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

SH Monthly meeting

8 May 2024

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Agenda

1. Upcoming events and news
2. Background information on the EPR
3. EPR results, weeks 11-14
   - Impacts on SEW, prices, flows, net positions, constraining CNECs
4. Specific hours walkthrough

Upcoming events and news

- **ID ATCE update**
  - The relaxation parameters of the ATCE method are 2 % PTDF relaxation, 0.01 MW on allocation constraints and 10 MW on CNECs (https://nordic-rcc.net/flow-based/methodology/, updated 25 April 2024)
  - The 6-month EPR period started on Monday 25 March, i.e., energy delivery week 13.
  - Historical re-runs for weeks 26/2023 – 12/2024 have been published at the RCC website. The TSOs aim to publish the weekly ATCE results every Friday, in accordance with other weekly publications.

- **Hybrid stakeholder meeting (focusing on ATCE) upcoming on Monday June 10, 09:30 - 16:00 CET**
  - You can participate either onsite at Stockholm Arlanda Airport (Sweden) or online via Teams. For onsite participation registration is required, please find further information in the latest CCM newsletter (May 7).

- **Next monthly EPR meeting on Thursday June 13, 9:00 – 11:00 CET**
  - This and the following monthly EPR events will cover an evaluation of the ID ATCE

- **Links to the recordings from the "FB for beginners" event (March 13) have been published at the RCC website**

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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

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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 week 11-14, 2024
11 March – 07 April

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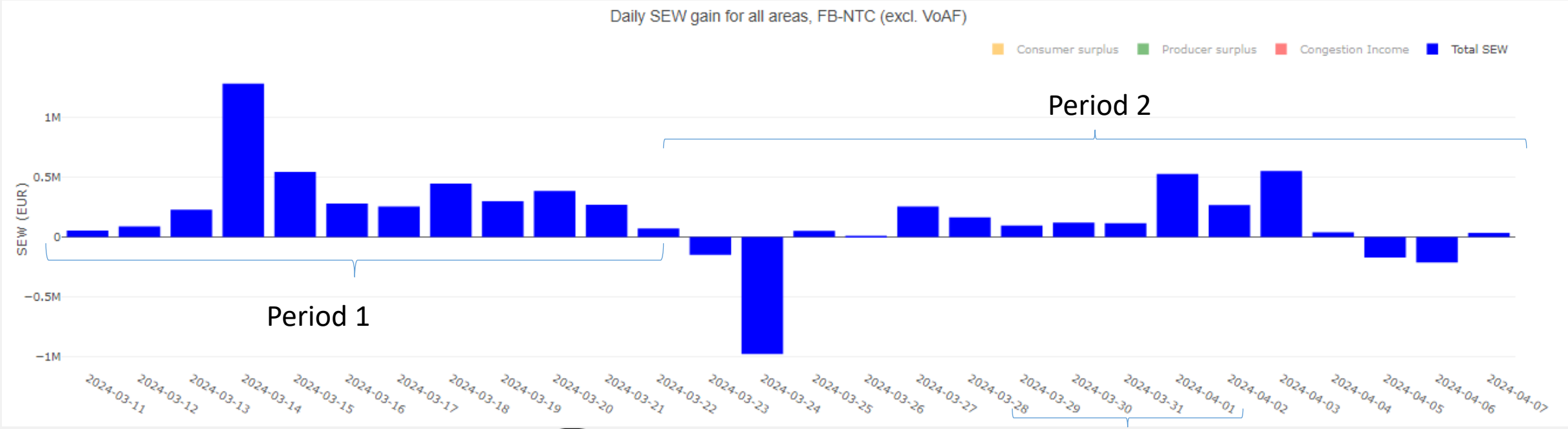
Social welfare change W11-14

- These four weeks are split into two periods:
  - Period 1, 11/3-22/3: Daily positive welfare impacts & positive net position
  - Period 2, 23/3-07/04 (including Easter): Daily positive or negative welfare impacts & varying net position. Sauda CNECs are impacting.
- Over the full 4-week period, flow-based results in a higher SEW compared to NTC for the Nordic region, and also for the whole market coupling region (SDAC).
  - Total Nordic SEW change +3.88 M€ (+4.60 M€ including Hansa congestion income)
  - Total SEW change in the SDAC region +4.97 M€



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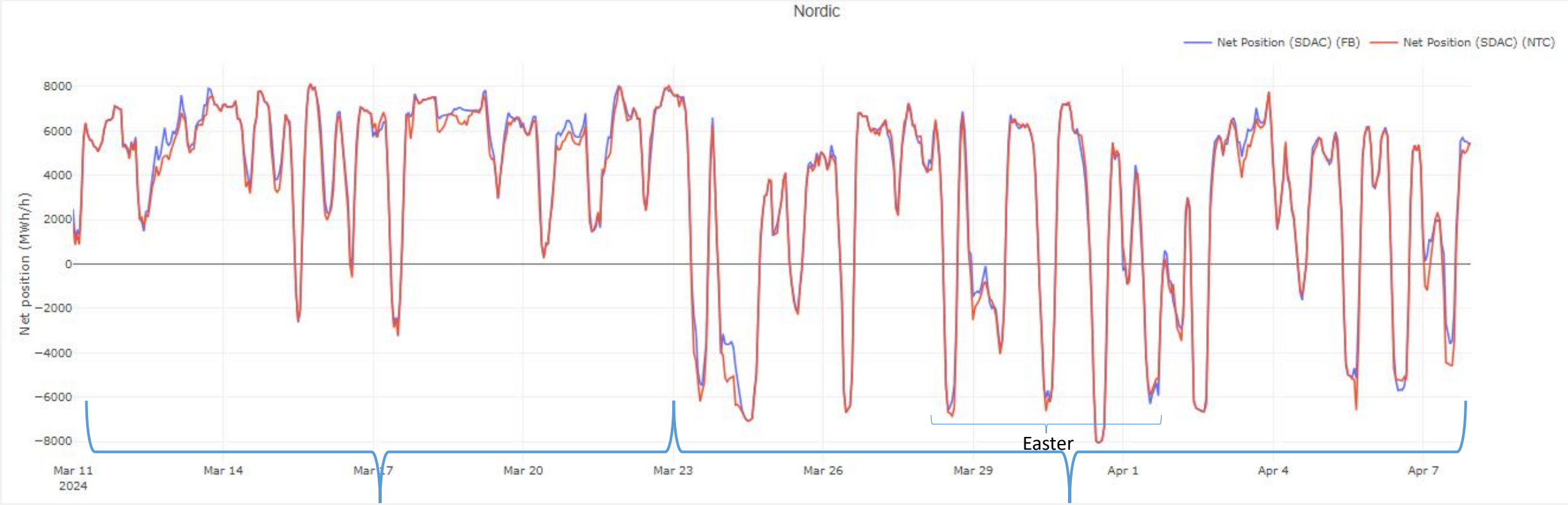
Nordic Net Position W11-14

- The total cumulative Nordic net position change is +117 GWh in FB compared to NTC
- Period 1: mainly export from the Nordics
  - From NTC to FB, the cumulative net position increases with 54 GWh from 1513 GWh to 1567 GWh
- Period 2: net position starts varying, considerably more import hours to the Nordics
  - From NTC to FB, the cumulative net position increases with 62 GWh from 540 GWh to 602 GWh.
    - In MTUs when the Nordic area exports to the continent, FB increases the flow with 23 GWh in total
    - In MTUs when the Nordic area imports from the continent, FB decreases the flow with 39 GWh in total



Nordic region in NTC in Period 1 (11.3. - 22.3.)

- As indicated by the net position, during the first period the Nordics are most of the time exporting power to the continent and the Baltics.
- Compared to the previous weeks, where the prices already were partly decreasing due to decreased consumption and increased wind production, the average prices continue to fall in many bidding zones (Norway, SE1-SE3, and Finland).
- The highest average prices are found in Denmark, the continent, and the Baltics, while the lowest prices are found in in SE1, SE2 & NO4.
- Overall Constraints in the grid:
  - Northern Nordics -> Southern Nordics
  - Nordics -> Continent & Baltics

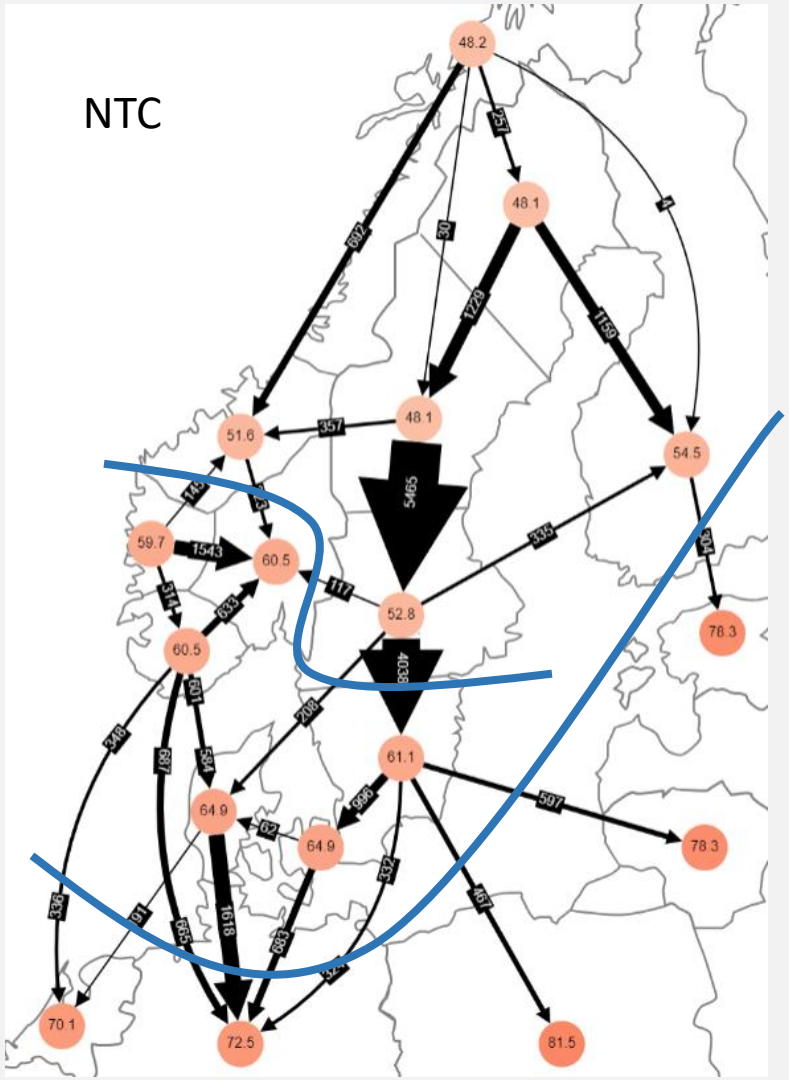


Figure: Average prices and flows in each BZ in NTC

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Nordic region in NTC in Period 2 (23.3. - 07.4.)

- For the second period, the market is more volatile due to changes in consumption during Easter and high wind production, so it is not as straightforward to draw general conclusions based on the average results.
- The Nordics are a net exporter region, but with a high number of import hours, unlike in period 1.
- The average prices in almost all Nordic areas decreased compared to period 1.
- The highest average prices are found in Poland, NO5, the Baltics and DK2. Otherwise, the average prices are very similar in NO4, Sweden & Finland.
- Constraints in the grid:
  - NO4 + Sweden -> South Norway & Denmark
  - Nordics -> Baltics + Poland
  - NO5 -> NO1, NO2, NO3

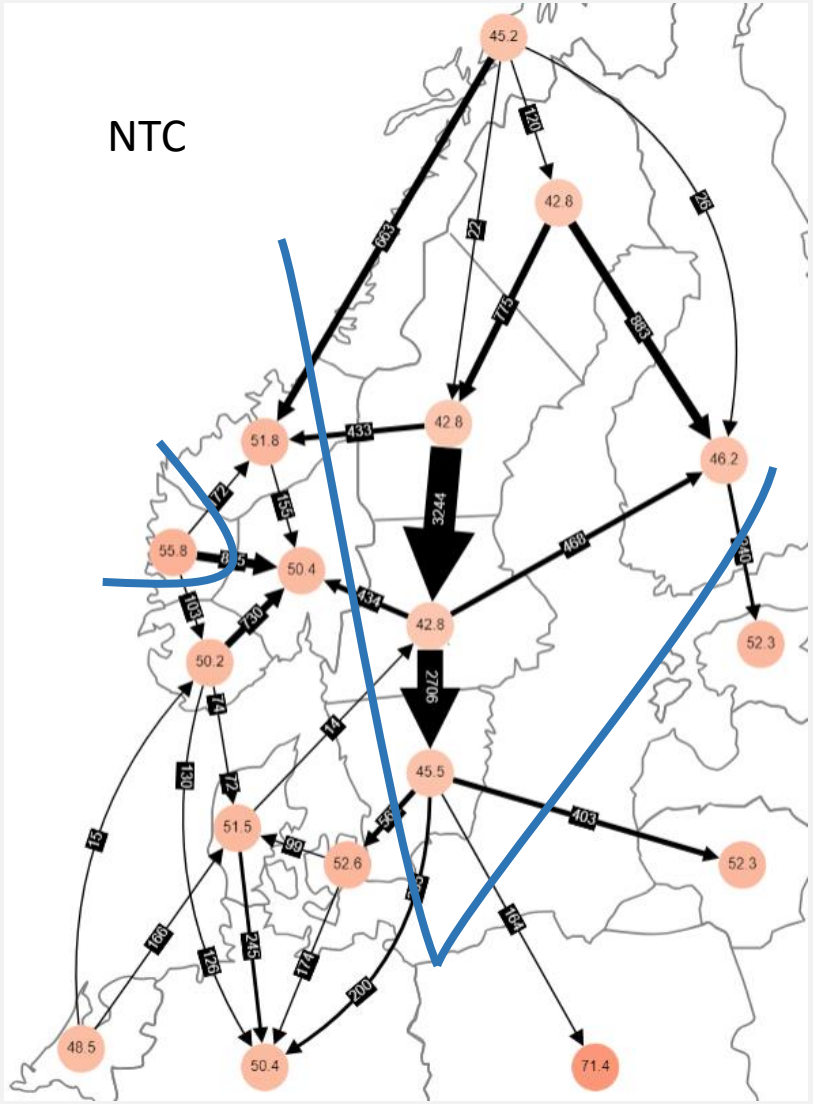

Figure: Average prices and flows in each BZ in NTC

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Average prices and flows in the Nordic region - Period 1 (11.3. - 22.3.)

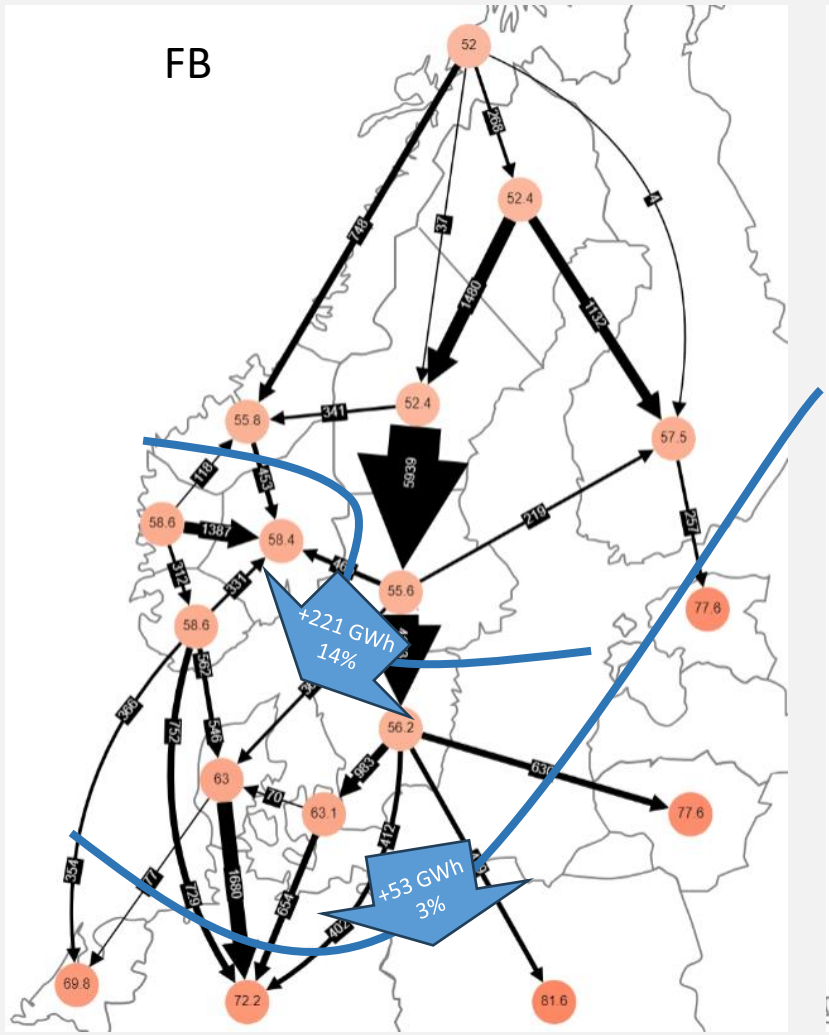
Overall constraints in the grid:

- Northern Nordics -> Southern Nordics
  - The overall flow on these borders was increased with 221 GWh in FB
- Nordics -> Continent & Baltics
  - The overall flow on these borders was increased with 54 GWh in FB

Prices:

- The price decreases with ~5 EUR/MWh in SE4 and with ~1-2 EUR/MWh in Southern Norway & Denmark. The prices in the continent and the Baltics are only decreased slightly.

- The price increases with ~3-4 EUR/MWh in SE1-SE3, Finland, NO3 & NO4.



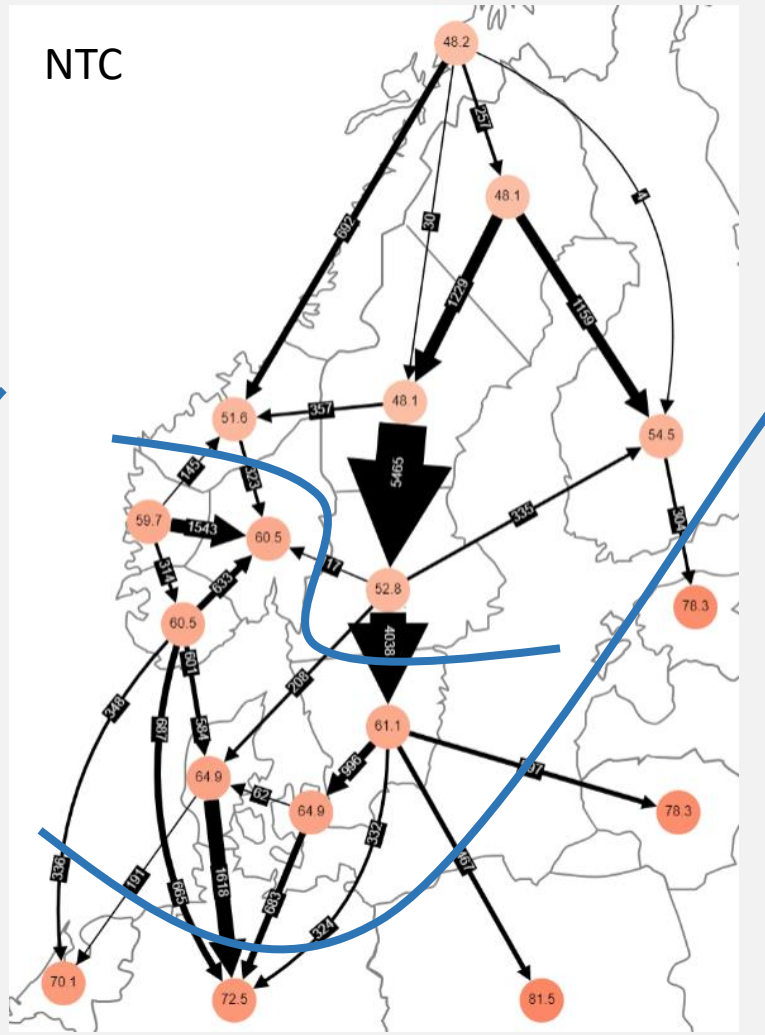


Figure: Average price in each BZ in FB and NTC. Arrows show the increased flow over constraining elements.

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Impact on buy and sell volumes (FB-NTC)
Period 1 (11.3. - 22.3.)

- Largest net position decreases are observed in NO2 and NO5.
- Largest net position increases observed in SE1 & SE2.
- The change in supply volumes is the main impacting factor for the changes in bidding zone net positions.

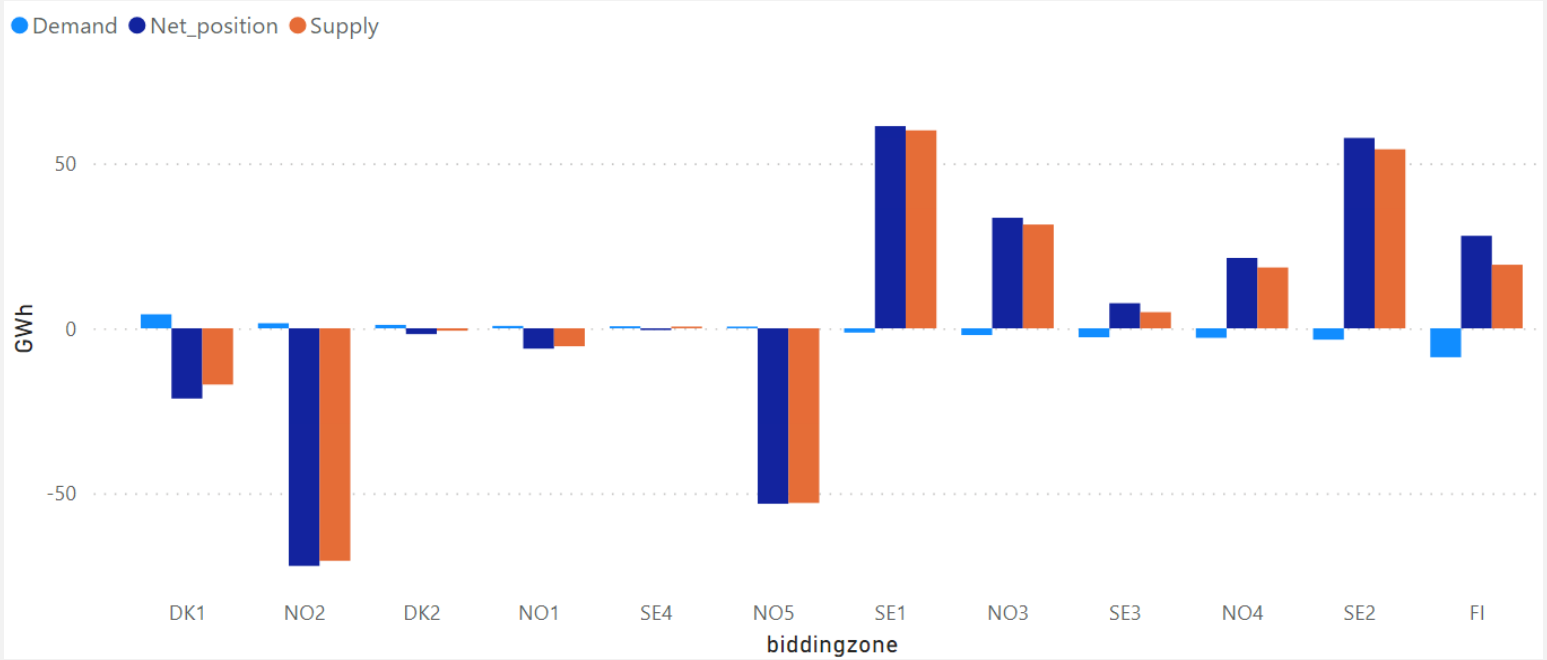

Figure: Demand and supply volume difference (FB-NTC) and the corresponding net position change

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Prices Period 1 (11.3. - 22.3.)

- Average prices in Denmark, NO1, NO2, NO5 & SE4 are decreased, and increased in the other bidding zones.
- The bidding zones with decreased prices are the ones with the highest average price, while the ones with the lowest prices increase the most.
- The maximum prices decreased for all bidding zones except for NO3, NO4, SE1 and SE2.
  - The decreases of the maximum price are much larger than the increases

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	10	11	↓ 155	169	63	65	↓ -2
DK2	10	13	↓ 168	169	63	65	↓ -2
FI	2	0	↓ 138	143	57	55	↑ 3
NO1	40	40	↓ 107	158	58	60	↓ -2
NO2	39	40	↓ 108	158	59	60	↓ -2
NO3	24	17	↑ 111	99	56	52	↑ 4
NO4	17	17	↑ 123	99	52	48	↑ 4
NO5	40	45	↓ 107	117	59	60	↓ -1
SE1	3	0	↑ 126	99	52	48	↑ 4
SE2	3	0	↑ 127	99	52	48	↑ 4
SE3	1	0	↓ 129	158	56	53	↑ 3
SE4	0	0	↓ 130	164	56	61	↓ -5

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

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Constraining CNECs in FB
Period 1 (11.3. - 22.3.)

- As previously, the Finnish CNEC representing export to Estonia is the most constraining in this period.
  - This is due to Estlink 2 (650 MW out of the total 1000 MW) being out of operation from January 26, 2024, until September 2024 (estimate).
- Mainly HVDCs are the most limiting elements.
  - Here, especially CCR-border HVDC to the continent & the Baltics are constraining
- High shadow prices indicate that more flow would have increased the total SDAC welfare.

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
FI_PTC_FI_EL_EXPORT	143	31.16	4,455.85
fbcac7cb618e486681f7fde3f5b735f7	159	27.18	4,321.76
c4247b25510e44bf9b87f7d582fd5178	144	24.31	3,501.14
AC_Minimum_SE4_BC	172	19.71	3,389.37
AC_Minimum_NO2_NK	194	16.91	3,280.15
PowerTransformer ENDK DK1 TRI KT51 1 Terminal : P|400KV LINE C_MAL-TRI	74	38.51	2,849.93
AC_Minimum_NO2_ND	179	15.70	2,810.39
AC_Minimum_DK2_KO|BASECASE	185	14.17	2,622.09
AC_Minimum_SE4_SP	94	23.14	2,175.63
DK2_SV_IMP|BASECASE	174	11.20	1,949.27
AC_Minimum_SE4_NB	65	28.92	1,879.91
89c2eb99986044d9bf74864990c73169	35	49.02	1,715.56
AC_Minimum_NO2_SK	90	15.43	1,388.58
AC_Minimum_FI_EL	56	24.44	1,368.80
FI_PTC_RAC_SE1-FI	108	11.70	1,264.12
d3d272e8ce2f4f48a184046ec01f3c86	75	14.61	1,095.84
ACLineSegment ENDK DK1 E_FOU-MOSV 1 F Terminal : F|400KV LINE C_FER-TRI	45	21.88	984.48
ACLineSegment (ZBR) ENDK DK1 E_KAE-STSV Z1 F Terminal : F|400KV LINE C_IDU-TJE	7	129.38	905.68
7093248330414163ab3657799994a8a4	13	58.82	764.62
6f6ceaf31e644f30926b05963170fde8	34	22.47	763.86
DK1_NL_EXP|BASECASE	58	12.22	708.64
4059d547d0394c069bb85040591ba23c	34	15.91	540.98
15ce5b1daf584fa6ad727ddde4649da1	8	61.56	492.46
L13461_10 55% 420 Nea-Klæbu + 420 Namsos-Ogndal + 300 Tunnsjødal-Verdal	44	9.77	430.06
8fa17295abec4a6f820c40b15fa69dc8	36	11.31	407.32

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SEW Impact on bidding zone level
Period 1 (11.3. - 22.3.)

- 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 DK2, NO1, NO4, SE1, SE2 and SE4.
- FB results in a gain for consumers in DK1, DK2, NO1, NO2, NO5 and SE4.

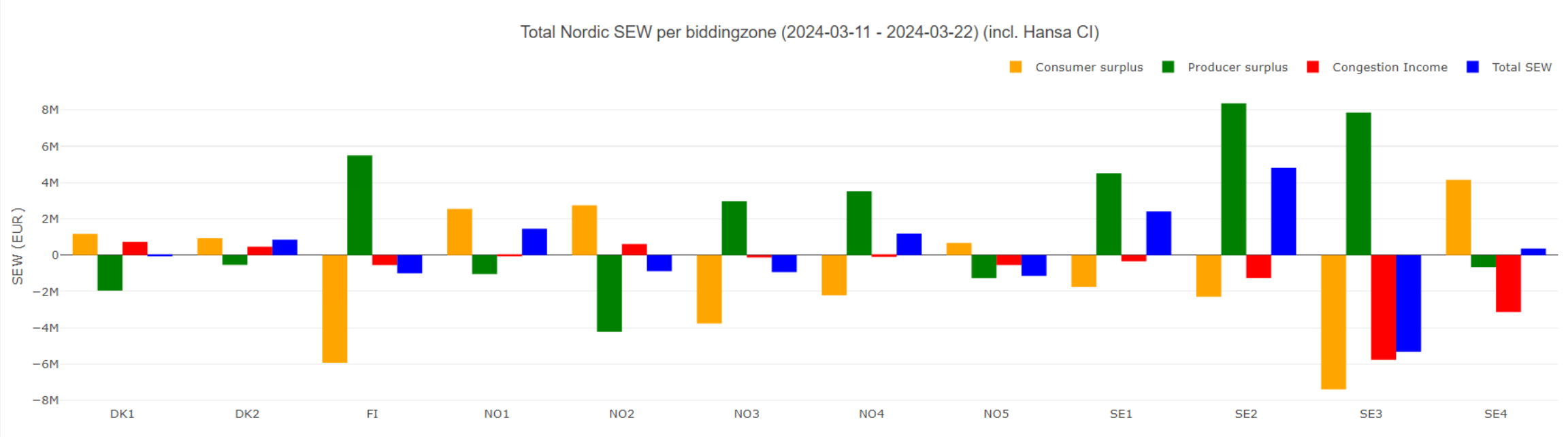

Figure: SEW change per stakeholder group in CCR Nordic, per bidding zone

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Average prices and flows in the Nordic region
Period 2 (23.3. - 07.4)

For these weeks, there are constraints between:

- NO4 + Sweden -> South Norway & Denmark
- Nordics -> Baltics + PL
- NO5 -> NO1, NO2, NO3

Very small average price changes:

- The average prices decrease with up to 3 EUR/MWh in Denmark & Southern Norway
- The average prices increase in North Norway, Sweden, FI & the Baltics.

This period is defined by the volatile net position that impacts the average prices & flows. It contains hours with high import, but also extremely high export, evening out the overview and making it challenging to draw conclusions based on average values.

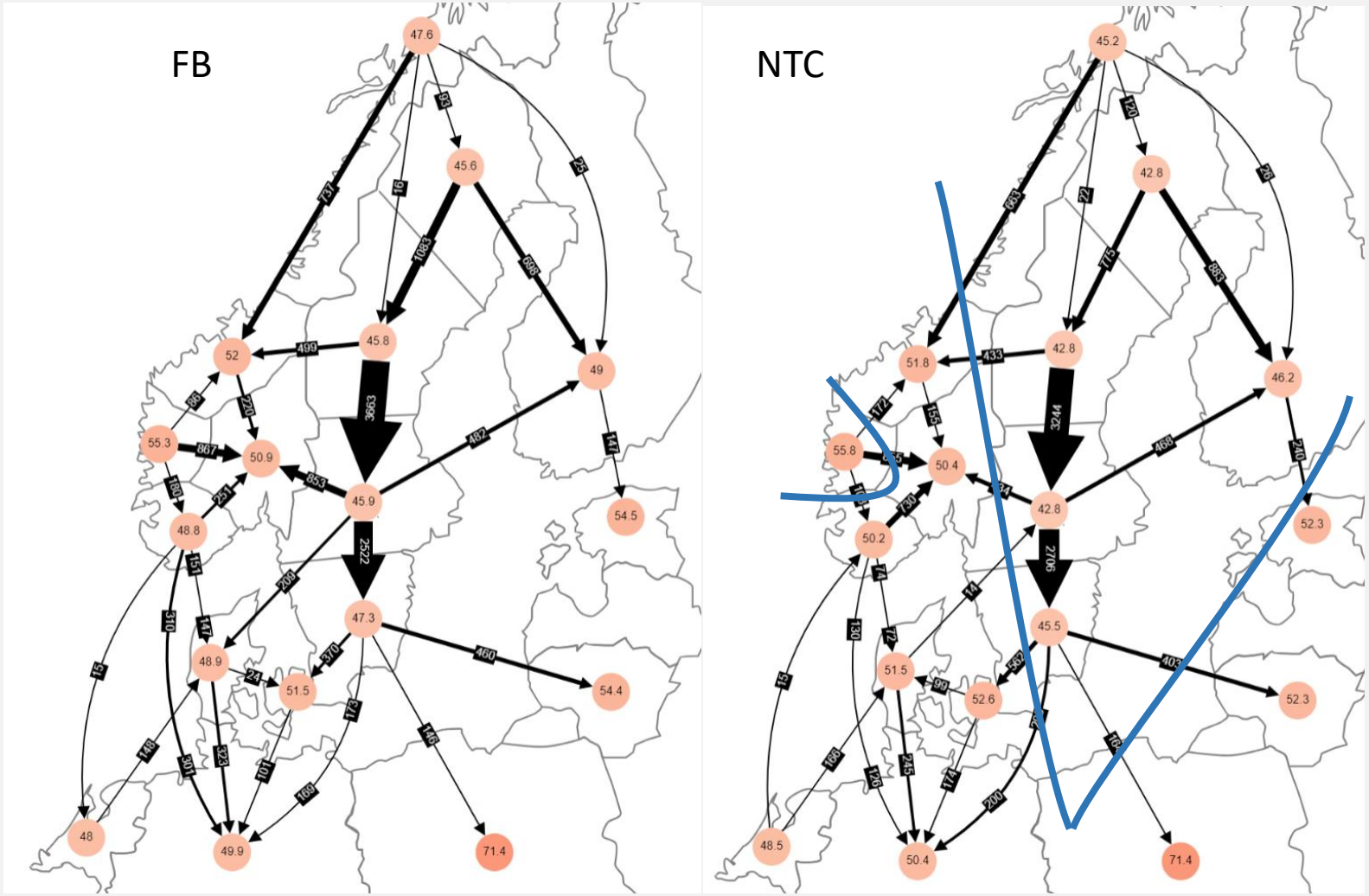

Figure: Average price in each BZ in FB and NTC. Arrows show the increased flow over constraining elements.

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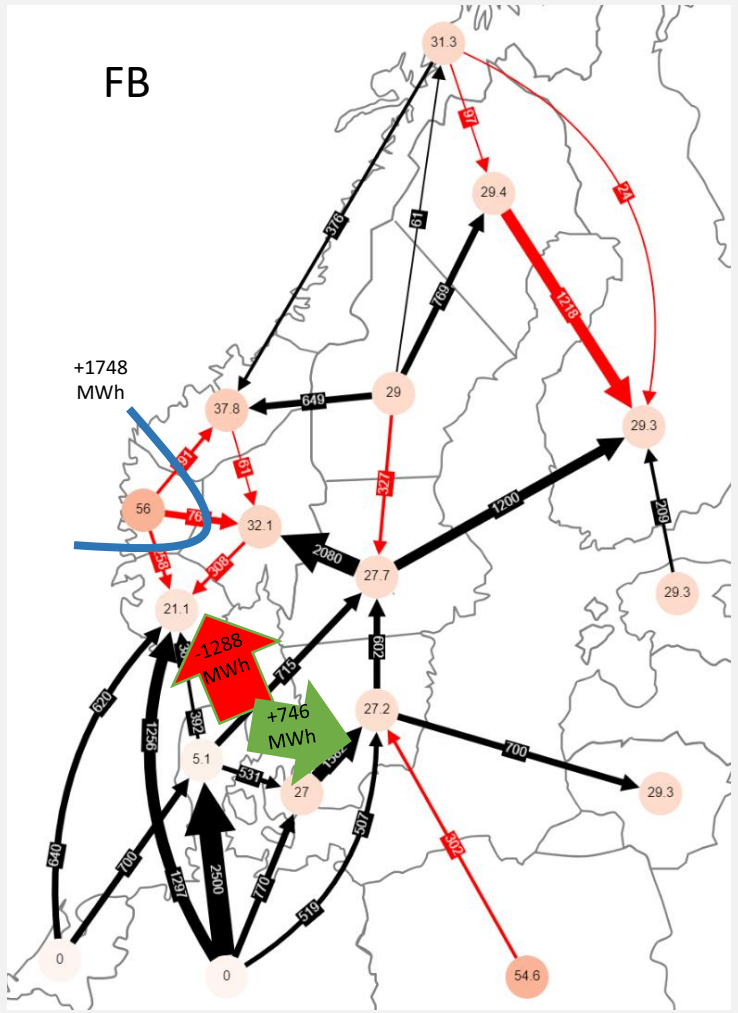
Hour with a negative Nordic net position (import) – March 28, MTU 15

- In NTC, the Nordic net position is –6670 MWh, which in FB increases to -6153 MWh.
- In NTC, the prices in DE & NL are zero, while the prices in the Nordics (except Southern Norway) and the Baltics are the same.
- FB decreases the prices in FI & SE with 1-3 €/MWh and with 10-25 €/MWh in Denmark & South Norway. In NO4 & NO5 the prices increase by 2 & 6 €/MWh.
- Sauda is the most constraining CNEC in both NTC & FB.
  - FB relieves this CNEC by increasing the net positions of NO4 & NO5 and increasing the flow towards NO1, NO2, NO3.
  - DK1 exports less towards NO2 and increases the flow through DK2 towards SE4, what relieves the Sauda CNEC in NO2 and decreases the price in DK2 & SE4.
  - The import from Germany to NO2 is reduced slightly, which relieves the Sauda CNEC further.



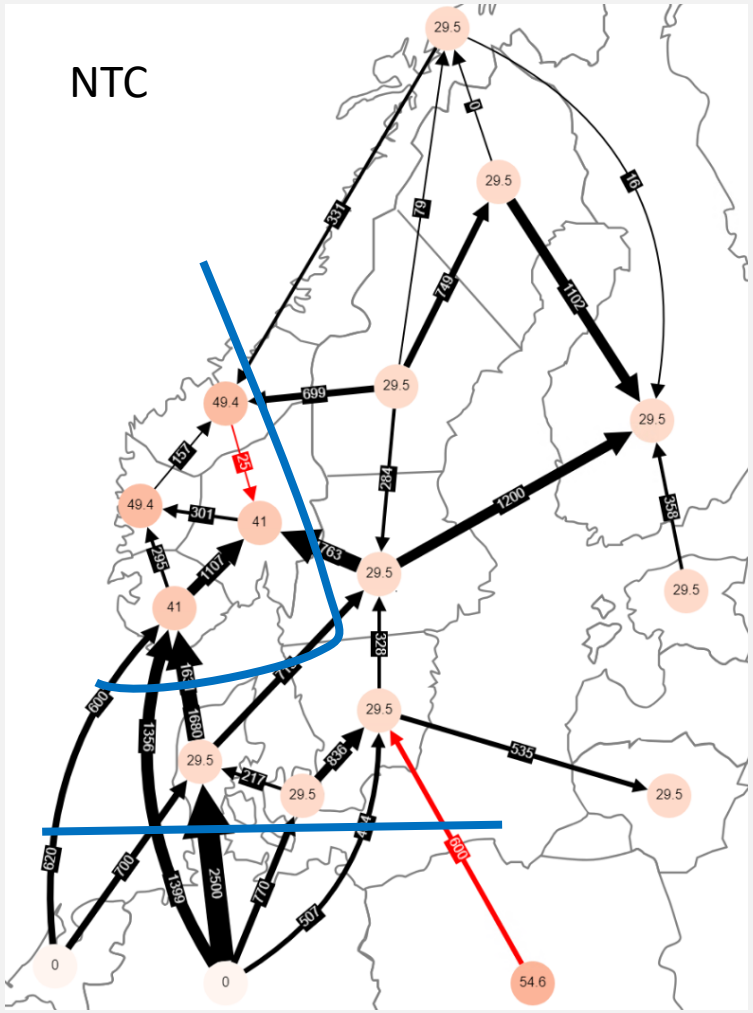


Figure: Price in each BZ in FB and NTC. Arrows show the increased flow over constraining elements.

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Hour with a positive Nordic net position (export) – 03 April, MTU 13

- In NTC, the Nordic Net Position is 5391 MWh, which in FB increases to 6070 MWh, causing a SEW gain of 21 k€.
- In these hours, the typical picture in NTC is that the price is the same in several Nordic BZs.
- In NTC, the prices in Northern Sweden and Finland are the lowest, while the prices in Southern Norway, Denmark & the continent are the highest.
- FB decreases the price with 14 €/MWh in South Norway & NO4, while the price in Sweden, Finland & NO3 increases with 6-10 €/MWh.
- FB utilises the grid more efficiently by allowing a higher flow from FI & SE towards Norway & the continent.
- The increase in net position of NO3 and decrease in NO4 relieve a constraining CNEC in Sweden, allowing further increased flow from North -> South & East -> West.

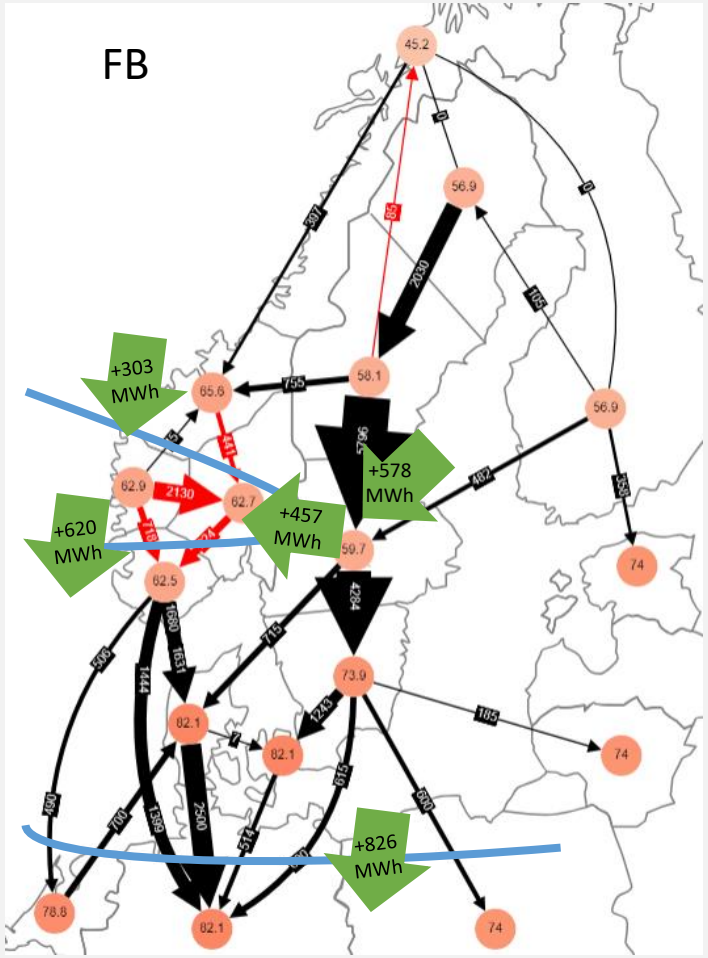

Figure: Price in each BZ in FB and NTC. Arrows show the increased flow over constraining elements.

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Impact on buy and sell volumes (FB-NTC)
Period 2 (23.3. - 07.4)

- The largest changes on net positions are in NO2, SE1 and SE2.
- The change in supply volumes affects the changes in net positions most.
- Multiple bidding zones have very small changes in both the demand and supply side, e.g. DK2, NO5, SE4.
- Biggest difference in the demand volumes is noted in DK1, SE2 and SE3.

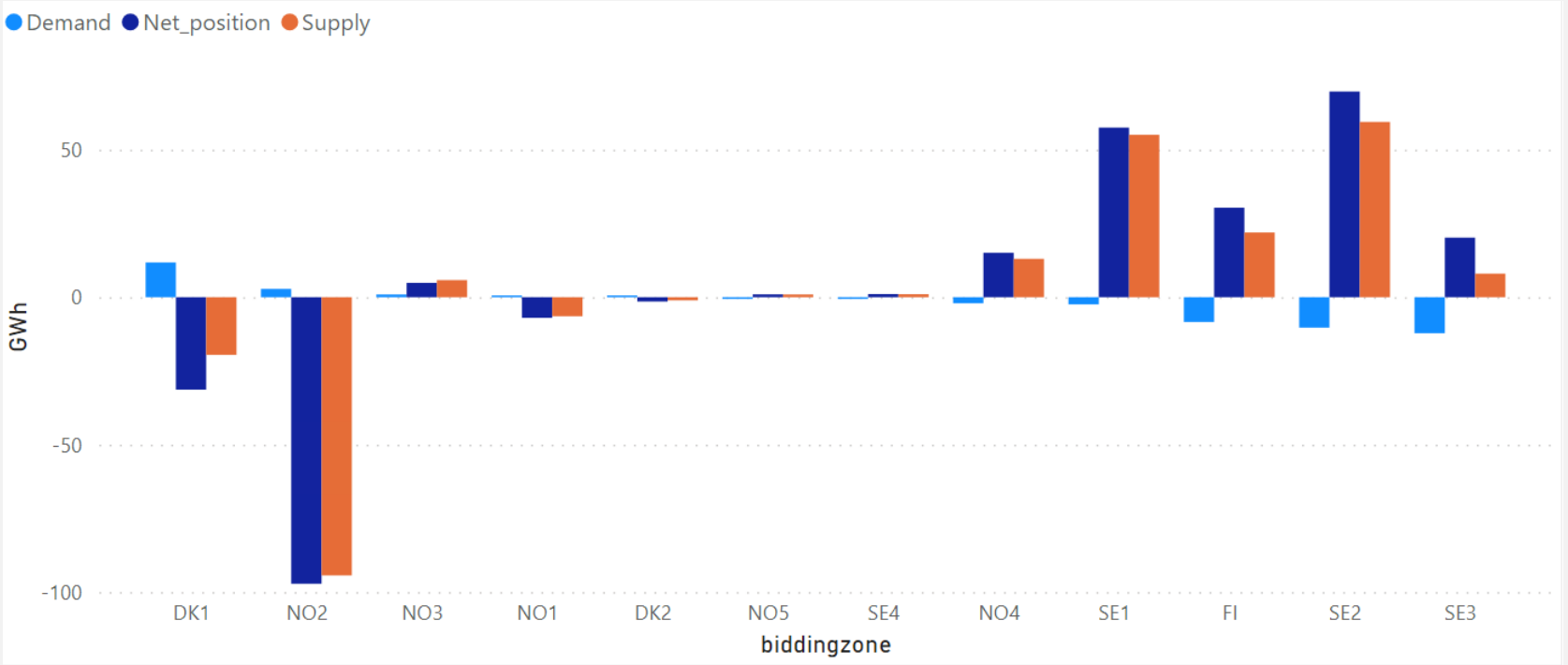

Figure: Demand and supply volumes difference (FB-NTC) and the corresponding net position change

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Prices in Period 2 (23.3. - 07.4)

- In general, the average prices are very similar in FB and NTC for all Nordic bidding zones.
  - The average prices vary between 43-56 €/MWh in NTC and between 46-55 €/MWh in FB
  - 3 €/MWh decrease in DK1, 1 €/MWh decrease in DK2, NO2 & NO5, while the average price in NO3 does not change at all
  - The average prices in the rest of the BZs increase, especially in Finland and Sweden
- For many BZs, the maximum price difference is unchanged or very small, e.g., DK, FI, Sweden, NO1, NO2 & NO5.
  - In Norway, NO3's maximum price decreases a lot, while the maximum price in NO4 increases.
- Import to the Nordics (negative net position) for some hours in the end of this period, prices are at a relatively low level

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	-10	175	175	49	52	-3
DK2	-7	-10	175	175	52	53	-1
FI	-5	-10	250	250	49	46	3
NO1	15	-10	160	160	51	50	1
NO2	-4	-10	160	160	49	50	-1
NO3	27	22	151	172	52	52	0
NO4	17	22	136	114	48	45	2
NO5	20	38	159	160	55	56	-1
SE1	-5	-10	172	172	46	43	3
SE2	-6	-10	171	172	46	43	3
SE3	-6	-10	171	172	46	43	3
SE4	-7	-10	173	172	47	45	2

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

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Constraining CNECs in FB
Period 2 (23.3. - 07.4)

- The most constraining CNECs are two CNECs representing the Sauda transformers in NO2, with shadow prices between 4000-9000 €/MWh.
  - As it was explained in previous presentations, these CNECS are often constraining when the Nordics are importing power from the continent.
- Except Sauda, the CNECs with the highest shadow prices are mainly HVDCs, typically CCR-borders to the continent.
  - This includes the Finnish CNEC related to export to Estonia
- Else, internal CNECs in Sweden, the Finnish PTC between SE1 and FI, and an internal Norwegian CNEC are on the list of 20+ most constraining CNECs

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
15351_334 95% Sauda T2 Transformator P + Sauda T3 Transformator P	65	135.58	8,812.57
14311_11 95% Sauda T2 Transformator P + Sauda T3 Transformator P	30	150.63	4,518.97
c4247b25510e44bf9b87f7d582fd5178	103	24.81	2,555.40
AC_Minimum_NO2_NK	161	15.16	2,440.36
AC_Minimum_NO2_ND	123	18.06	2,221.09
AC_Maximum_SE4_BC	82	24.06	1,972.66
AC_Minimum_SE4_BC	119	15.96	1,898.92
DK2_SV_IMP|BASECASE	155	12.03	1,865.29
d3d272e8ce2f4f48a184046ec01f3c86	118	15.80	1,864.41
e4d443df37ed4aa898ba019979c26a49	53	33.35	1,767.76
FI_PTC_FI_EL_EXPORT	152	11.12	1,689.54
AC_Maximum_DK2_KO|BASECASE	69	23.90	1,649.14
fbcac7cb618e486681f7fde3f5b735f7	112	14.20	1,590.17
AC_Maximum_NO2_ND	80	19.54	1,563.03
FI_PTC_RAC_SE1-FI	95	13.12	1,246.14
AC_Maximum_NO2_NK	42	27.54	1,156.77
13792_325 65% 420 Namsos-Ogndal + 30% 420 Namsos-Hofstad + 300 Tunnsjødal-Verdal	62	18.24	1,130.64
AC_Minimum_SE4_NB	61	17.83	1,087.64
AC_Minimum_NO2_SK	77	13.89	1,069.21
AC_Minimum_DK2_KO|BASECASE	94	11.20	1,052.39
DK2_DK_IMP|BASECASE	88	11.69	1,028.67
AC_Minimum_SE4_SP	60	16.15	968.75
AC_Minimum_SE3_KS	66	13.29	877.20
b1a47b3e95c24e13a3557b52d1090616	30	26.24	787.07
6f6ceaf31e644f30926b05963170fde8	45	16.31	733.98

Table: The 20 CNECs with highest aggregated shadow prices during the period

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SEW Impact on bidding zone level
Period 2 (23.3. - 07.4)

- The largest SEW changes can be seen for the Swedish BZs, with overall gains in SE1-SE3 and loss in SE4. The other BZs are only slightly impacted.

- The SEW gains are typically driven by producer surplusses. Consumers gain in Denmark & NO2.

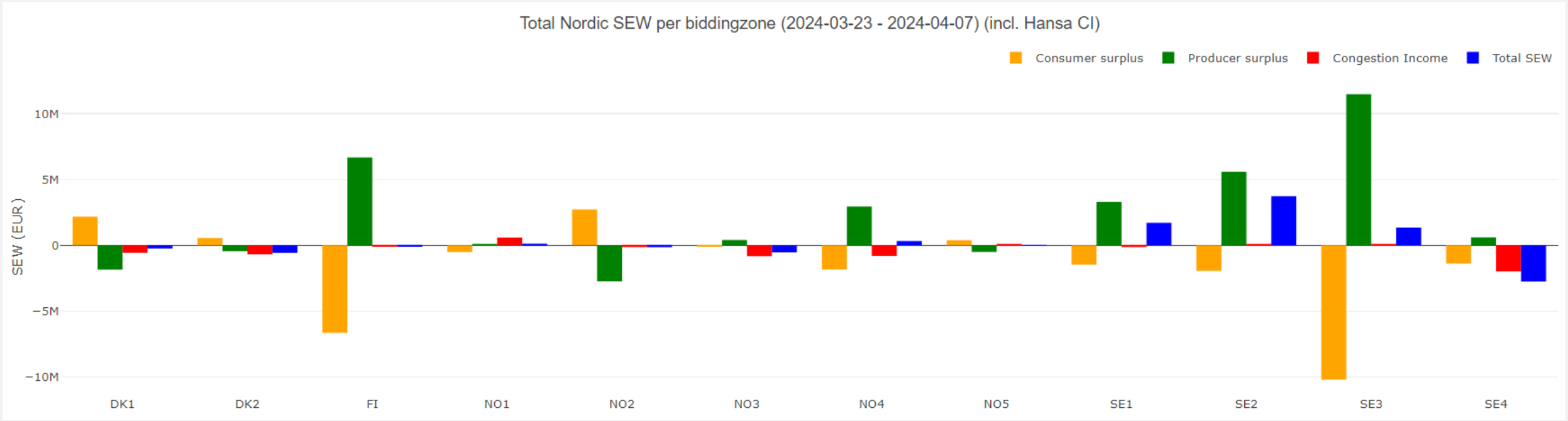

Figure: SEW change per stakeholder in CCR Nordic per BZ

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Specific hour walkthrough

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March 17 MTU 20, W11

- In NTC, a constraint and a high price difference between North and South, leading to two ”price regions”:
  - Northern Norway and Northern Sweden
  - All other Nordic and neighbouring bidding zones
- In FB, highest consumer surplus spike of the week (+600 k€ in the Nordics) and a positive gain for the entire DA market (+30 k€ in the SDAC area)

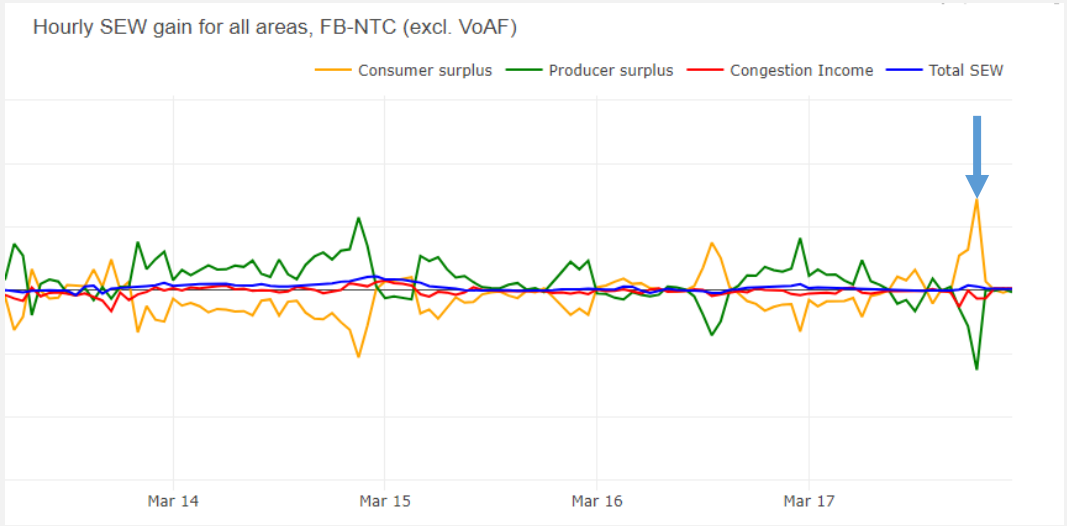

Figure: SEW, consumer and producer surplus and congestion income for all areas

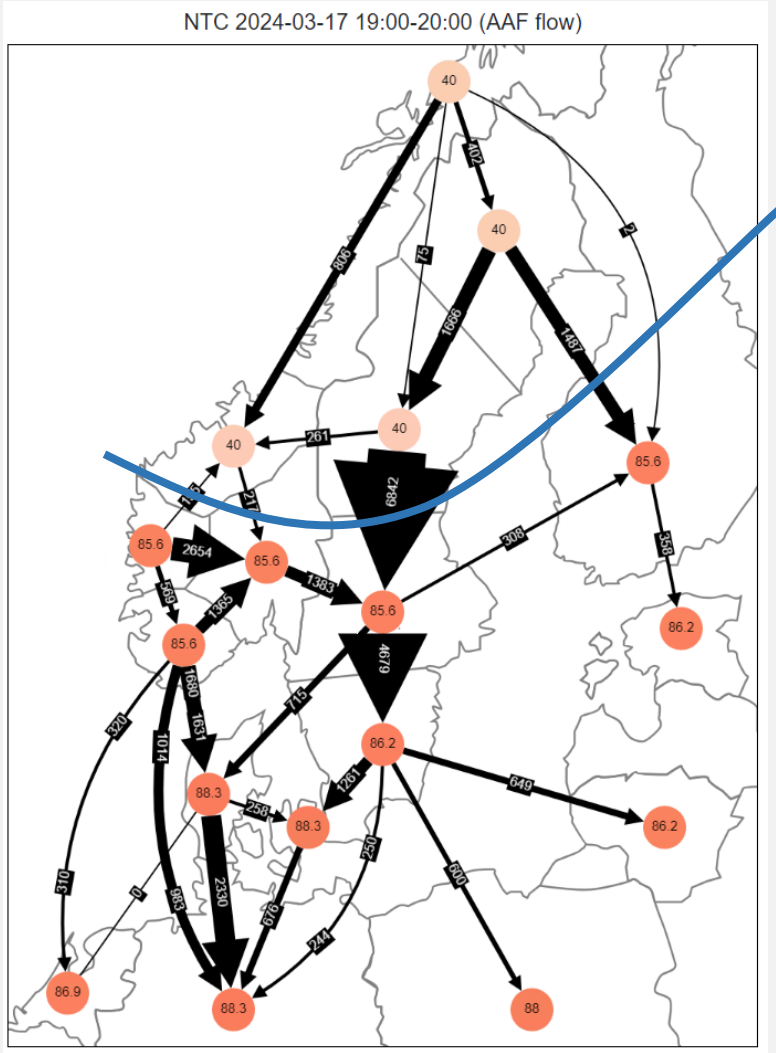

Figure: NTC flows and prices for 17 March, MTU 20

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March 17 MTU 20, W11

- In FB, considerable price decrease in Finland, Southern Norway and Sweden, and the Baltics → creation of a third mid-range “price region”
- The Nordic net position is positive and ca. 580 MWh/h higher in FB than NTC (i.e., higher exports to the continent)
- Higher net position in NO4, NO3, SE1, and SE2 and higher flows enabled from North to South (especially SE2-SE3 and onwards to SE4, NO1 and FI, and further out of the Nordic CCR).

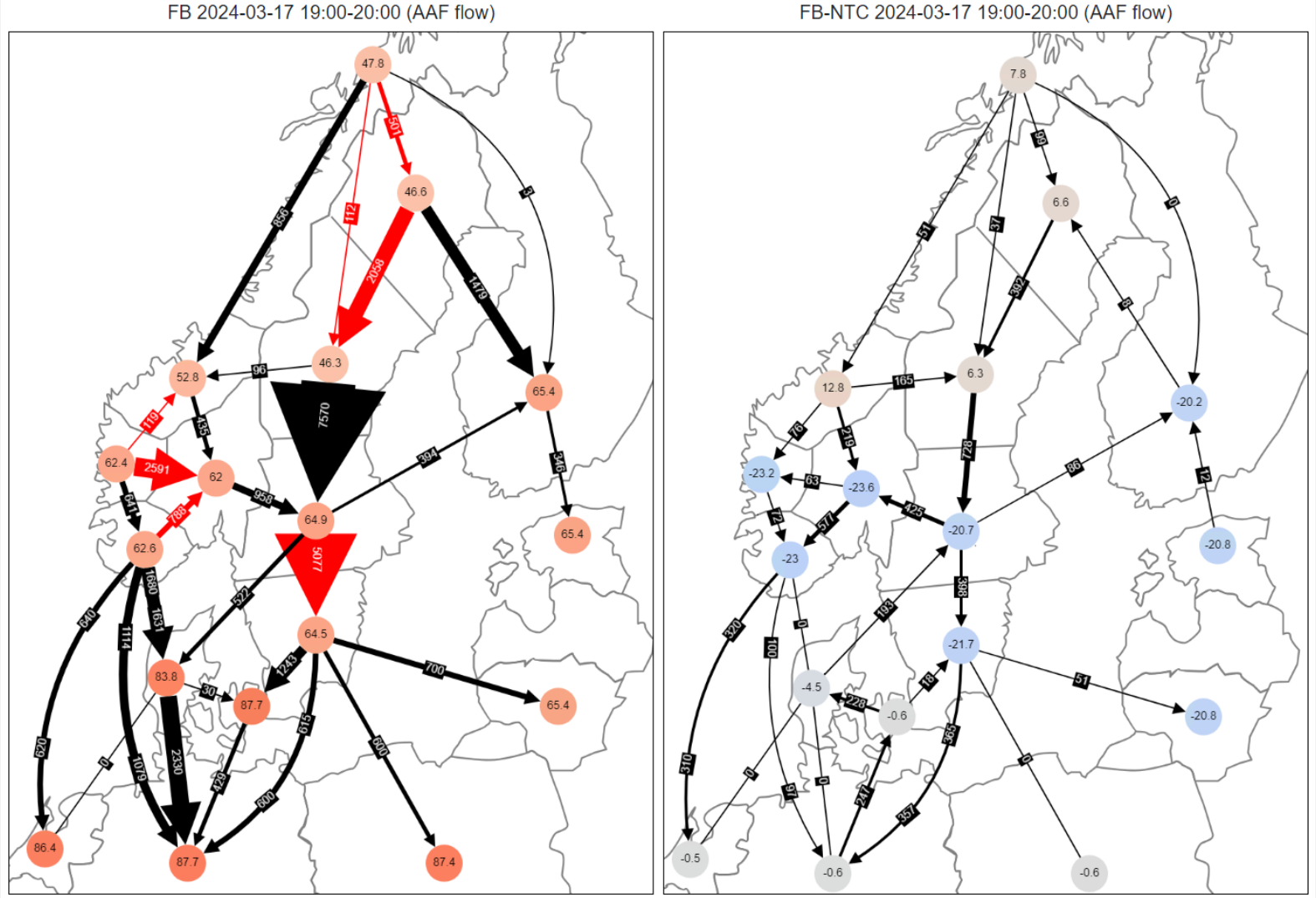

Figure: Left (FB) and right (FB-NTC) simulated flows and prices for 17 March, MTU 20

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Positive SEW spikes on 18-19 March, W12

- In the morning & evening hours on March 18-20, several spikes with a higher SEW gain can be observed.
- All spikes have in common that in NTC the hourly prices in the DK, South Sweden and the Baltics are significantly higher than the rest of the Nordic.
- FB managed to increase the flow to these areas and thereby lower the price and increase the consumer surplus and the total welfare.
- For all three spikes, the market/grid situation is similar. The evening spike on March 18th is therefore chosen as an example.

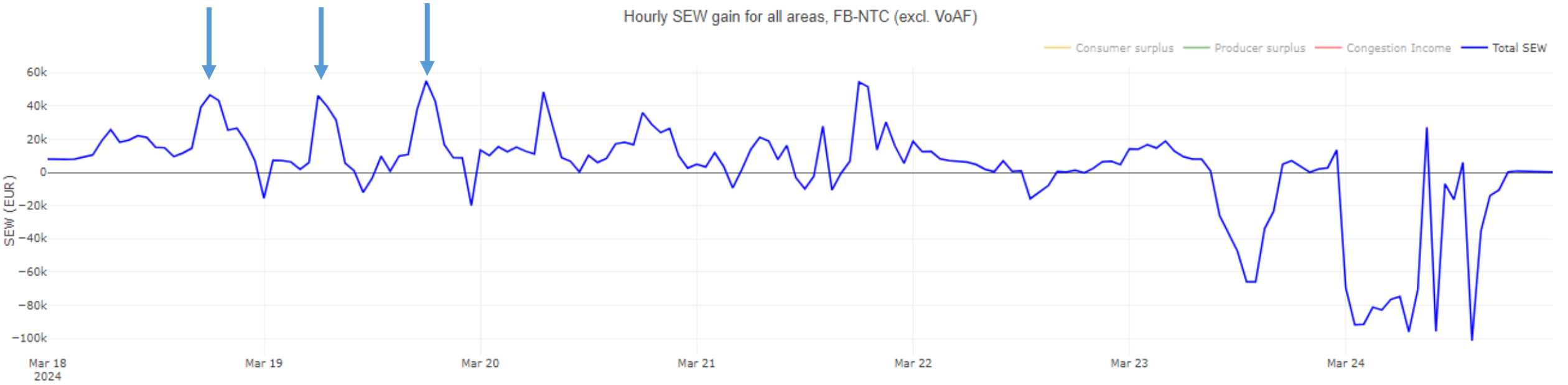

Figure: SEW gain for all areas in W12

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Positive SEW spikes on 18-19 March, W12
Example: 18.03, MTU 19

- In NTC, the prices in SE4, DK2 as well as the Baltics and the continent are very high with 130-145 €/MWh.
- In FB, the prices in DK2 & SE4 decrease with 61 €/MWh, the prices in the Baltics/continent decrease with 1-4 €/MWh, while the prices in the North, DK1 & FI increase with 2-7 €/MWh.
- An increased Nordic NP with 717 MWh.
- FB increases the flow from SE2 to SE3, from NO1 to SE3, from SE3 to DK1 & SE4 (940 MWh) as well as SE4 to DE & PL
- This means that FB finds a better solution by utilising the grid more efficiently, enabling more flow from the North to the South, causing a huge increase in consumer surplus (+320k€) in the total SDAC area.
- NO1-SE3 flow is West → East, enabling the increase in North→ South flow.

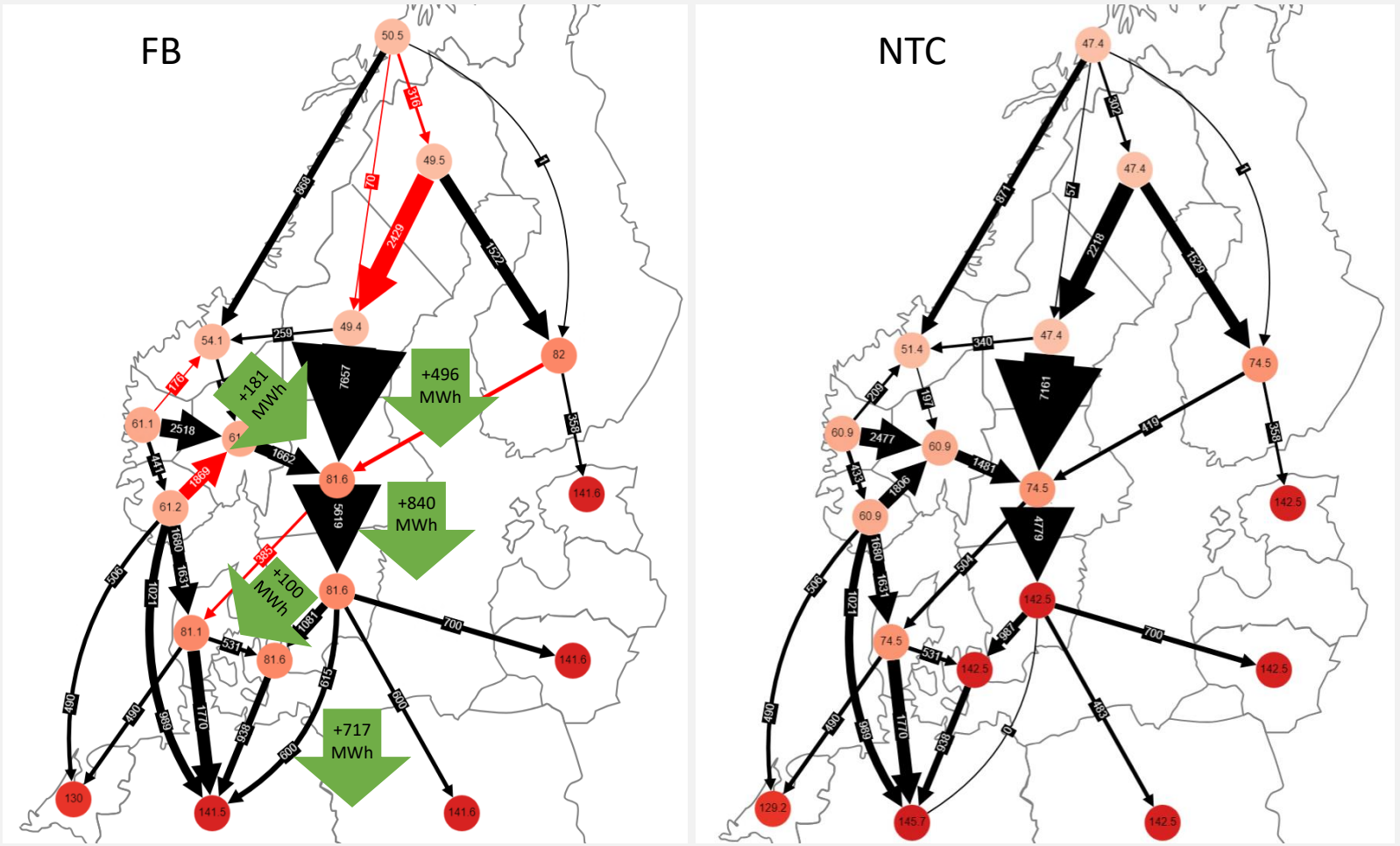

Figure: FB vs NTC simulated flows and prices for 18 March, MTU 19.

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Easter Holidays: March 29, MTU 8

- March 29th was the Good Friday in the Easter Holidays.
- Low consumption during the holidays, causing relatively low prices in DE, Denmark, FI, Sweden, Northern Norway & the Baltics.
- The Nordics are importing from Germany during these hours. The most constraining CNEC is Sauda in FB.
- FB increases the price by 10 €/MWh in NO3 and 2-4 €/MWh in the North, while decreasing the price in NO2 with 11 €/MWh and 1-5 €/MWh in Denmark & Southern Norway.
- A small circular flow on Fennoskan & non-intuitiv flow on Kontiskan relieve an internal Swedish CNEC allowing for more power to flow from North to South.
- Nordic SEW gain of 18 k€, as FB can utilise the grid more efficiently by increasing the flows from North to South towards NO1 & DK.

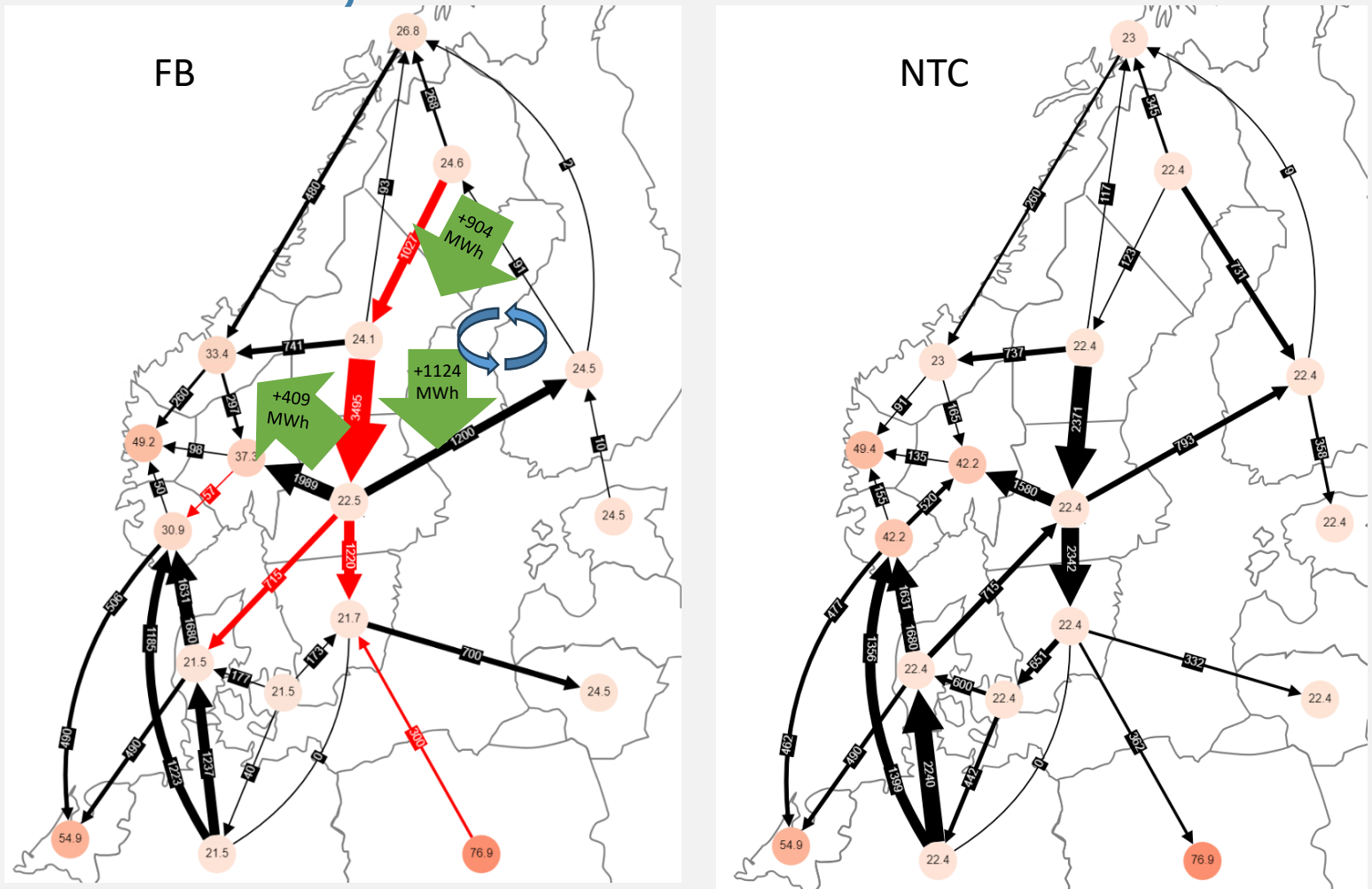

Figure: FB vs NTC simulated flows and prices for 18. March, MTU19.

Questions?

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Thank you!

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