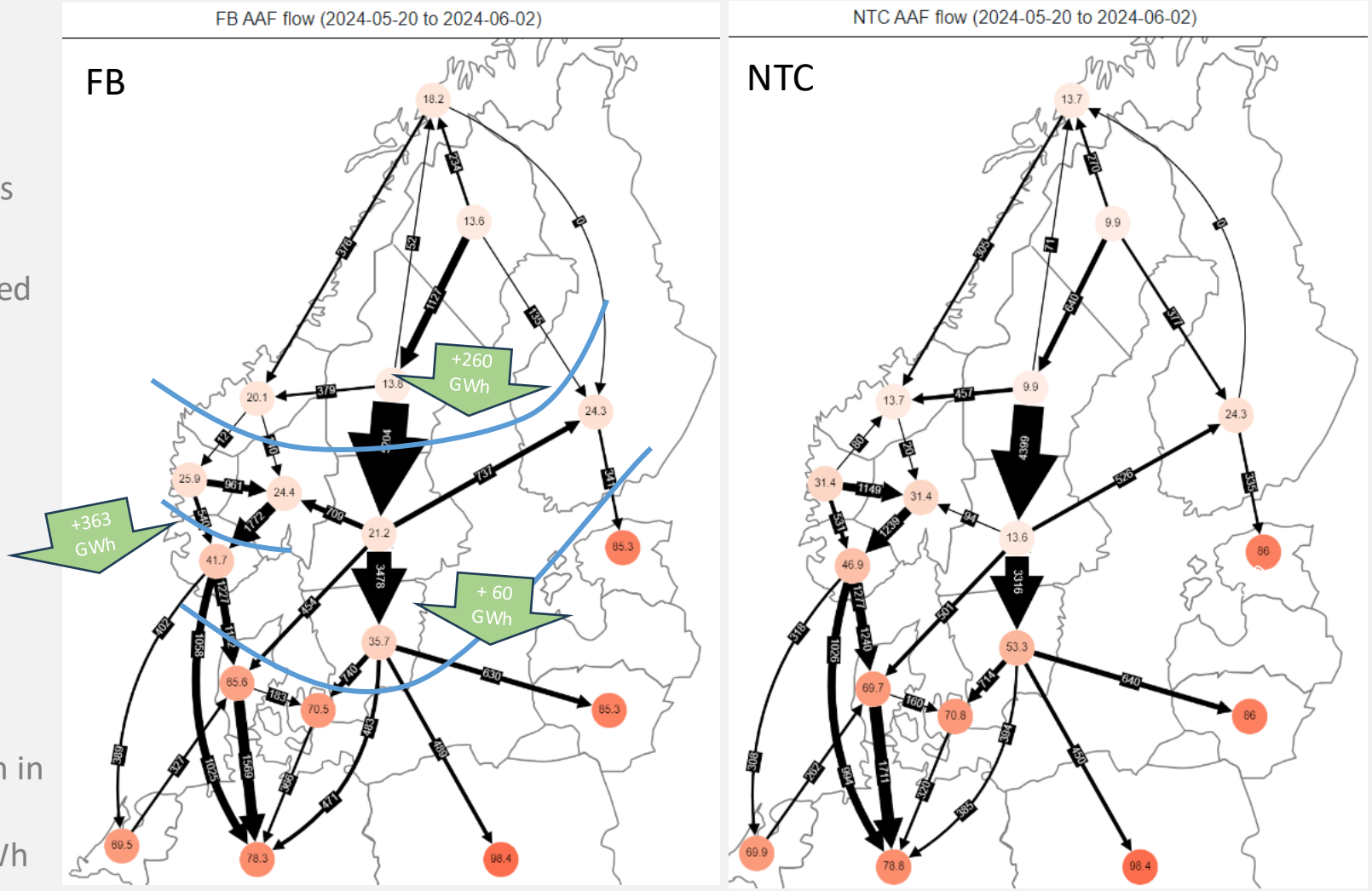

Figure: Average price in each BZ in FB and NTC. The arrows show the increased flow over constraining elements.

SEW Impact on bidding zone level
Period 2 (20.5. - 2.6.)

- The largest changes in SEW can be seen for SE3 and SE2, with overall SEW gain in DK2, NO1, NO2, NO4, SE1, SE2 and SE4.
- The SEW gains are typically driven by producer surplus. However in many bidding zones, congestion income is increasing SEW gain.
- Several bidding zones have smaller changes in total SEW, but larger changes between consumer and producer surplus.

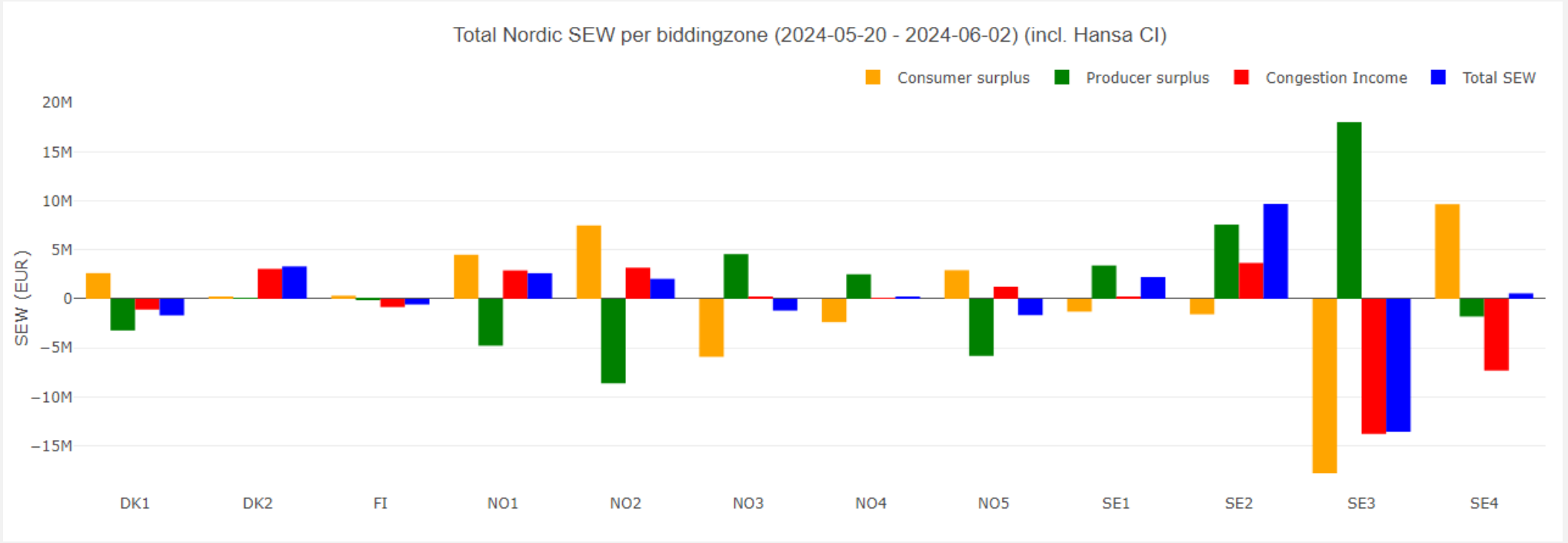

Figure: SEW change per stakeholder in CCR Nordic per BZ

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Prices in Period 2 (20.5. - 2.6)

- Average prices increase in NO3, NO4, SE1, SE2 and SE3
  - Highest decrease in SE4: 18 €/MWh
- Max prices decrease in DK2, FI and SE4
  - Highest decrease in max price in FI: 50 €/MWh
- On average, DK2 and FI areas had no change between FB and NTC, however these areas had a lower max price

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	-8	-9	184	176	66	70	-4
DK2	-7	-6	212	221	70	71	0
FI	-6	-6	200	250	24	24	0
NO1	-7	-6	76	76	24	31	-7
NO2	-7	-6	83	80	42	47	-5
NO3	1	0	46	38	20	14	6
NO4	2	0	45	38	18	14	5
NO5	-7	-5	77	76	26	31	-6
SE1	-6	-6	45	38	14	10	4
SE2	-7	-6	45	38	14	10	4
SE3	-7	-6	105	76	21	14	8
SE4	-7	-6	180	209	36	53	-18

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

Constraining CNECs in FB Period 2 (20.5. - 2.6.)

- High shadow prices indicate that more flow would have increased the total SDAC welfare.
- A Norwegian CNEC which is limiting NO1-NO2 border is the most constraining in this period.
- The Danish CNECs explained in Period 1 are limiting in the second Period as well.
- Other limiting elements were some Swedish internal CNECs and HVDCs, typically them on the border of the CCR-region.

Counts of hours with shadowprice (FB)

Thousands separated by comma and decimal separated by dot. Example: 1,234.56

CNEC	Count of hours	Average shadowprice	Total shadowprice
13792_325 65% 420 Rød-Grenland + 300 Rød-Porsgrunn	103	183.46	18,895.94
FI_PTC_FI_EL_EXPORT	240	75.71	18,171.57
ACLineSegment ENDK DK1 E_KAE-LYK_2 1 N Terminal : N|165KV LINE E_KAE-LYK_1	36	410.06	14,762.25
3960da658c6541ca8638a5d7bd681e88	137	96.47	13,217.02
43c83c43e5114e35b4ea6538e13c178e	192	57.50	11,040.65
AC_Minimum_SE4_BC	220	49.35	10,856.38
b914dcee8db6403596c2d80ce5abc78e	68	153.63	10,446.81
AC_Minimum_NO2_NK	281	35.09	9,859.54
DK2_SV_IMP|BASECASE	211	46.15	9,737.17
aaec5375219241e88251875ea4183284	132	55.14	7,278.14
AC_Minimum_NO2_ND	240	29.61	7,107.16
fd20839c0f1740e4a0991204d2133bab	31	226.28	7,014.67
AC_Minimum_SE4_NB	110	49.29	5,421.43
14311_11 60% 300 Blåfalli-Sauda + 300 Husnes-Børtveit	79	61.10	4,827.21
AC_Minimum_NO2_SK	163	29.43	4,797.25
AC_Minimum_SE3_KS	81	50.13	4,060.26
AC_Minimum_SE4_SP	77	50.96	3,924.02
FI_PTC_RAC_SE1-FI	87	42.14	3,665.76
ACLineSegment ENDK DK1 E_KAE-LYK_3 1 N Terminal : N|165KV LINE E_KAE-LYK_1	6	595.36	3,572.14
12017b46da954fbb94052bfe724b8536	52	57.01	2,964.28
2af3f2c4dc1d45fc82ff2afe7cff4dfa	106	27.87	2,954.58
15320_10 420 Sylling-Rjukan + 420 Hasle-Rød + 300 Sylling-Flesaker + 300 Tegneby-Flesaker	114	24.87	2,835.56
AC_Minimum_DK2_KO|BASECASE	96	28.18	2,704.92
90b94345c1804aa288a086a9d5ef853a	52	45.15	2,347.73
AC_Minimum_FI_EL	40	58.29	2,331.62

Table: The 25 CNECs with highest aggregated shadow prices during the period

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Impact on buy and sell volumes (FB-NTC) Period 2 (20.5 – 2.6)

- Largest net position decrease is observed in NO2, followed by NO5 & DK1.
- The largest net position increases are observed in SE1, SE2 and NO3.
- The change in supply volumes is the main impacting factor for the changes in bidding zone net positions.

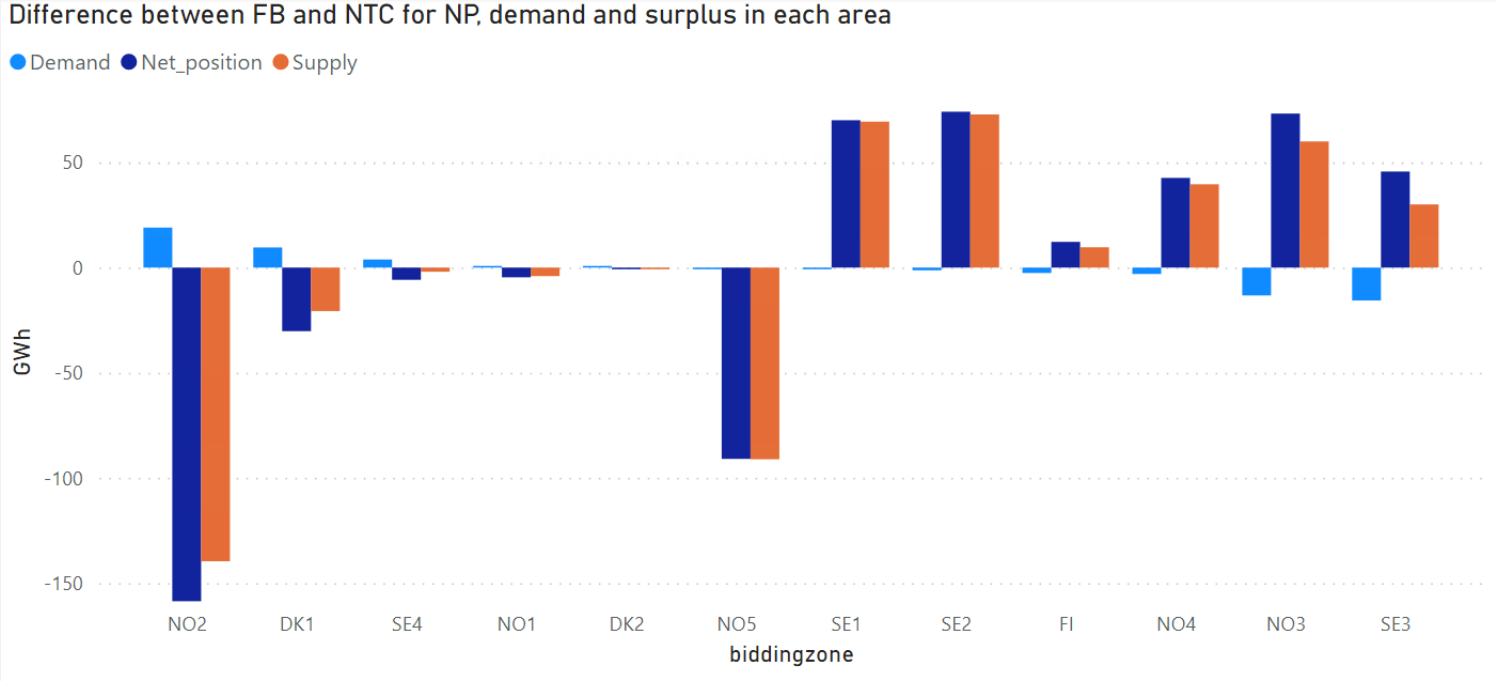

Figure: Demand and supply volume difference (FB-NTC) and the corresponding net position change

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Specific hour walkthrough

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Specific hours

- W19: 10.05. Non-intuitive flow northward from SE2
- W20; 13.05.: High price decrease in Finland
- W22: 27.5.: Circular-flow through Fennoskan with non-intuitive flows

Non-intuitive flow northward from SE2
May 10th 15:00-16:00

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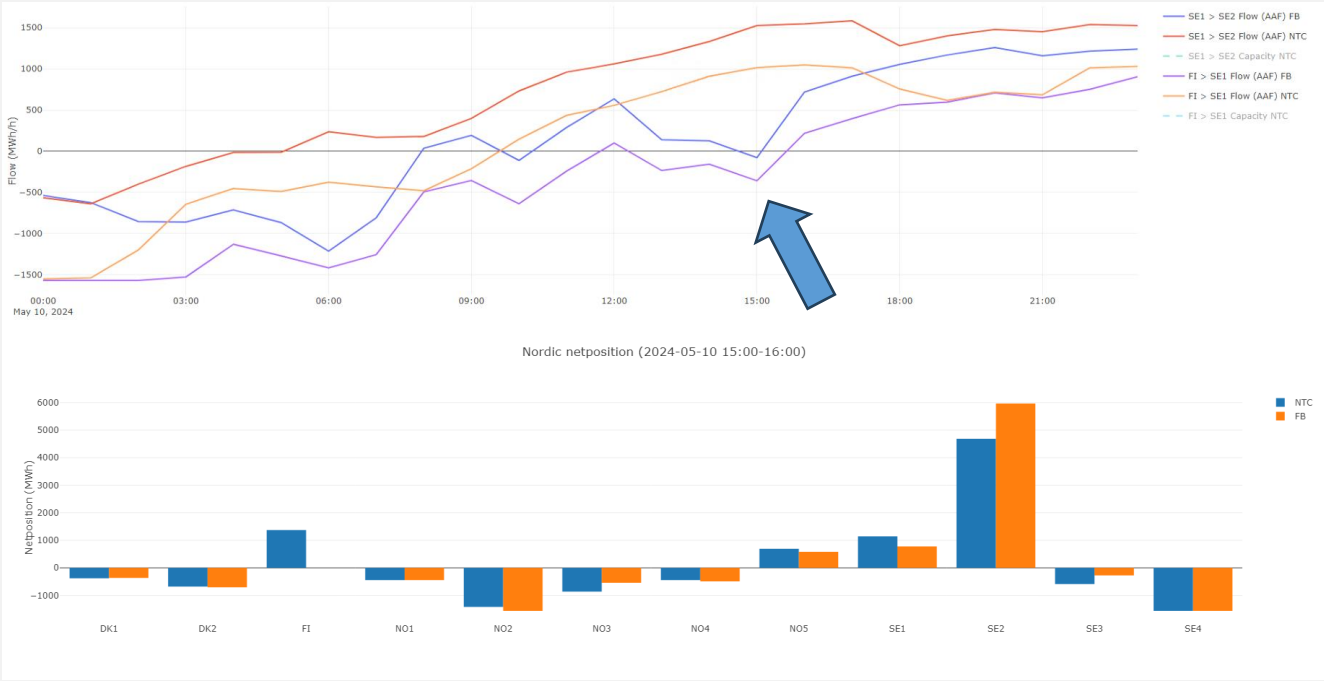
W19: 10.05. Non-intuitive flow northward from SE2

- Starting from MTU2 on May 10th, NTC would allocate much higher flow from SE1 towards the south
- While usually flow towards south is beneficial as it allocates more flow between bidding zones, in this case it seems that FB is shifting flow from north as the net position changes
  - However, this approach reduces the Nordic SEW for MTU16 by 0.5k€ but SDAC still gains 6.5k€.
  - Cumulative Nordic SEW gain for this EDD is 416k€
- Largest difference between NTC and FB flow is on MTU 16
  - FI and SE1 netpositions are much lower in FB and conversely SE2 and SE3 NP are higher



Top Figure: Flow on May 10th
Bottom figure: Nordic Net Position in MTU 16

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W19: 10.05. MTU 16: Non-intuitive flow northward from SE2

- Some CNECs in Swedish grid are constraining the flow on the SE2-SE3 border
  - The southbound flow is reduced with 516 MWh in FB.
  - The flow on SE3->NO1 and SE4->SE3 are increased, as well as northbound flow from SE2.
- The price differences are mostly same in the Nordics, with a small reduction in area price in SE1 and FI and increase in SE3, DK1 and DK2
- In this MTU, the export to the continent and Baltics is reduced by 571 MWh.
- Prices reduce in SE1, FI, NO1, NO2 and NO5 by ~1-3 €/MWh and increase in SE2 & Denmark by ~4-6 €/MWh. In SE3, the price increases by 16.5 €/MWh

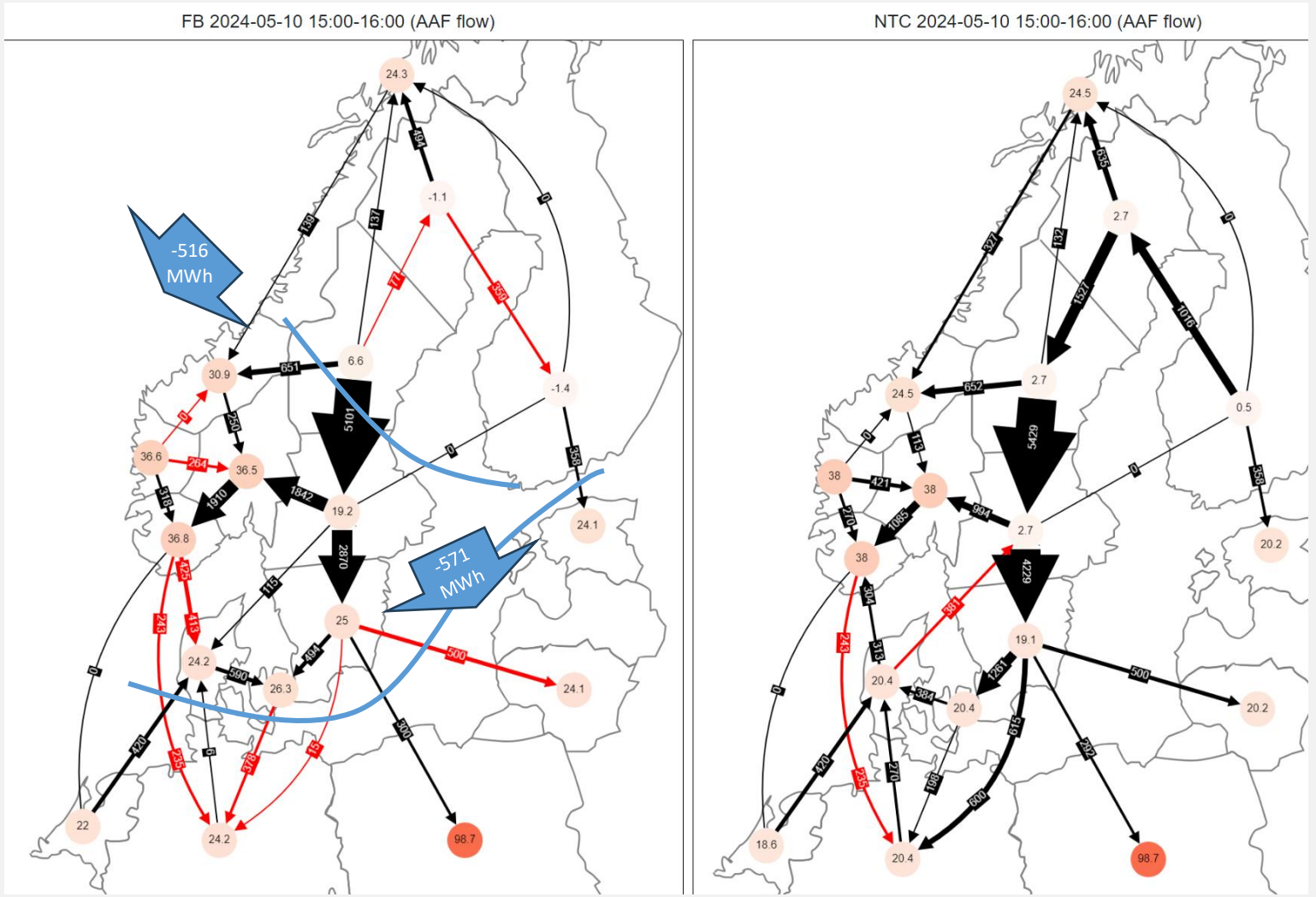

Figure: Price in each BZ in FB and NTC. The arrows show the reduced flow over constraining elements.

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W19: 10.05. MTU 16: Non-intuitive northward flow

- The CNECs with the highest shadow prices are Swedish CNECs, that are loaded by flow on the SE2->SE3 border.
- These CNECs are highly impacted by the Net Positions of FI, SE1 and SE2 (z2s PTDF).
  - Flow on these CNECs have a relieving effect on constraints on other borders
  - In the FB solution, FI & SE1 netpositions were lower than NTC, which leads to less constraints for flow in southern Nordics, mostly reducing south NO area prices
  - FB is changing the flow direction to northbound flow from SE2->SE1 and from NO3->NO4, which is relieving these CNECs.
- This results in a SEW gain of 34k€ for this MTU and 1.49 M€ for the whole day.

Bidding zone	Min. price		Max. price		Avg. price		Avg. price diff	
	FB	NTC	FB	NTC	FB	NTC	FB-NTC	(FB-NTC)/|NTC| (%)
DK1	0	0	130	160	69	71	-1	-2%
DK2	0	0	135	167	70	73	-3	-4%
FI	-1	-1	21	25	3	6	-3	-44%
NO1	2	0	60	51	35	41	-6	-15%
NO2	2	0	61	58	46	44	2	5%
NO3	13	15	36	25	25	23	2	9%
NO4	17	15	25	25	22	23	-1	-3%
NO5	2	0	61	51	38	41	-3	-8%
SE1	-1	-1	21	25	3	6	-3	-53%
SE2	0	-1	20	25	6	6	-1	-10%
SE3	0	-1	67	51	29	14	15	108%
SE4	0	-1	66	167	31	51	-20	-40%

Figure: Overview about the Market Prices

CNEC	Flow (MWh)	RAM (MWh)	Shadow price (EUR/MWh)
c82fa84fa5a54bd286d71e7b8e752c97	286	286	56.27
ddb6c1c74baf4b968ccfb3e4c27286da	1,199	1,199	55.63
6857fcea85fc418780cb22ceb629f828	1,190	1,190	52.27
FI_PTC_FI_EL_EXPORT	358	358	25.54

Figure: Overview about the most constraining CNECs

	ztz SE2-SE3	ztz NO3-NO4	ztz SE1-SE2	zts FI	zts SE1	zts SE2	zts SE3	zts NO1	zts NO2
CNEC 1 (SvK) 6857f…	0.13	-0.04	-0.02	0.17	0.17	0.19	0.06	-0.09	-0.10
CNEC 2 (SvK) c82fa…	0.01	0.16	0.02	0.03	0.03	0.01	0.00	-0.02	-0.01
CNEC 3 (SvK) ddb6c…	0.10	-0.24	0.14	0.31	0.31	0.17	0.07	-0.08	-0.08

Table: Overview about parts the PTDF-domain (ztz & zts)

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High price decrease in FI
May 13th

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W20: 13.05. High price decrease in FI

- On this day, several spikes with a SEW of up to 80 k€ can be observed, caused by an increased Consumer Surplus
- This CS can be observed in Finland, which has several MTUs with prices of more than 150 €/MWh.
- FB decreases the prices in FI, as the average price decreases with 45%.
- The congestion income is mostly negative as high area prices are decreasing and therefore price differences between areas are smaller in FB

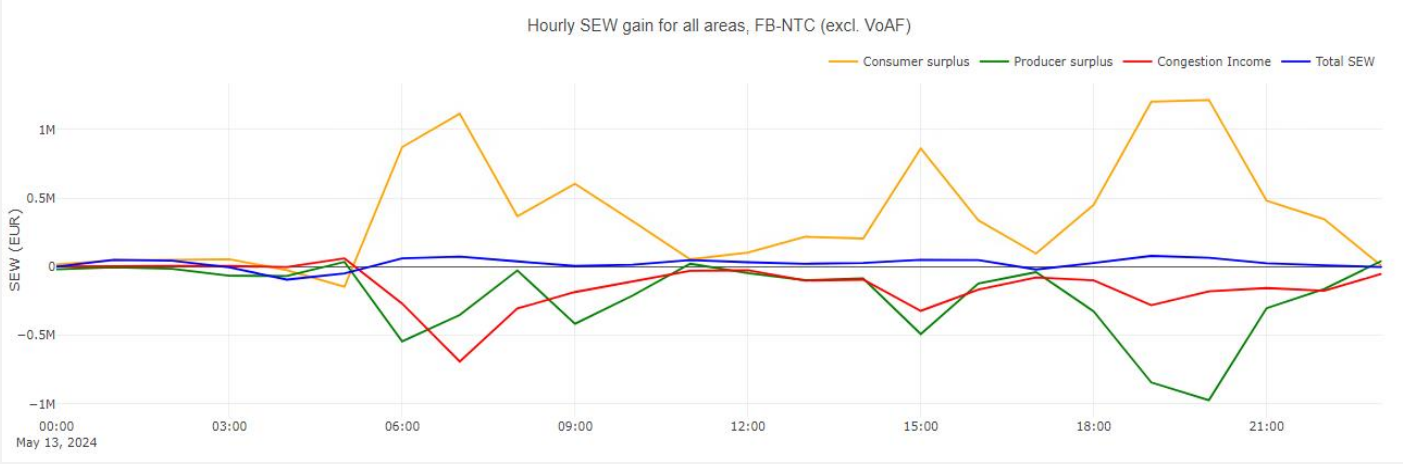

Figure: Change in SEW in the total SDAC area on May 13.

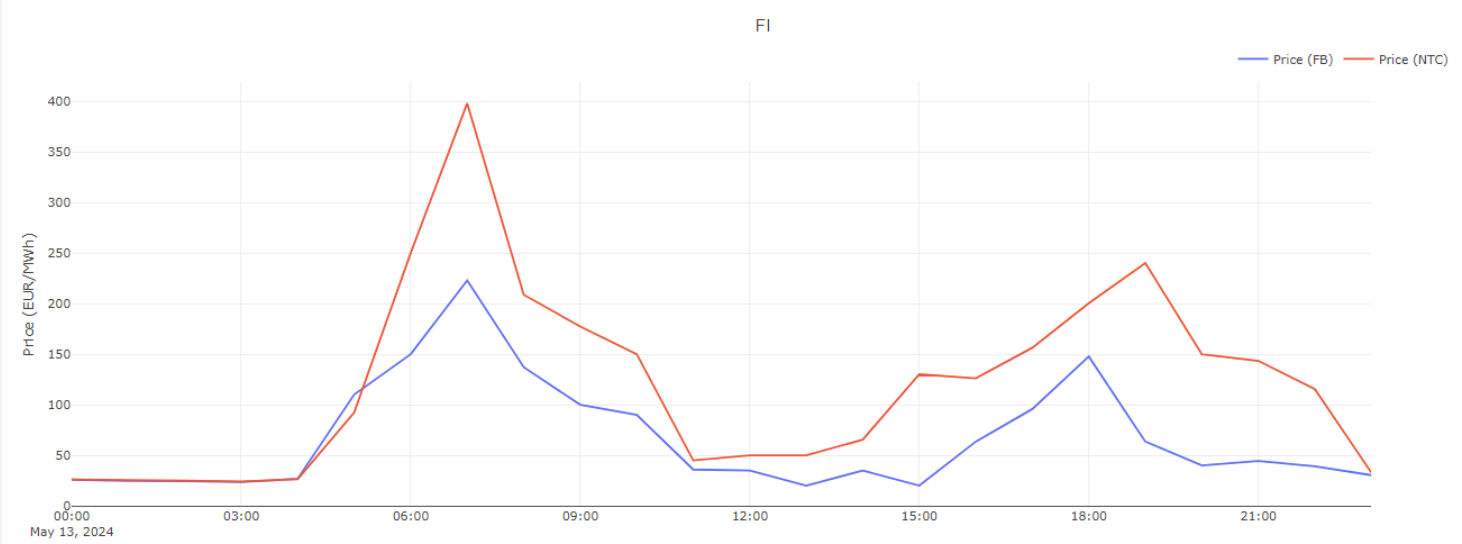

Figure: Price in Finland on May 13.

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W20: 13.05. High price decrease in FI

- SE1-FI flow was limited due to an outage close to the border equipment that limited the flow on NTC to 1000 MW.
  - This outage started on 13.5. 6:00 CET
- Since the limitation is thermal and not dynamic or PTC otherwise set by a dimensioning fault, FB is able to allocate more flow on the border than NTC
  - On MTU 20 we can especially see that the flow on FI-SE1 is limited in NTC and FB is allocating flow to the PTC limit set by Fingrid.

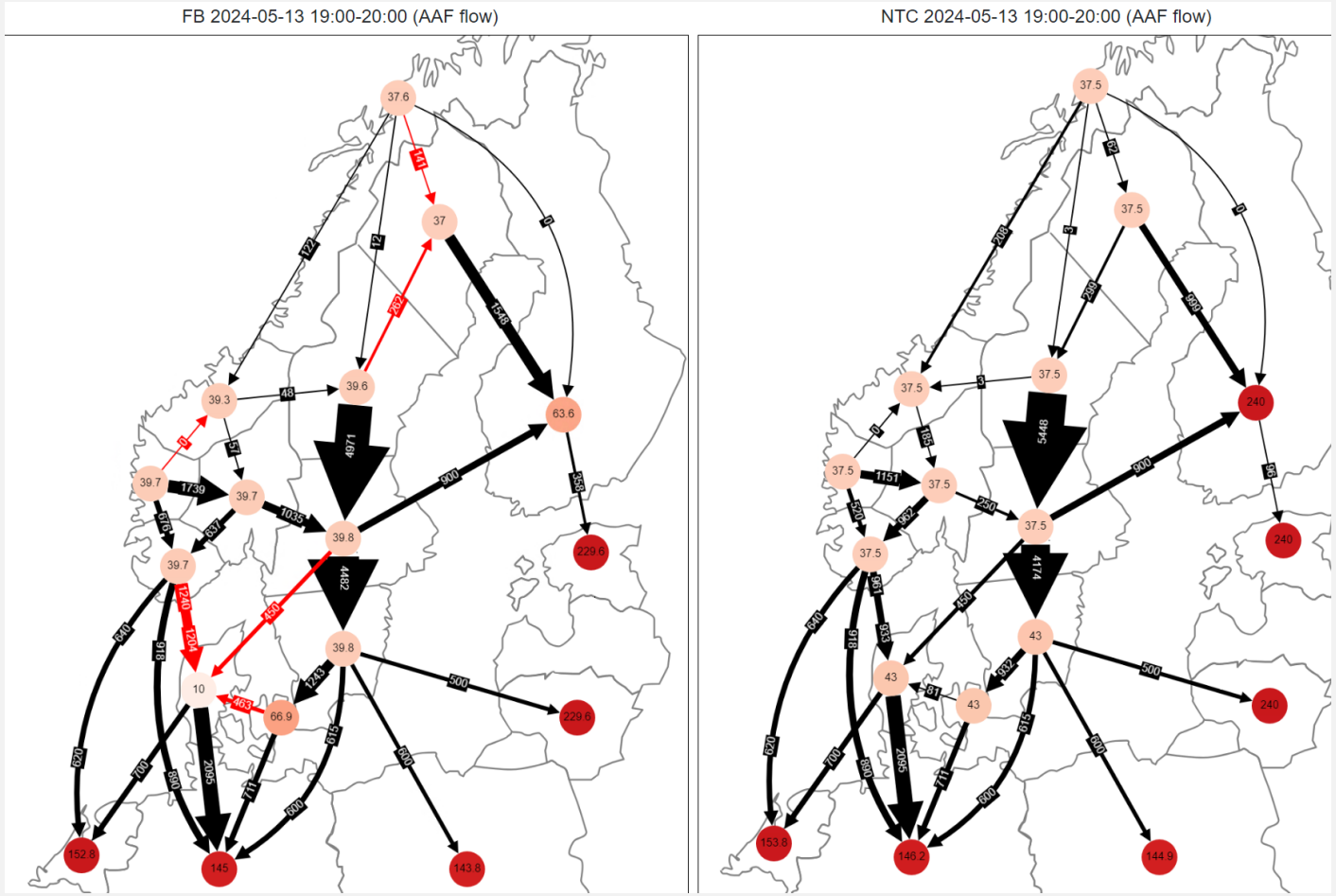

Figure: Flows and prices in each BZ in FB and NTC.

W20: 13.05. High price decrease in FI

- FB increases the flow on the SE1-FI border & Fennoskan towards Finland with 9 GWh on this day, which decreases the Finnish price significantly.
  - Largest decrease in FI area price is on MTUs 8 and 20, where the price decreases from 398 -> 223 €/MWh and 240 -> 63.6 €/MWh
- Additionally during this time, two large production plants were on outage in Finland which were attributing to high price in FI.

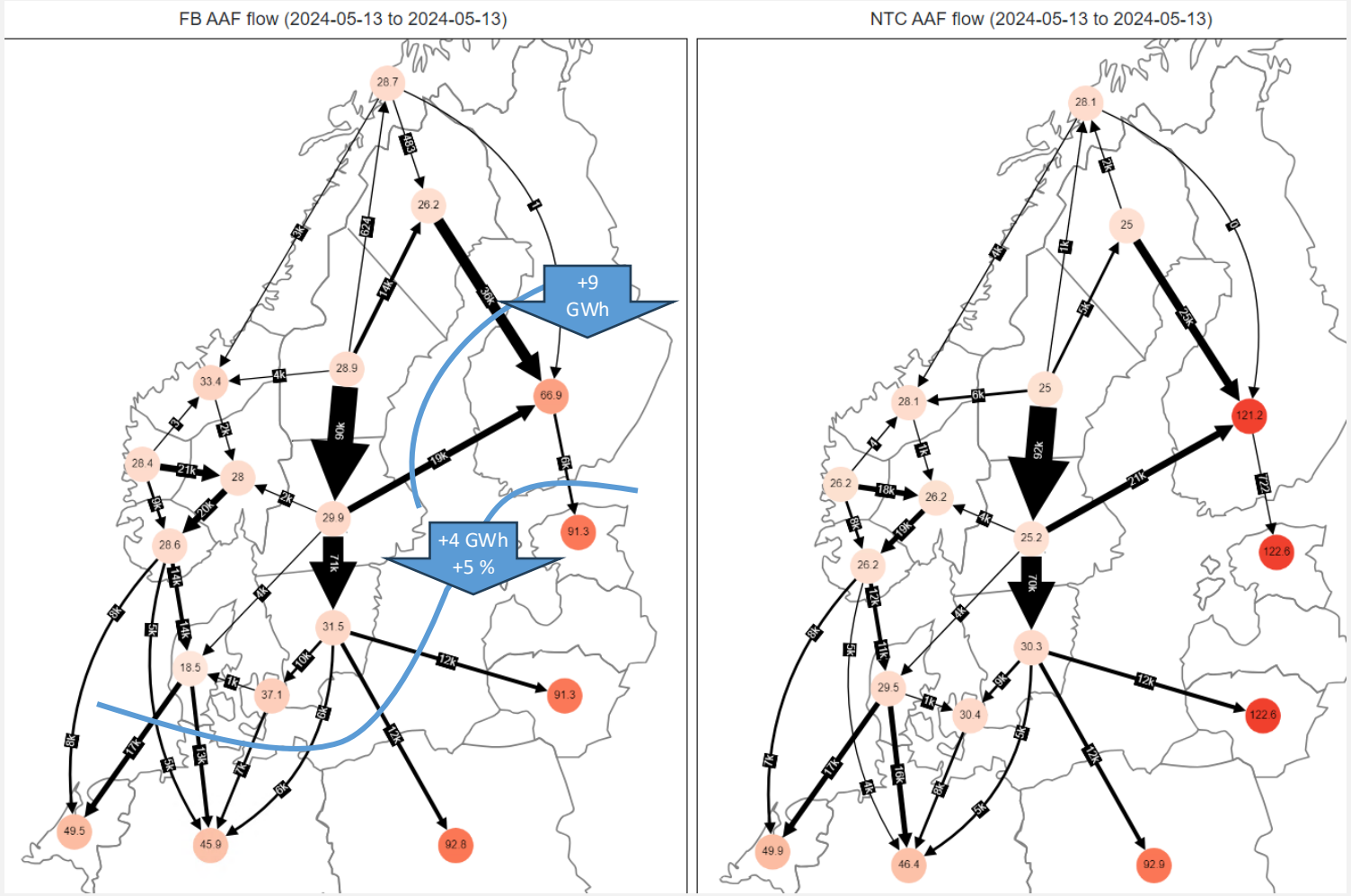

Figure: Price in each BZ in FB and NTC. The arrows show the increased flow over constraining elements.

ENERGINET SVENSKA KRAFTNÄT FINGRID Statnett

W20: 13.05. High price decrease in FI

- NP changes in SE2 and NO4 seems to contribute the most to increased flow towards Finland and the price decrease in FI area.
- Flow on FI->SE1 is relieving constraint on a Swedish CNEC.
- Other Nordic area prices increase by around 1-7 €/MWh.

	DK2-SE4	FI-NO4	FI-SE1	NO1-NO2	NO1-NO3	NO1-NO5	NO1-SE3	NO2-NO5	NO3-NO4	NO3-NO5	NO3-SE2	NO4-SE1	NO4-SE2	SE1-SE2	SE2-SE3	SE3-SE4	shadowprice	load
68e59d561e1b4ac1a22ddf66c6a8462d	0.00	-0.84	-0.89	0.00	-0.03	0.00	0.00	0.00	-0.10	0.03	0.02	-0.06	0.13	0.18	0.01	0.00	1.00	211.57
f4faadf473d64f77b18b0ca683c70283	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	18.58
AC_Minimum_NO2_NK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	29.12
AC_Minimum_DK2_KO|BASECASE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	13.07

Figure: Overview about the ztz PTDF-values

Volumes

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

Area	Net position			Buy volume	Sell volume
	FB	NTC	FB-NTC	FB-NTC	FB-NTC
Nordic	86,398	83,639	2,759	3,472	6,231
NO2 + Denmark	7,517	13,519	-6,002	1,691	-4,311
Northern Scandinavia	127,830	118,872	8,958	-696	8,263
South Norway	23,945	18,953	4,992	548	5,540
DK1	9,993	18,622	-8,629	1,576	-7,053
DK2	-1,275	-1,755	480	-155	325
FI	-49,257	-45,808	-3,449	2,246	-1,204
NO1	-4,502	-4,242	-260	33	-227
NO2	-1,201	-3,348	2,147	272	2,417
NO3	-5,328	-8,652	3,324	-668	2,656
NO4	2,789	450	2,339	-41	2,298
NO5	29,648	26,543	3,105	244	3,350
SE1	21,955	22,474	-519	14	-505
SE2	108,414	104,600	3,814	0	3,814
SE3	7,291	6,908	383	-50	332
SE4	-32,128	-32,153	25	3	29

Figure: Overview about the Net Positions, Buy volumes & sell volumes

Market prices

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

Bidding zone	Min. price		Max. price		Avg. price		Avg. price diff	
	FB	NTC	FB	NTC	FB	NTC	FB-NTC	(FB-NTC)/|NTC| (%)
DK1	-2	-2	93	101	19	30	-11	-37%
DK2	0	0	93	101	37	30	7	22%
FI	20	24	223	398	67	121	-54	-45%
NO1	-3	0	73	45	28	26	2	7%
NO2	-2	0	74	45	29	26	2	9%
NO3	23	17	67	44	33	28	5	18%
NO4	14	17	45	44	29	28	1	2%
NO5	-2	0	74	45	28	26	2	9%
SE1	7	0	39	44	26	25	1	5%
SE2	4	0	72	44	29	25	4	15%
SE3	3	0	74	45	30	25	5	18%
SE4	2	0	93	101	31	30	1	4%

Figure: Overview about the Market Prices

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Circular-flow through Fennoskan with non-intuitive flows
May 27th

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W22: 27.5. Circular-flow through Fennoskan with non-intuitive flows

- In this MTU, some of the most constraining CNECs are located in Sweden.
- The flow on the SE2->SE3 border is constrained by the capacity limit set in NTC
- In FB we see an increased flow on Fennoskan towards FI, which has a relieving effect on the constraining elements on SE3
  - That makes an increased flow on the SE2->SE3 & SE3->SE4 borders possible
  - The flow on the DK1-SE3-NO1 lineset is also increased, as Fennoskan relieves the CNEC that was constraining this connection.
- Flow on Fennoskan increases FI netposition and leads to flow towards SE1

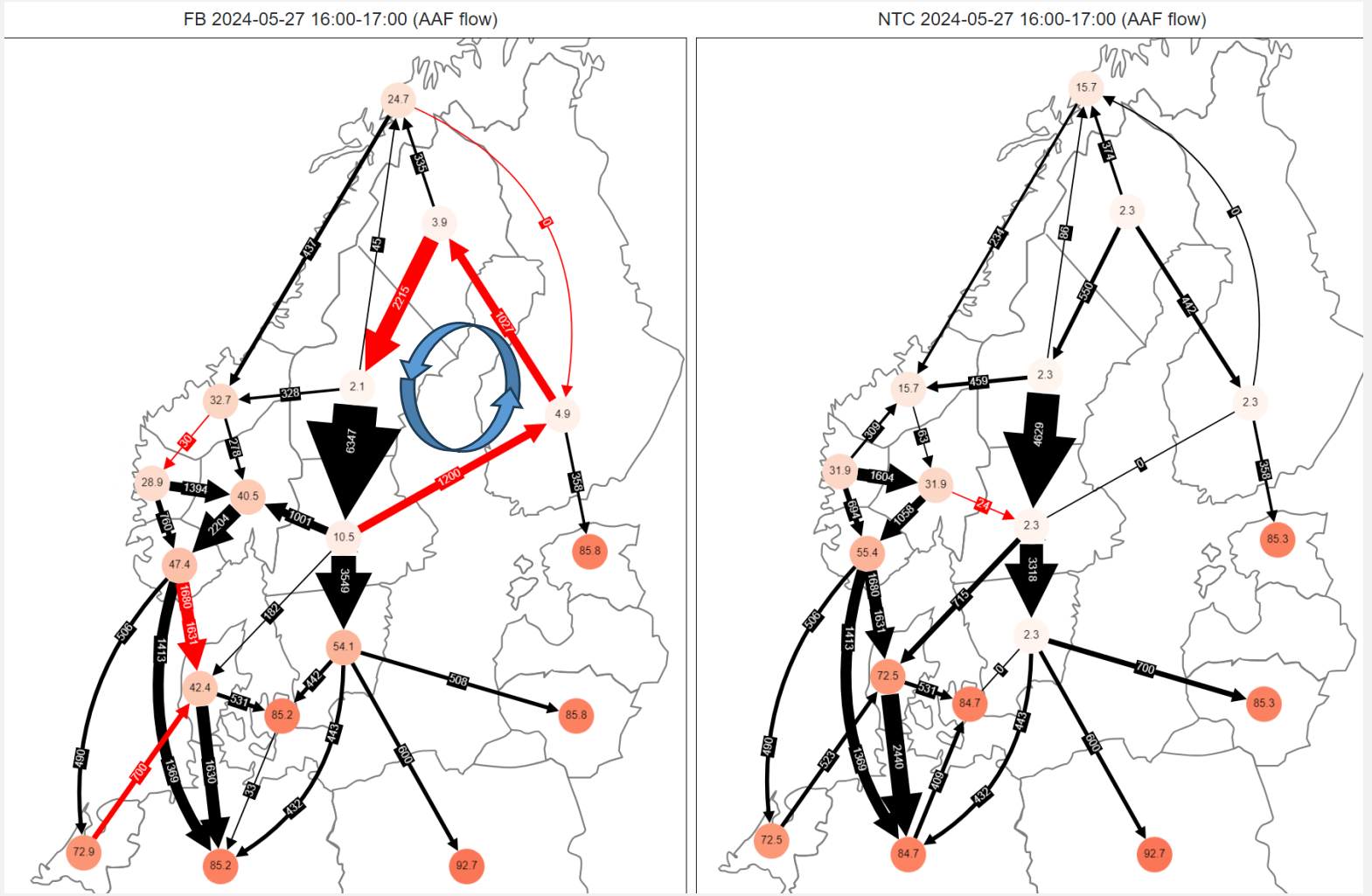

Figure: Flows and prices in each BZ in FB and NTC.

W22: 27.5. Circular-flow through Fennoskan with non-intuitive flows

- For most of the day, the SEW is positive due to an increased congestion income and producer surplus.
- Southern areas in the Nordics mostly reduce in price by ~5-16 €/MWh while northern areas increase by ~3-13 €/MWh
- Regardless, differences in area prices and increased flow on borders with larger price differences increase congestion income

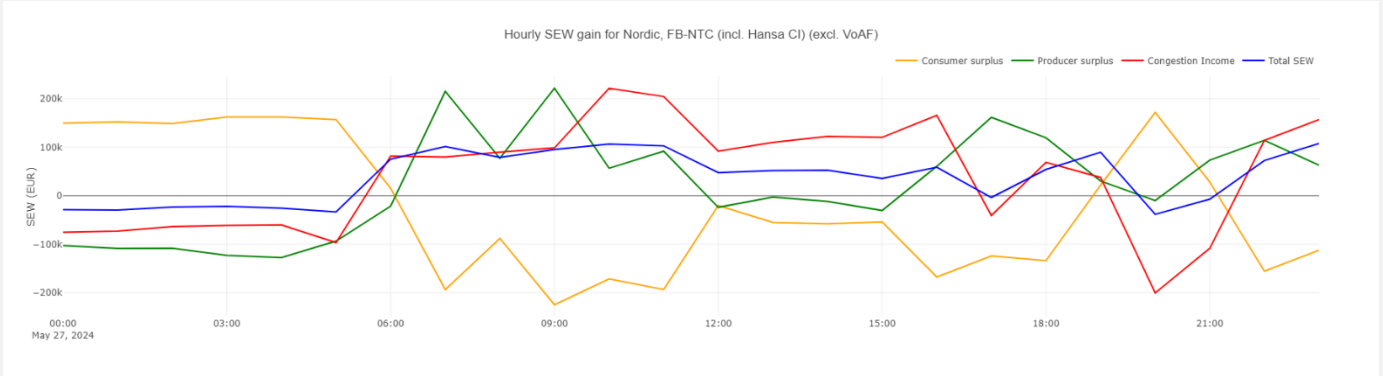

Figure: Change in SEW in the Nordic area (incl. Hansa) on May 27.

Market prices

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

Bidding zone	Min. price		Max. price		Avg. price			Avg. price diff
	FB	NTC	FB	NTC	FB	NTC	FB-NTC	(FB-NTC)/|NTC| (%)
DK1	30	65	173	155	88	95	−7	−7%
DK2	69	68	212	221	105	106	−1	−1%
FI	−1	−2	23	12	5	2	2	90%
NO1	3	24	48	49	27	32	−5	−15%
NO2	40	49	58	70	46	57	−10	−18%
NO3	5	2	37	16	22	9	13	144%
NO4	4	2	25	16	18	9	8	90%
NO5	11	24	31	49	25	32	−7	−21%
SE1	0	−2	23	12	4	2	2	81%
SE2	0	−2	23	12	5	2	3	110%
SE3	0	−2	30	28	12	4	8	175%
SE4	−1	0	133	209	44	60	−16	−26%

Figure: Overview about the Market Prices on May 27th.

Questions?

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

SH Monthly meeting

4 July 2024

Krishna Solberg (Statnett)

Contact: Krishna.Solberg@statnett.no

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Agenda

1. Quick summary of the methodology of ATCE
2. EPR intraday results, weeks 19-22
   - Comparison to actual trades
3. Specific cases walkthrough

Background and methodology of ATCE

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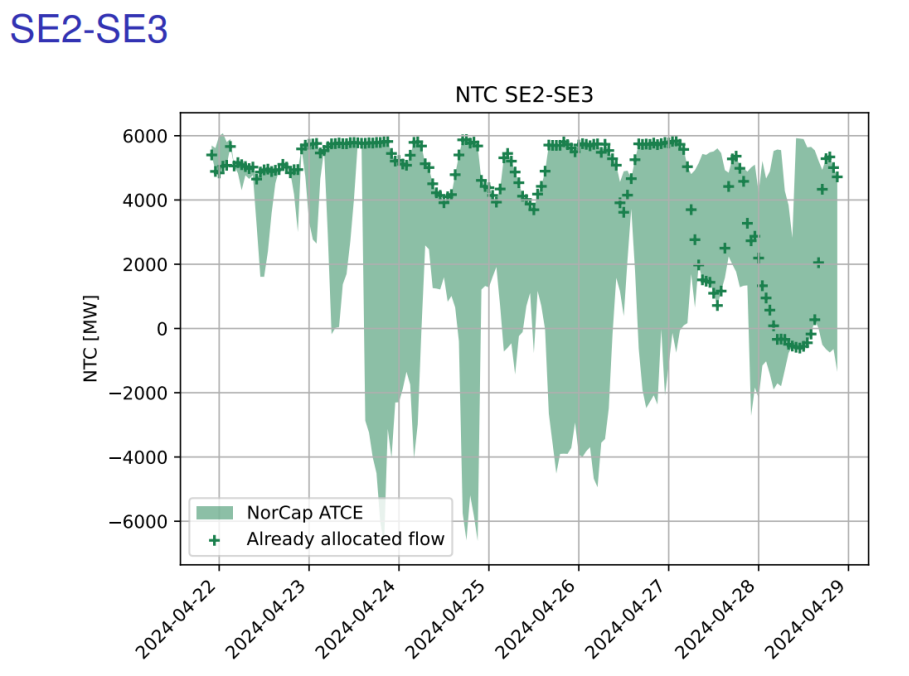
Introduction

Background

- The “left over” capacity from the flowbased day-ahead market will be allocated for the intraday market with the ATCE-method
- The ATCE-method optimizes the available transfer capacity as a CNTC (“NTC-like”) capacity
  - Based on the FB-DA result
  - Distributed among all corridors
  - Using relaxation on certain parameters
- The main result is that the capacities are more varying (and in general smaller) compared with the current NTC method
- During the ongoing EPR the results are published weekly and available at the NRCC-website



Example: ATCE on the SE2-SE3 border

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Main difference between current NTC and ATCE

Higher utilization and optimised flows on FB-DA result in less ID-capacities

ATCE takes into account all flow scenarios likely as well as unlikely resulting in more strict ID-capacities

ATCE takes into account loop-flows which increase operational security and limits ID-capacities

All capacities are dynamic and depends on the flow direction

- For FB DA the market turnout optimise the capacities depending on the flow direction

More flow scenarios affects capacities

- NTC-world considers only forecasted/likely flows and optimise the capacities where there needed the most
- The ATCE-world considers ”all flows” to be possible and allocates capacities to manage all of these
    - Capacities derived from one scenario can limit the flow in another scenario (even if the two will not happen at the same time)

Accounting for loop-flows

- The NTC world assumes trade from BZ to BZ in a straight line
- In reality the same trade will transfer through several bidding zones (as in the ATCE-world)
- Example: Trade in Sweden might be limited by bottlenecks in Norway (and vice versa)

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Applied ATCE-relaxation

Applied relaxation in the ATCE-method to avoid unnecessary restrictions

- Capacites are more operational secure but also more conservative compared to current NTC-method
- Motivates some relaxation to the ATCE-parameters to increase the capacities in an operationally secure and more comparable way
- Applied relaxations adjust for unrealistic loop-flows (less than 2 %) and takes a calculated risk that all 'loading' flows won't happen at the same time (increased RAM)
- Relaxation leads to increased capacities but also opens up arbitrage possibilities

Relaxation: A trade-off between increased capacities and operational security

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Summary of week 19-22, 2024
6 May – 2 June

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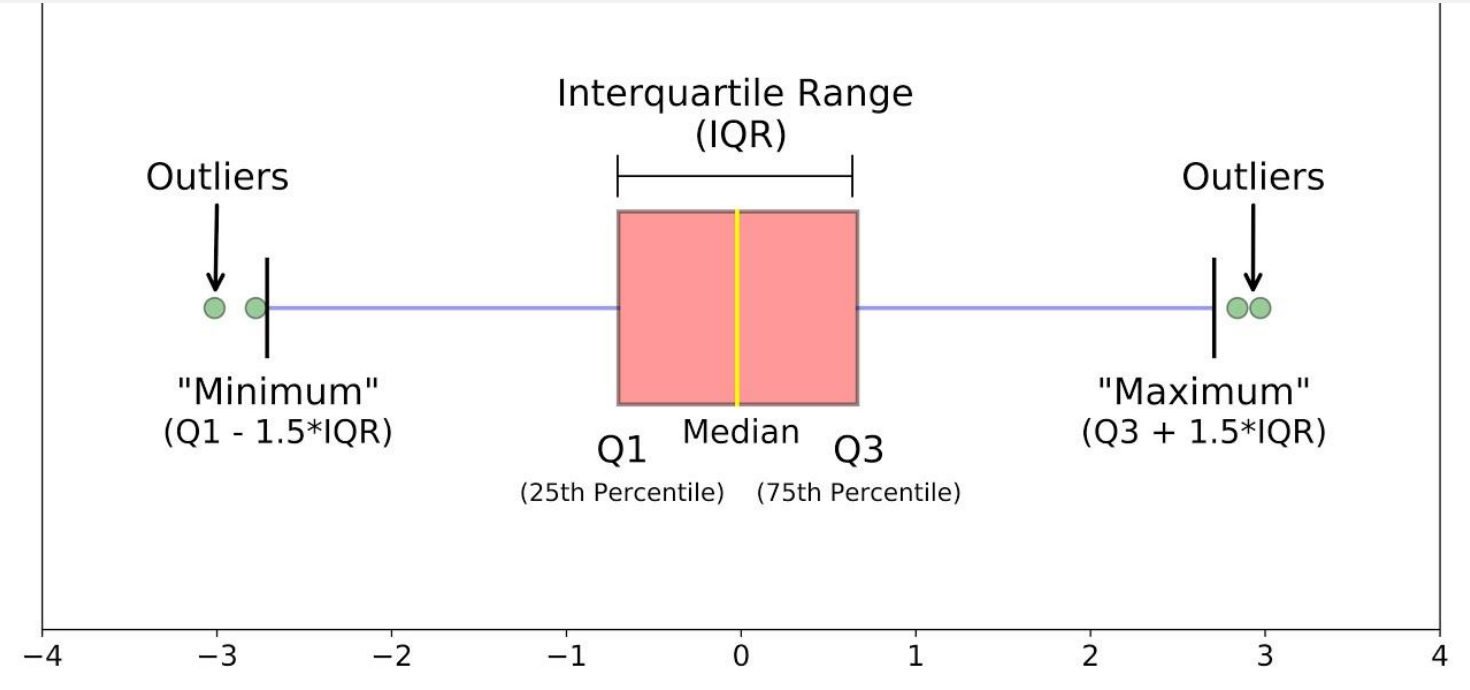
Explanation of box-plots for the next figures

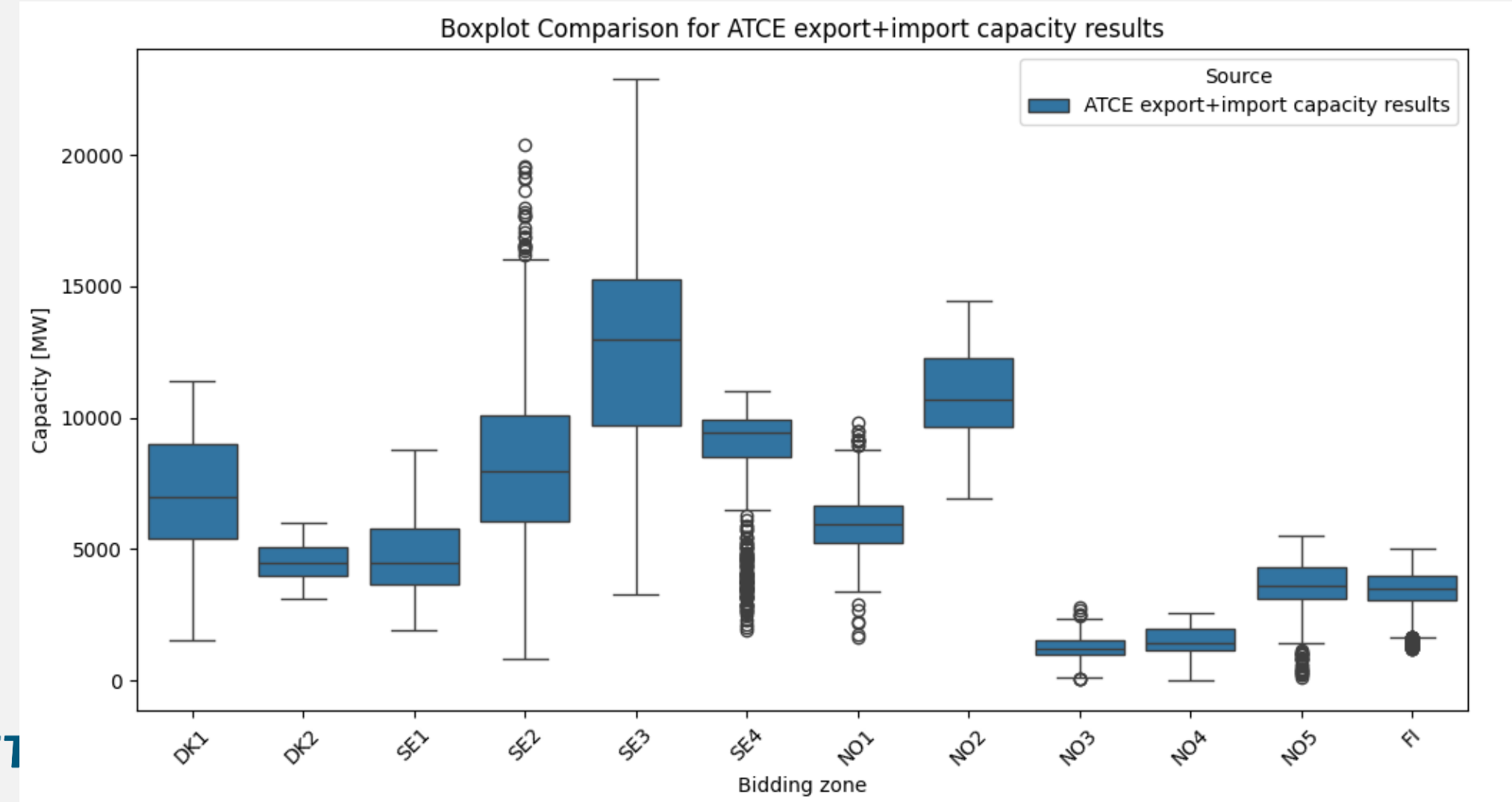
- The box-plots show statistical results of hourly values. They show the median value (yellow line in the middle of the box), 50% of the values (inner box – interquartile range) and ~99% of all values (vertical lines - "minimum" & "maximum") for each border
  - Outliers that are beyond the "minimum" and "maximum" are marked as circles



ATCE export+import for week 19-22

- ENTSO-E's transparency platform is missing numbers for the current market's capacities, so no comparison here.
- Big variation between the bidding zones, NO3 and NO4 has the lowest

- Note: external TSO limitations not taken into account here



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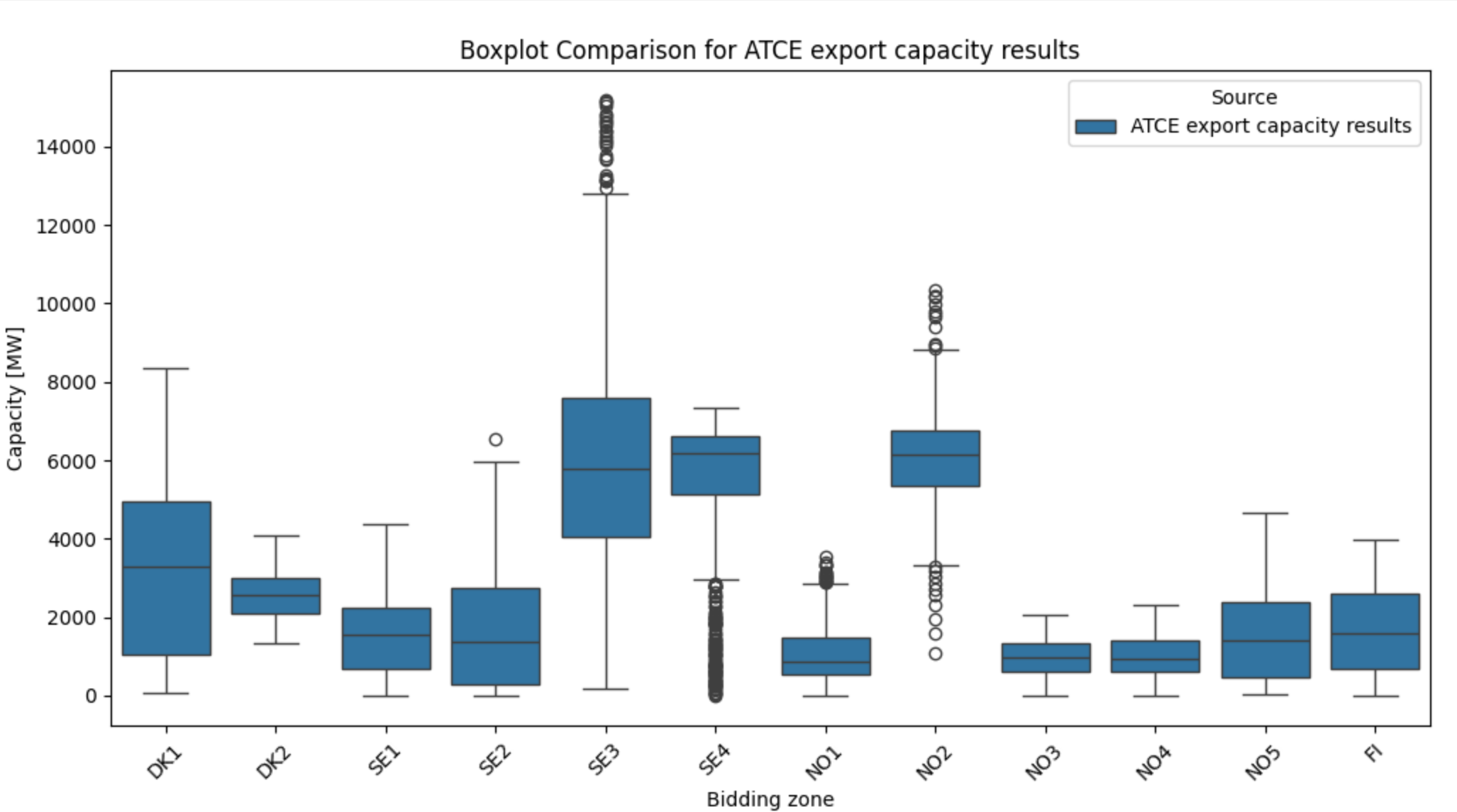
ATCE export results for weeks 19-22

- ENTSO-E's transparency platform is missing numbers for the current market's capacities, so no comparison here.
- Highest capacities in SE3, SE4 and NO2, lowest in NO3 and NO4

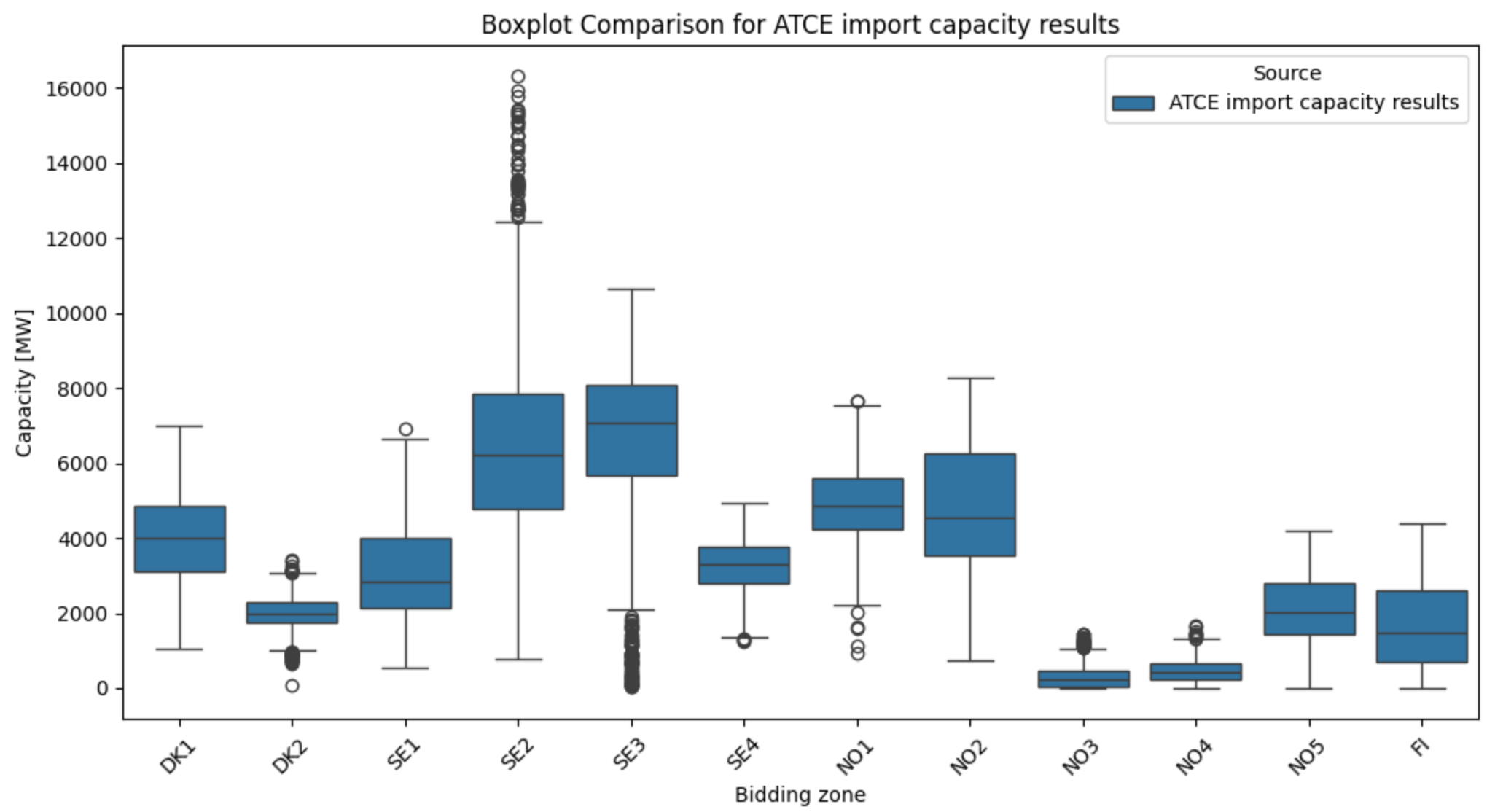
- Note: external TSO limitations not taken into account



ATCE import results for week 19-22

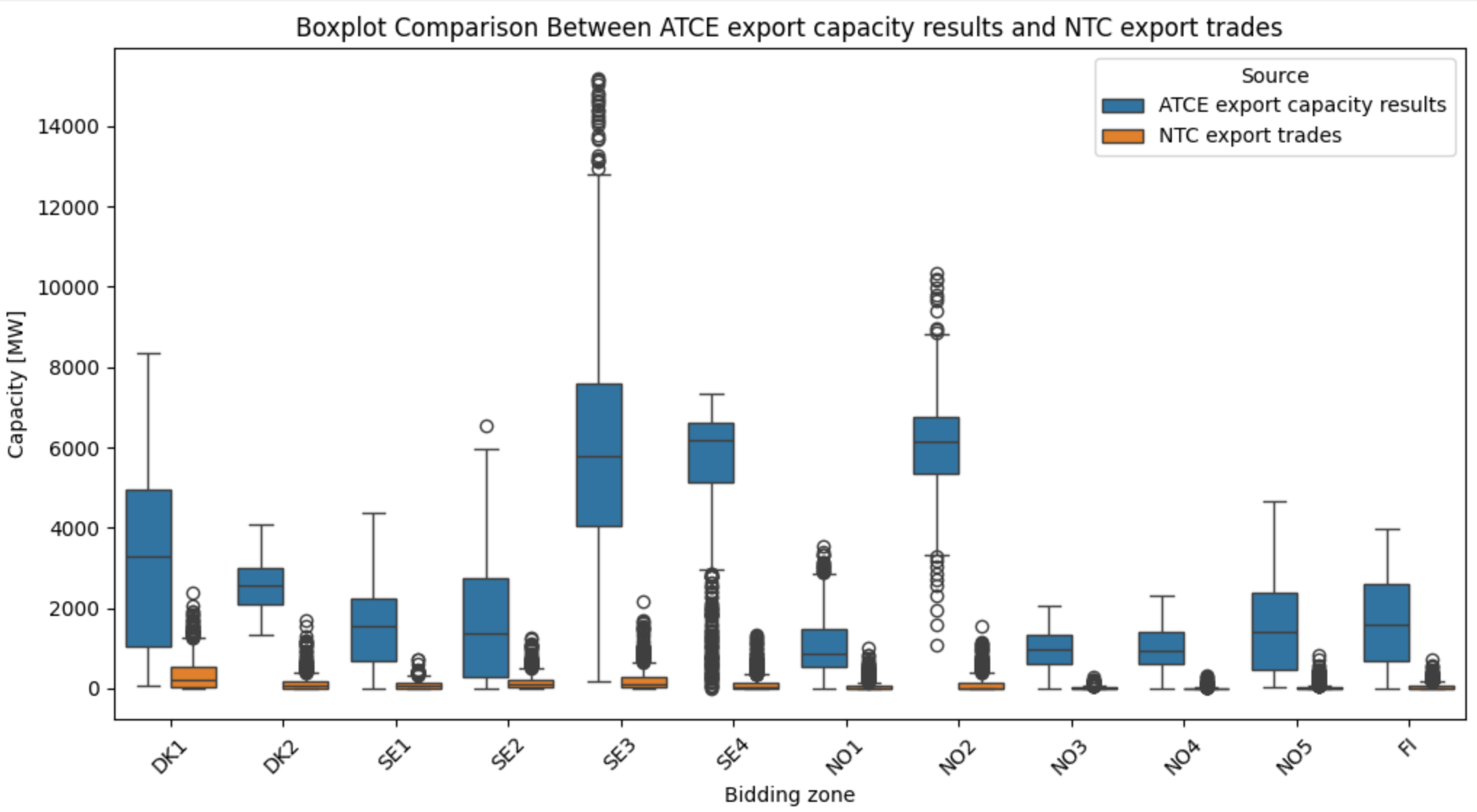
- More variation than export, very low capacity in NO3 and NO4 compared to the other bidding zones.
- ENTSO-E's transparency platform is missing numbers for the current market's capacities, so no comparison here.

- Note: external TSO limitations not taken into account



Comparison of ATCE export results (blue) and actual traded intraday export volumes (orange)

- Compared to actual traded volumes, the export capacities provided by ATCE should suffice most of the time.



- Note: external TSO limitations not taken into account

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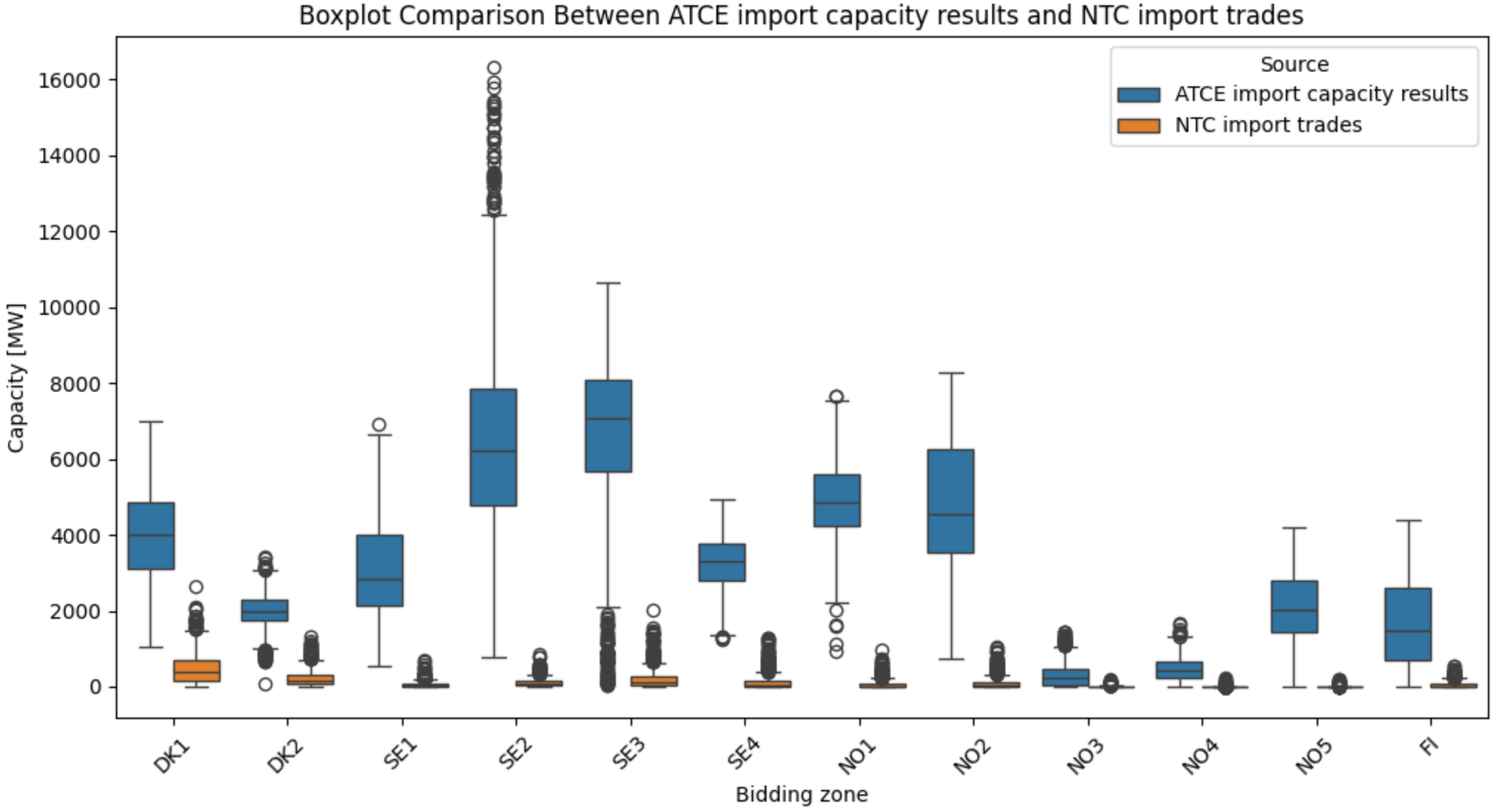
Comparison of ATCE import results (blue) and actual traded intraday import volumes (orange)

- Compared to actual traded volumes, the import capacities provided by ATCE should also suffice most of the time.



- Note: external TSO limitations not taken into account

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Percentage of time where ATCE capacities are not able to facilitate ID needs (import + export)

- Only three bidding zones (NO3, NO4 and NO5) have larger intraday trades than the given ATCE capacity (export + import) for this period

Bidding zone	Percentage of time ID trade > ATCE capacity
DK1	0.00 %
DK2	0.00 %
SE1	0.00 %
SE2	0.00 %
SE3	0.15 %
SE4	0.00 %
NO1	0.00 %
NO2	0.00 %
NO3	0.31 %
NO4	0.31 %
NO5	0.46 %
FI	0.00%

Percentage of time where ATCE capacities are not able to facilitate ID needs (export)

- For export, the ATCseveral bidding zones that usually export fully (SE1, SE2, NO3 and NO4) have quite a high percentage of times where actual intraday trades were higher than the ATCE result

Bidding zone	Percentage of time ID trade > ATCE capacity
DK1	4.02 %
DK2	0.15 %
SE1	9.91 %
SE2	8.51 %
SE3	0.31 %
SE4	0.00 %
NO1	1.08 %
NO2	1.39 %
NO3	5.26 %
NO4	4.95 %
NO5	5.42 %
FI	0.31 %

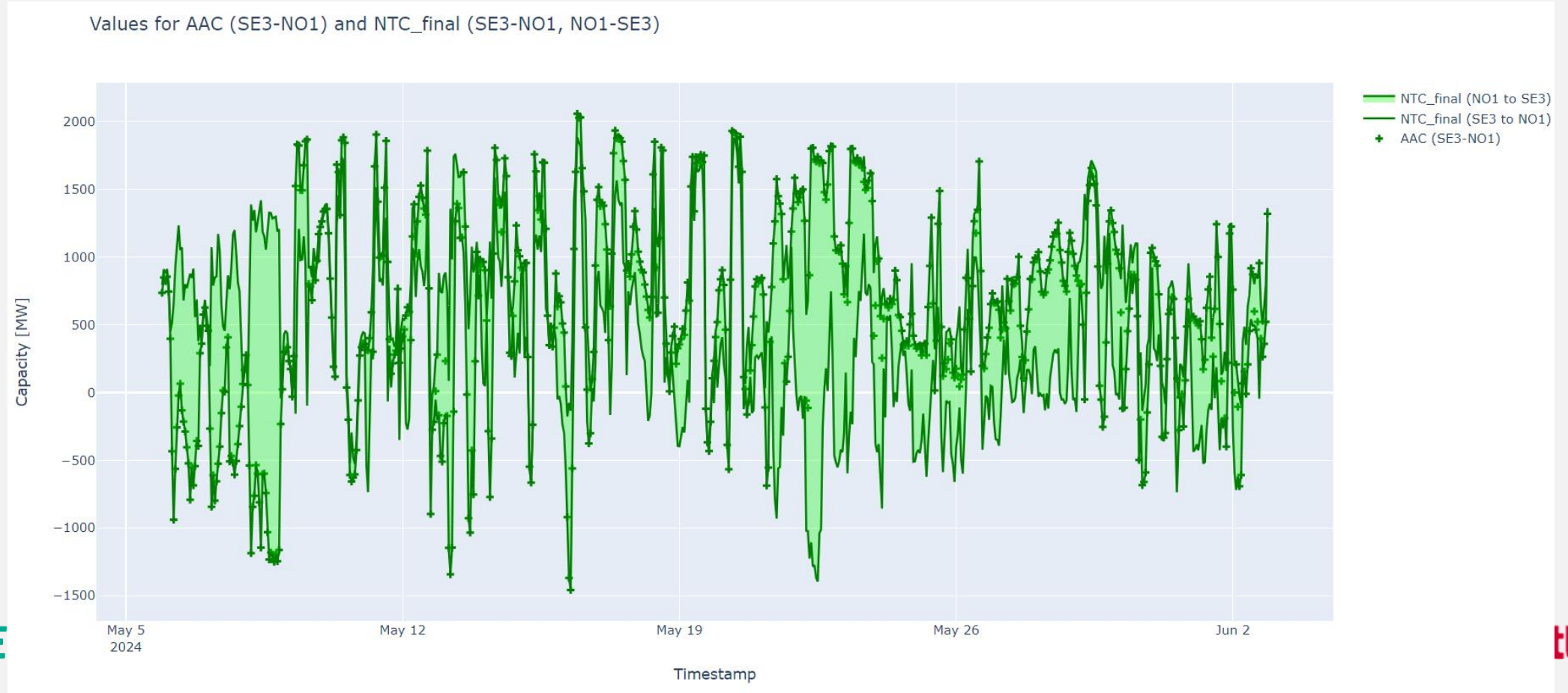
Percentage of time where ATCE capacities are not able to facilitate ID needs (import)

- For import, some bidding zones have less capacity provided by ATCE than the actual traded volumes.

Bidding zone	Percentage of time ID trade > ATCE capacity
DK1	0.00 %
DK2	0.15 %
SE1	0.00 %
SE2	0.00 %
SE3	1.55 %
SE4	0.00 %
NO1	0.00 %
NO2	0.00 %
NO3	9.91 %
NO4	0.46 %
NO5	0.00 %
FI	0.31 %

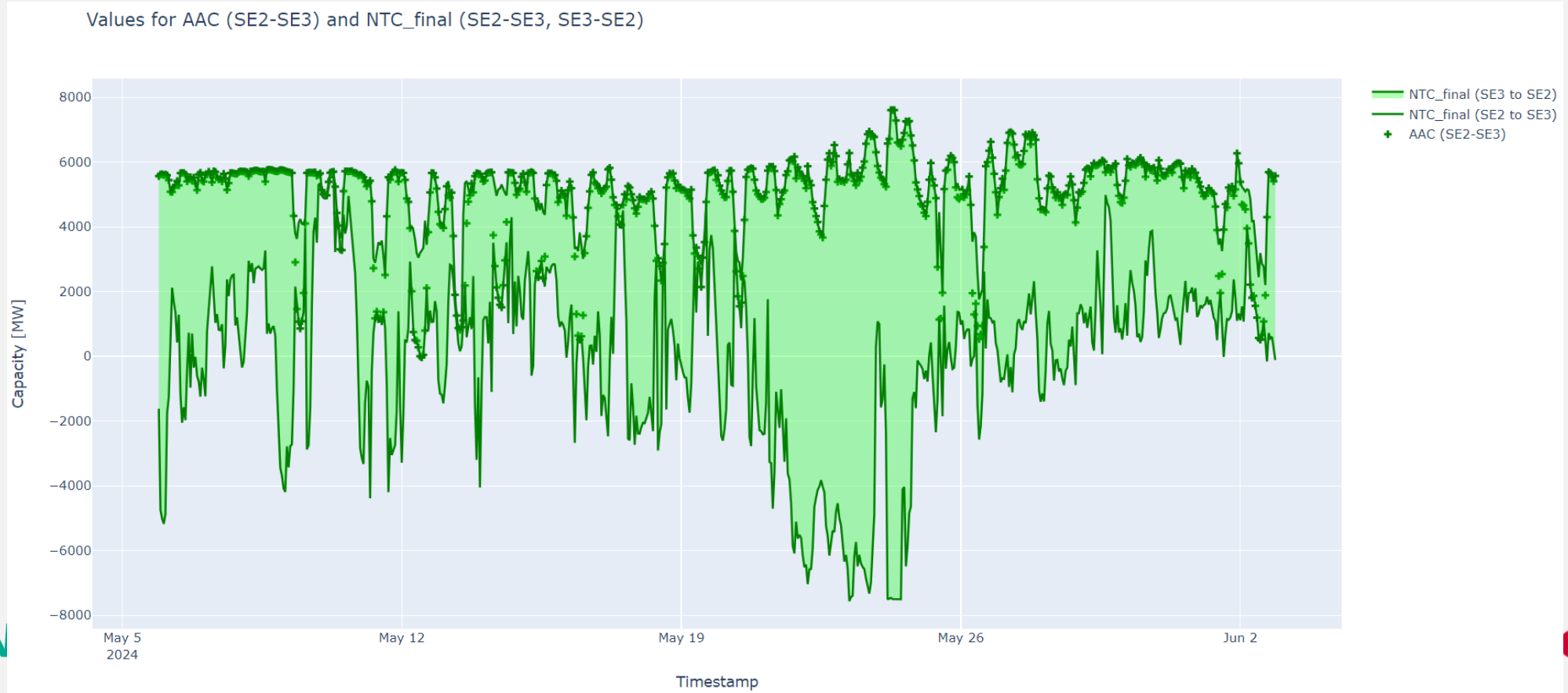
Border capacity SE3-NO1

- Quite low capacity for many hours and high volatility
- Will look at hub-to-hub capacities later



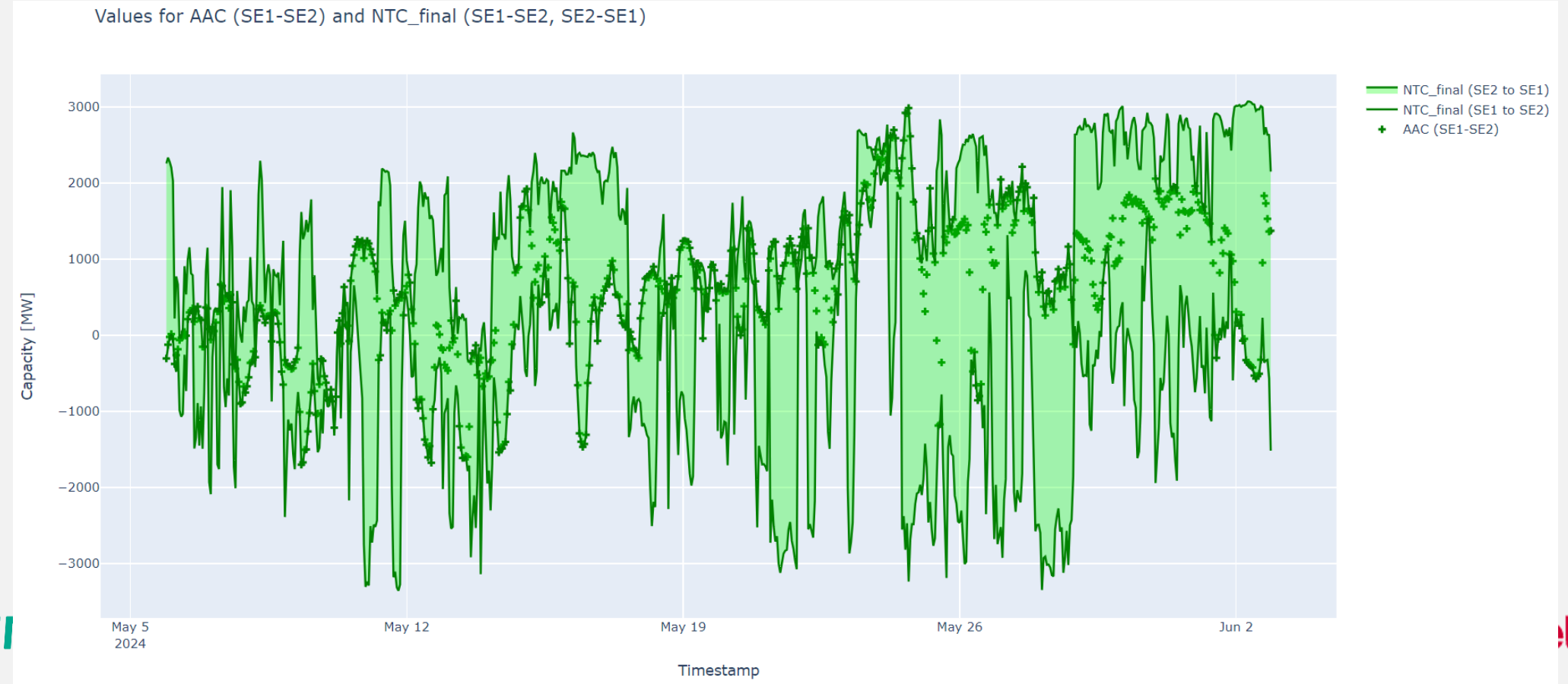
Border capacity SE2-SE3

- Mostly high capacity in SE3-SE2 with some exceptions
- Mostly zero capacity in SE2-SE3 as the AAC is at the physical limit



Border capacity SE1-SE2

- Many hours where AAC is in the middle → capacity in both directions
- Hours with low capacity, and high volatility of capacity (e.g. 24 May)



Specific cases walkthrough

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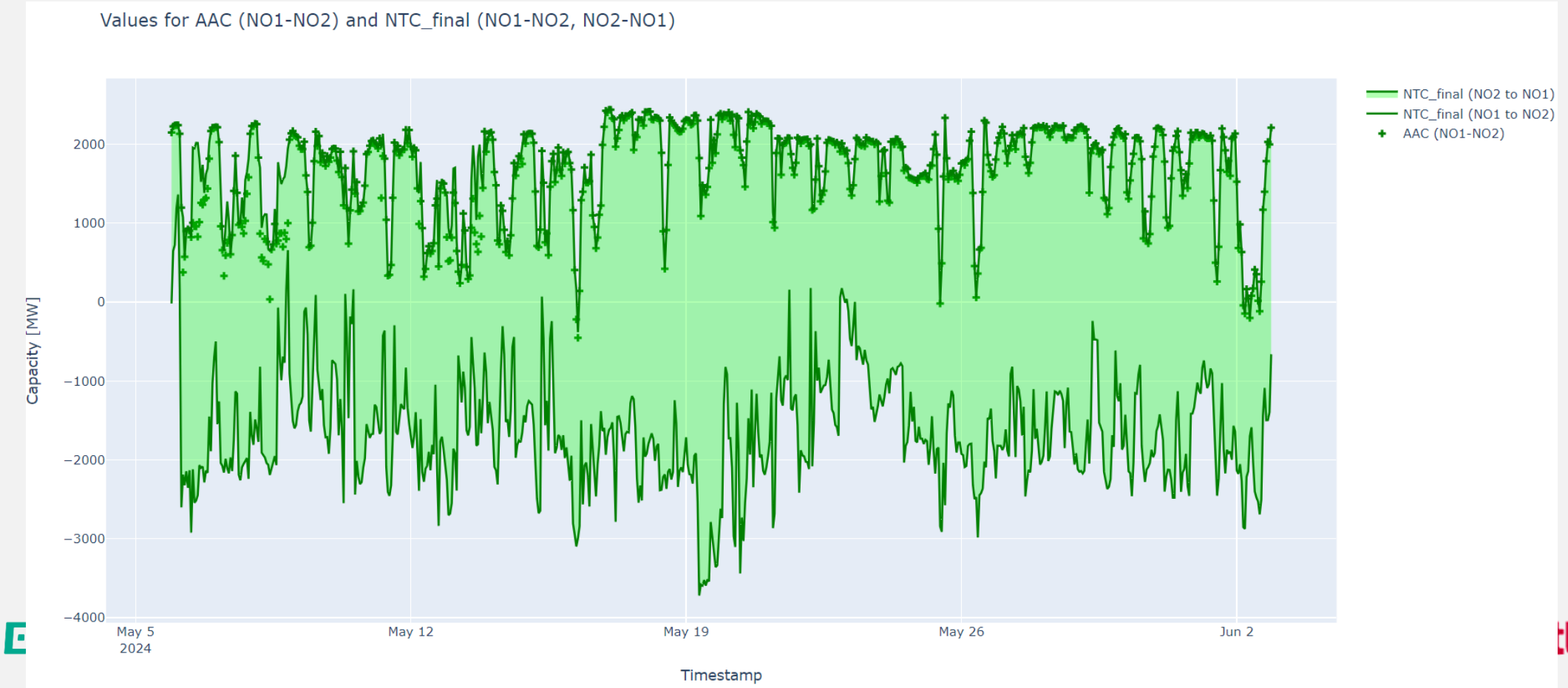
Border capacity NO1-NO2

- Generally high capacity, especially NO2-NO1 as AAC is in direction NO1-NO2

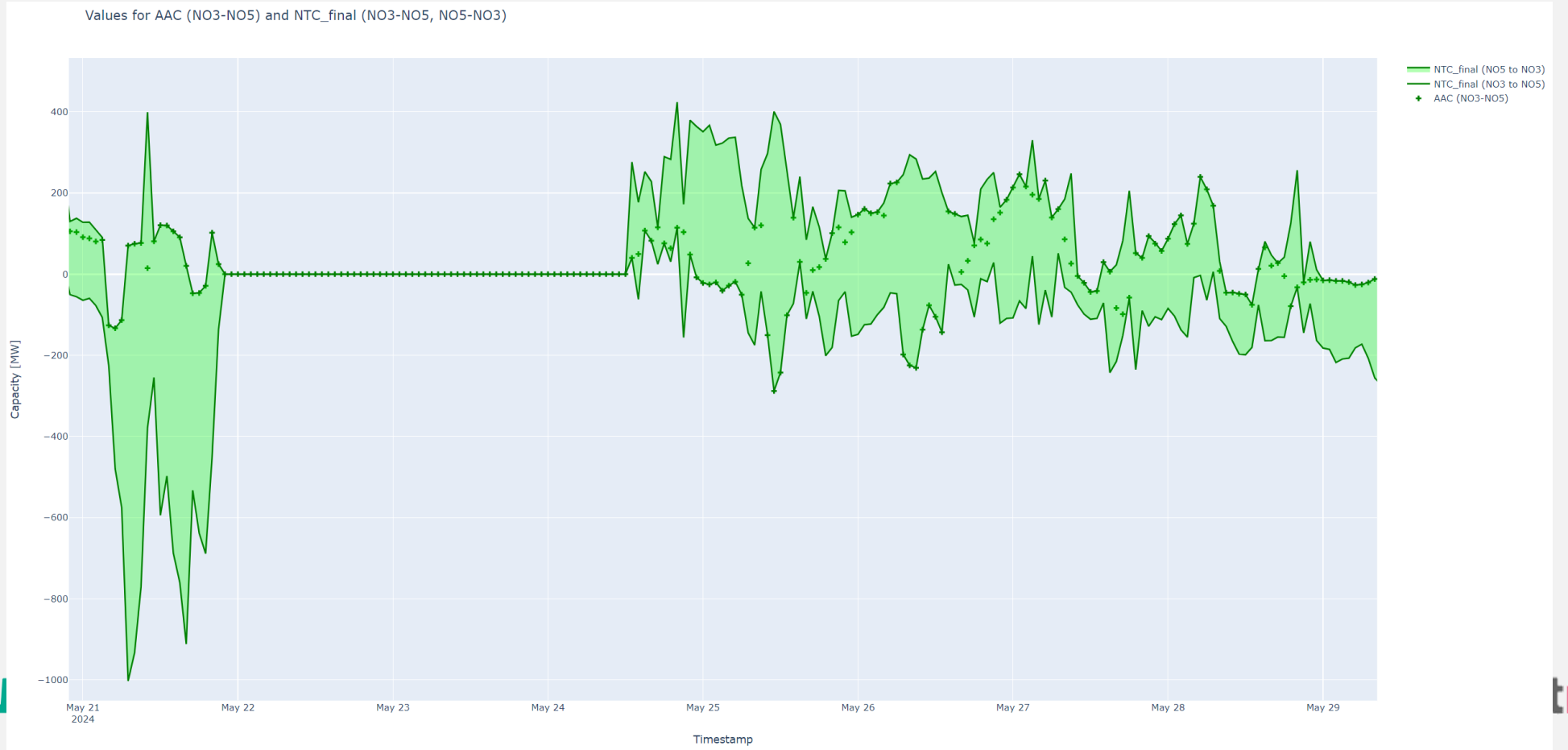


Grid split in Norway in week 21

- There was planned maintanence on NO3-NO1 and NO5-NO1 in week 21
- In these situations, NO5 can get a high surplus of power
- When the flow from NO3 to NO5 is too high, a transformer in NO5 can get overloaded
- The operator solution is to split the grid between NO3 and NO5 to avoid this overload
  - This happened during week 21 (22 – 24 May in particular)

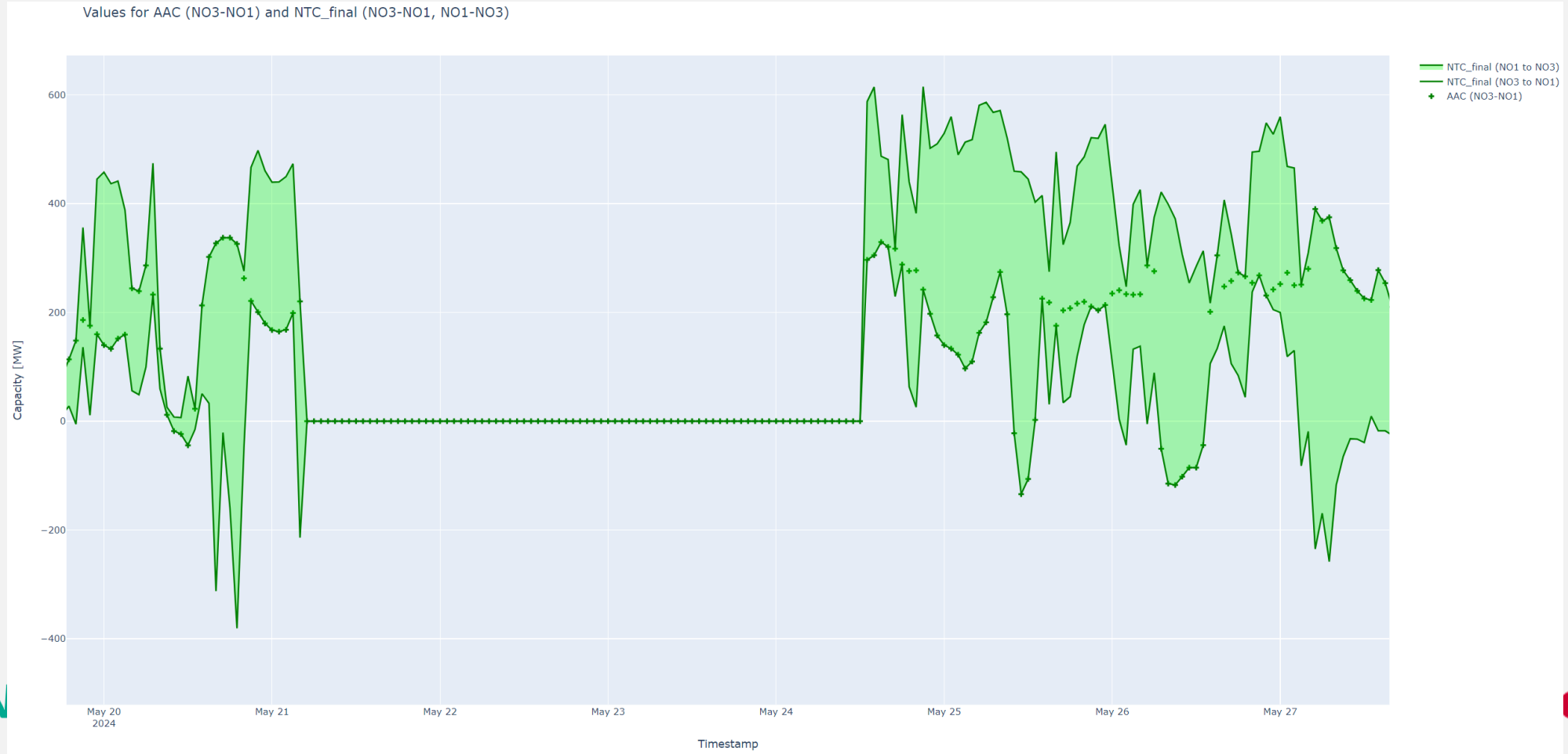
Grid split in Norway Week 21 (22 – 24 May)

- During the grid split, the capacity is set to zero on NO3-NO5



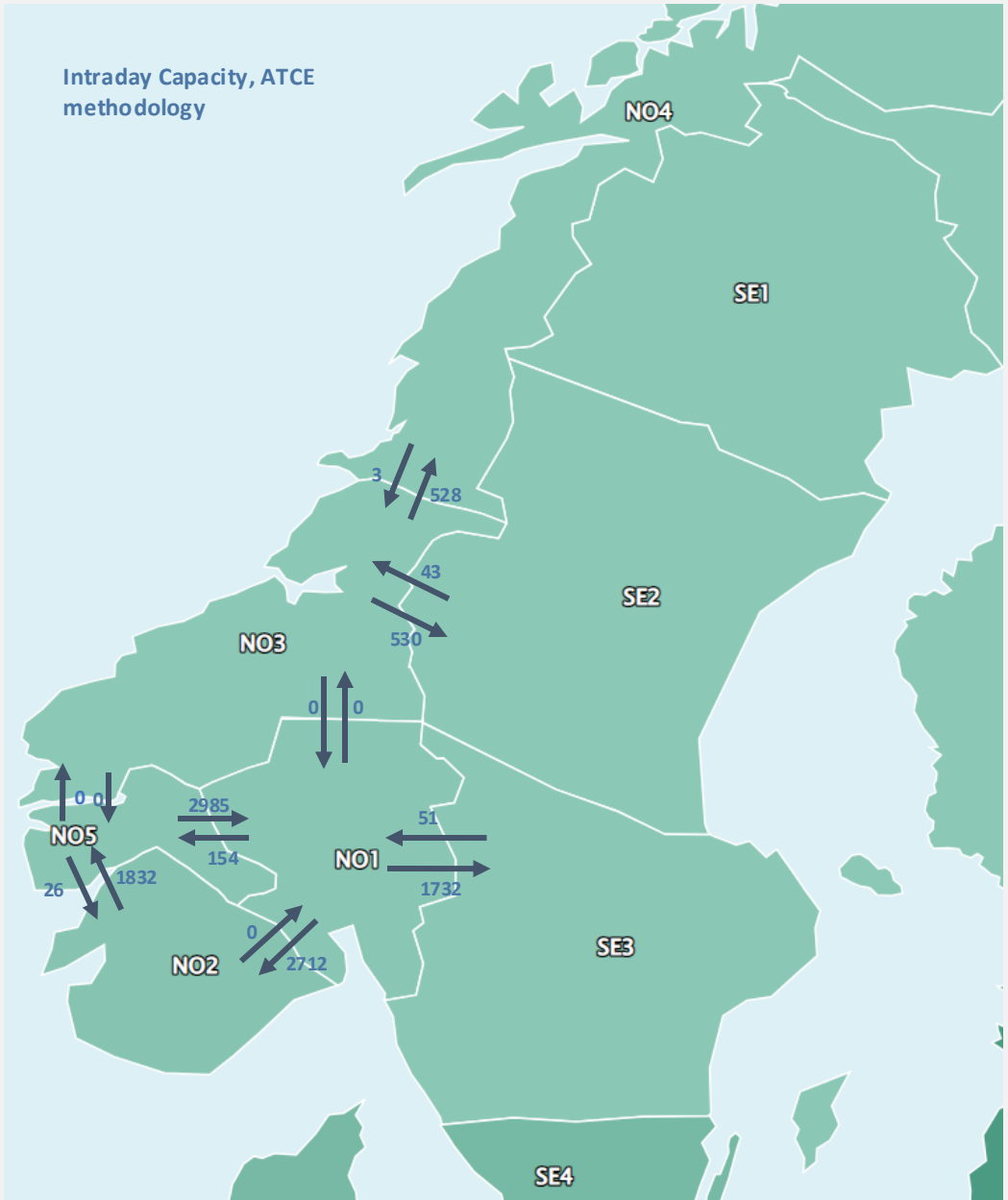
Grid split in Norway Week 21 (22 – 24 May)

- During the grid split, the capacity is set to zero on NO3-NO1



Grid split in Norway Week 21 (22 – 24 May)

- Here, we see the average ATCE capacities during the grid split
- As we saw, there are zero capacity in both directions between NO3-NO1 and NO3-NO5 due to maintenance and grid split
- The other borders still have decent capacity (at least in the opposite direction of AAC)
- NO3 have very little import capacity for this period
  - We will look further into how we would balance this in operation



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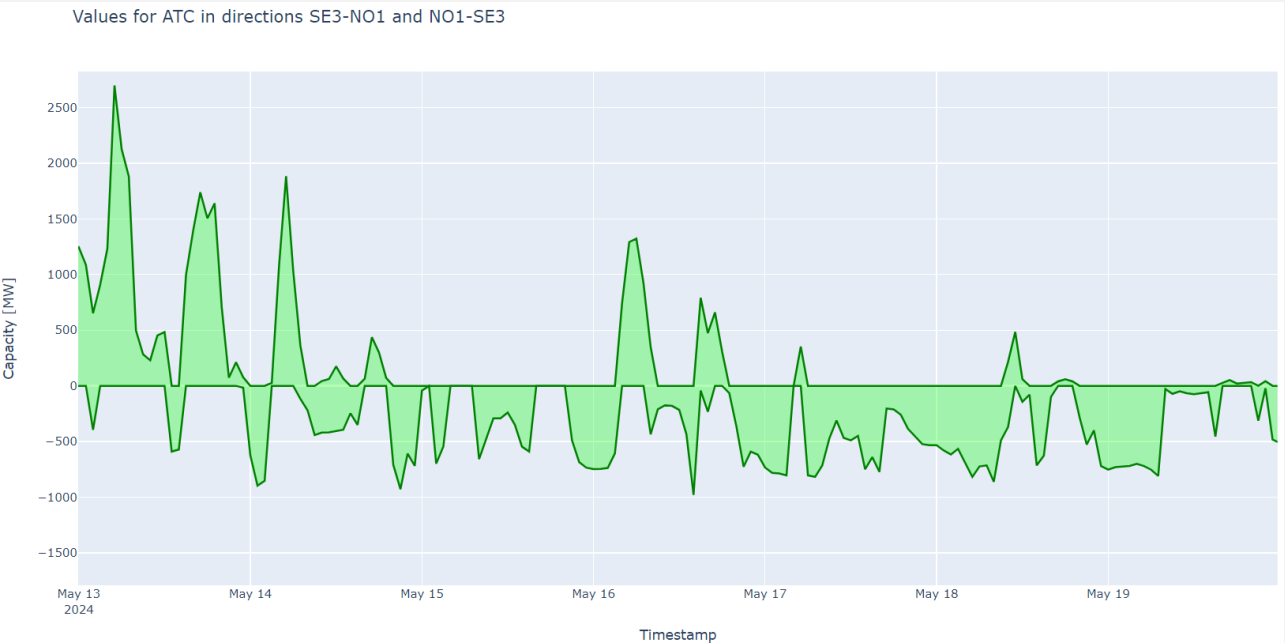
Hub-to-hub analysis – week 20

- When trading is needed from one bidding zone to another, traders might not just be interested in border capacity, but also the full capacity from one bidding zone to another
  - This includes all possible routes the flow can take to go from one bidding zone to another
- Example: capacity between SE3-SE2 can be X MW, but the hub-to-hub capacity would be the capacity from SE3>NO1>NO3>SE2 and SE3>NO1>NO3>NO4>SE2 and SE3>FI>SE1>SE2 etc.
- Gives a better indication of possible trade between the two bidding zones
- Might be overoptimistic still, since other trades might block certaint routes

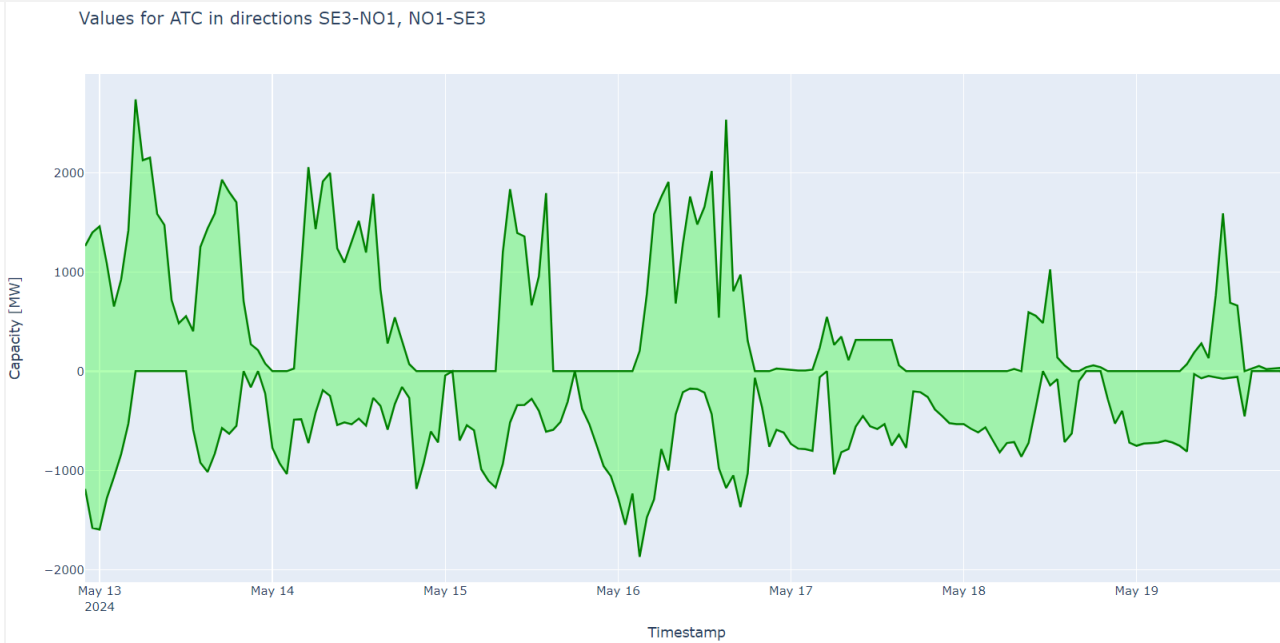
Border capacity vs hub-to-hub SE3-NO1 for the ATCE capacities

- Looking at the ATC values for the Border SE3-NO1 (left), the capacities are smaller than the hub-to-hub capacities
- More hours in both directions for the hub-to-hub where there is non-zero capacity

ATC border capacities

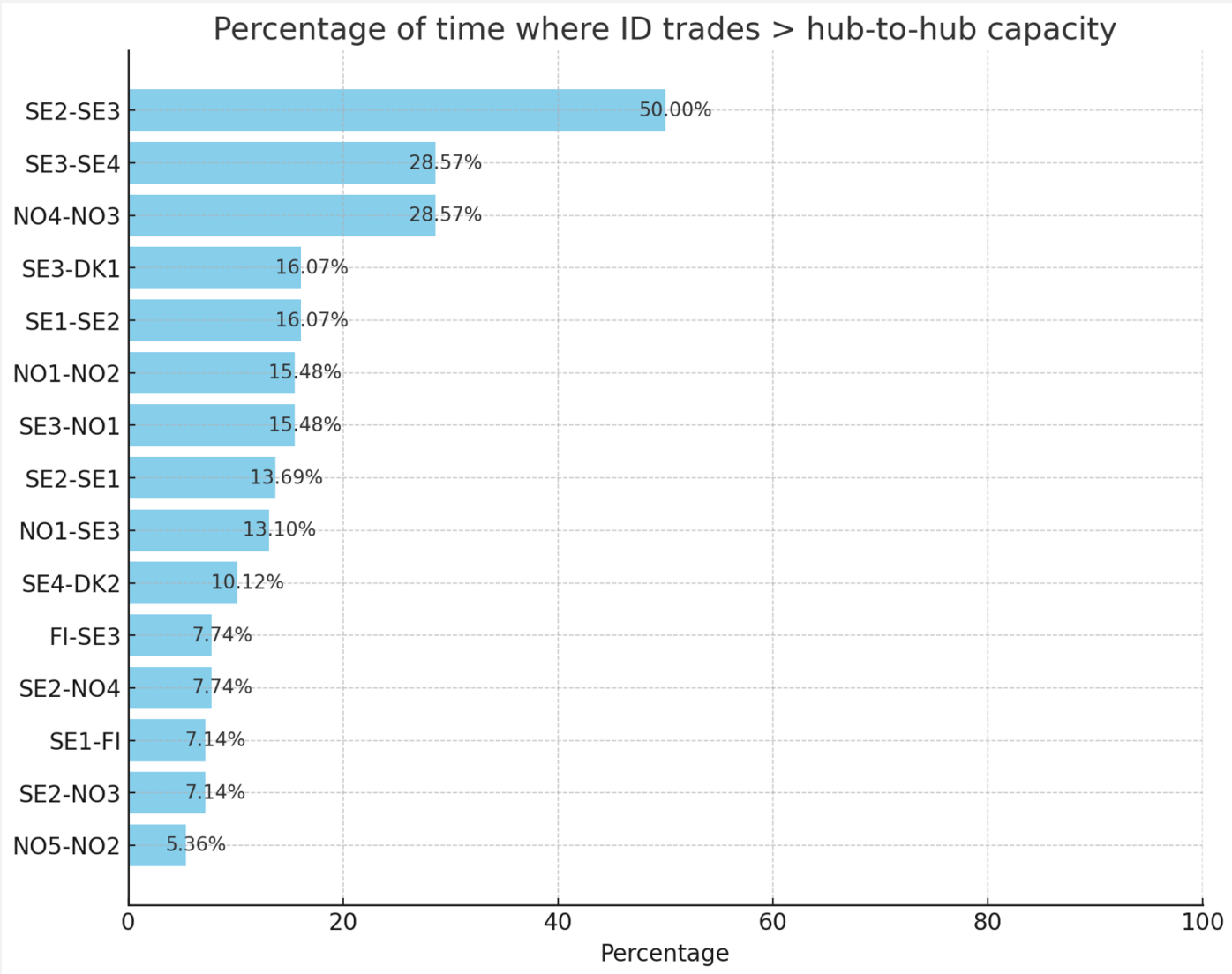


Hub-to-hub ATC capacities



Hub-to-hub-capacity compared to intraday trades for week 20

- The figure shows the percentage of time where the actual intraday trades in today's market were larger than the hub-to-hub capacity (more than 1MW larger) with the ATCE results.
- The borders with the highest values are in the direction of the usual market trades
  - With flowbased, the capacities in day-ahead are already usually utilized, thus there is rarely any more capacity provided in intraday
  - SE2→SE1 most noticable of the capacities against the normal flow direction.



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Hub-to-hub: analysis plan after the summer

- Will include all weeks to have a more general illustration.
  - Did not have time to calculate more than one week this time.
- Maybe also include non-neighboring borders to get even more insight into hub-to-hub

Questions?

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Thank you!

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