



TSO reflection on DA market outcome

Nordic CCM post go-live stakeholder event
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Agenda

1. Introduction to key takeaways
2. Summary of day ahead-market
3. Non-intuitive flows
4. Flows before and after FB
5. FB domain adjustments

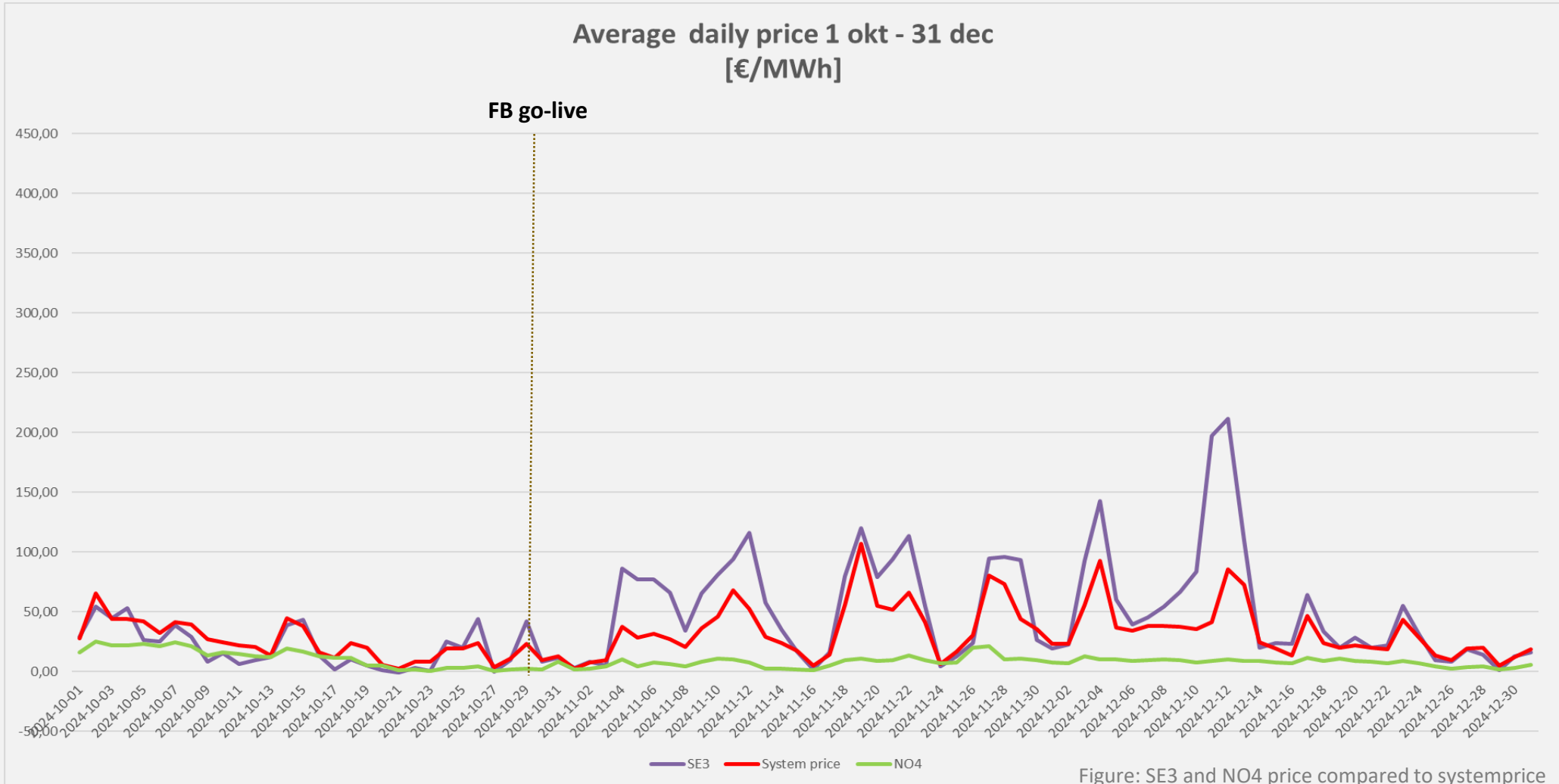


Key takeaways post FB go-live

- Low renewable production and higher consumption led to an increase in electricity prices after go-live; this was not a result of the Nordics introducing flow-based.
- The amount of non-intuitive flows aligns with the EPR results.
- Operation has been good and secure
 - Good frequency quality
 - No backup domains
 - More capacity to the DA market
- Flow-based has increased capacity and moved it closer to the operational boundary.
 - A calibration of the FB domain boundaries is expected in the coming period due to larger FRMs and reserved AAC.
 - Flow-based will continue to be adjusted and improved as it is an ongoing process aimed at finding the right balance.



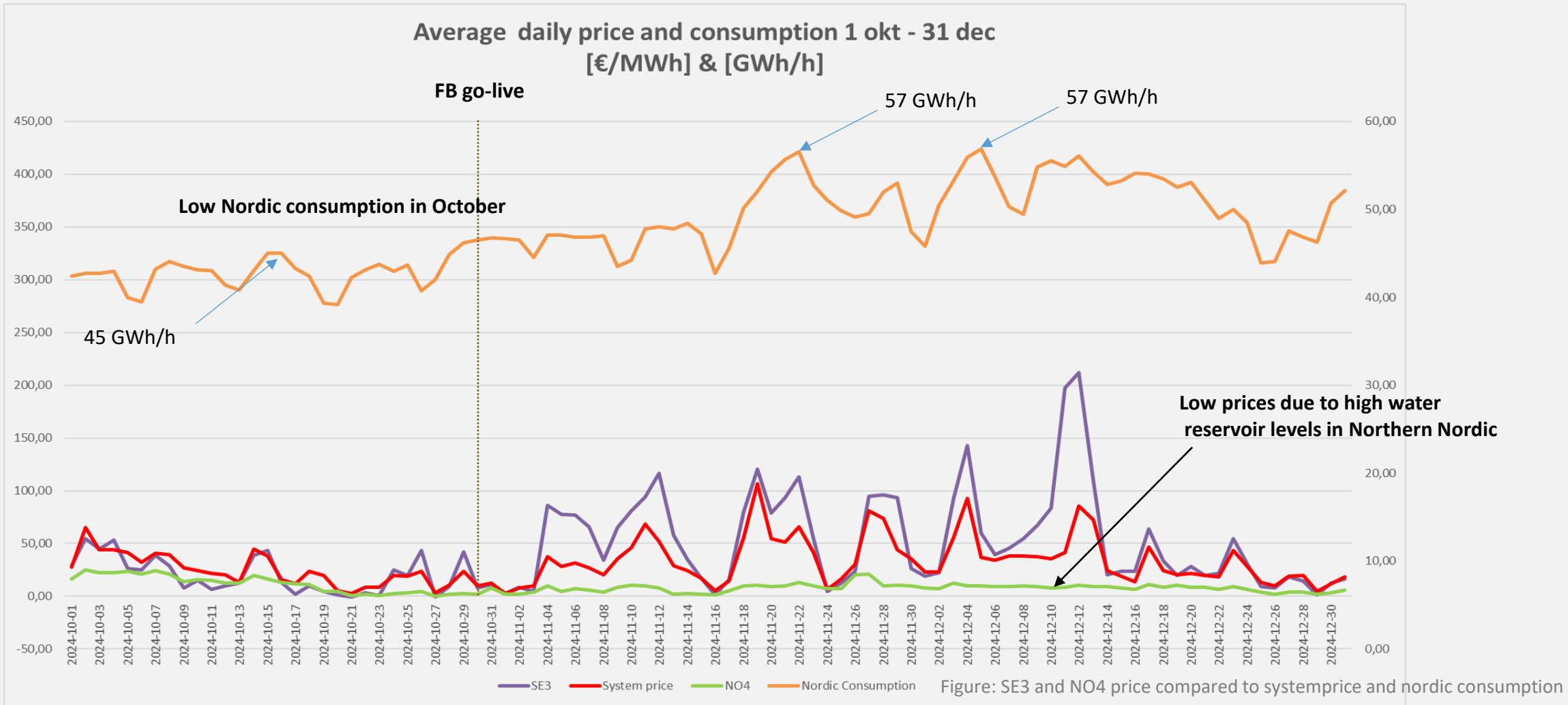
Day-ahead prices before and after FB go-live



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Day-ahead prices before and after FB go-live



Day-ahead prices before and after FB go-live

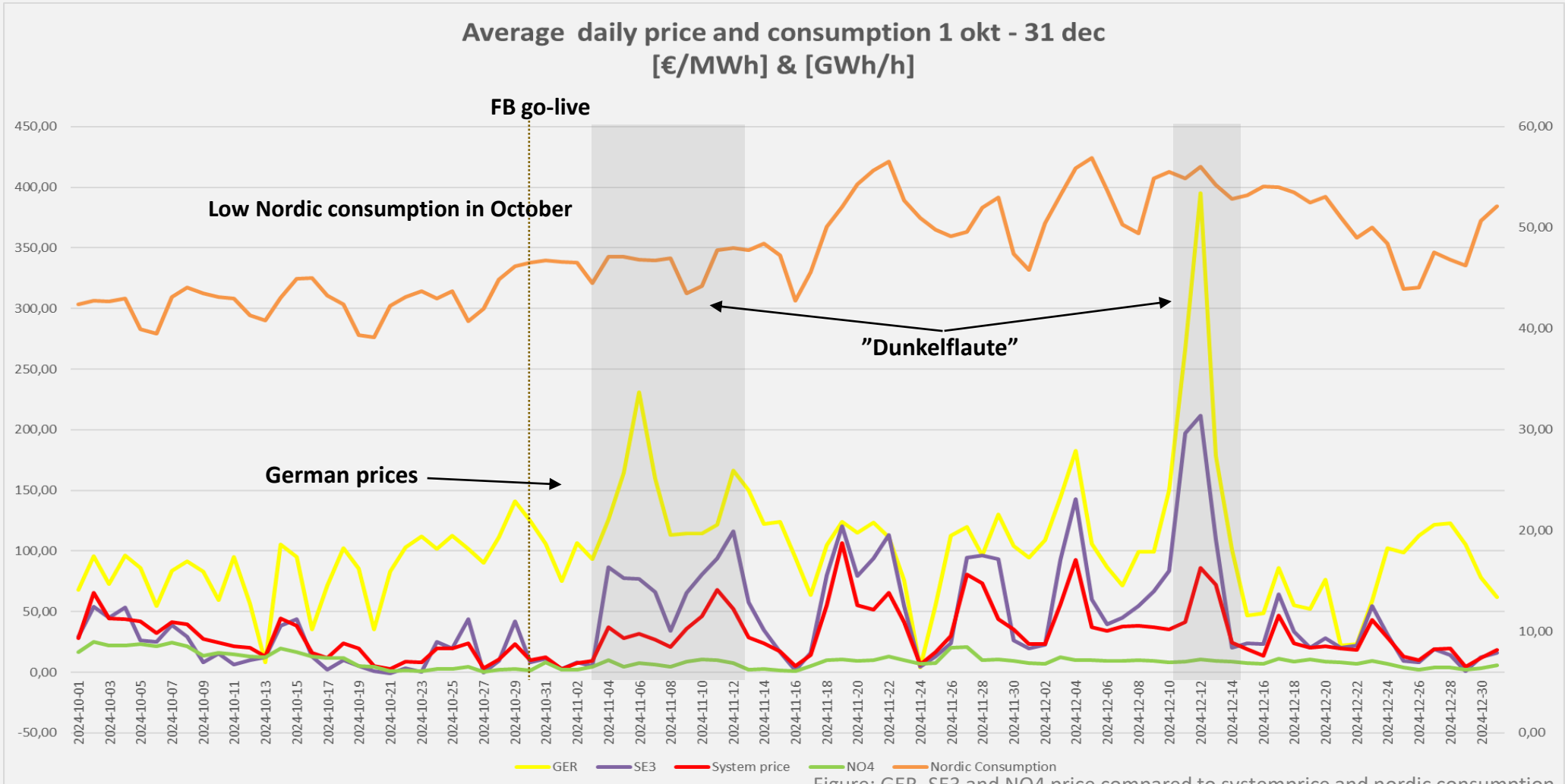


Figure: GER, SE3 and NO4 price compared to systemprice and nordic consumption



Non-intuitive flows

Non-intuitive flows occur from the market coupling and are flows that go from higher-priced to lower-price bidding zones.

- Allows more flow on another border, thereby leading to increased socioeconomic welfare
- Integrated part of the flow-based capacity calculation method and maximizing market benefits

Post flow-based go-live, the non-intuitive flows in the Nordics match the expected results, similar to those seen in EPR

More information can be found in the Annex at the end of this slide package

Note: data comparison in slide 7 – 9: First two months post go-live (Nov and Dec 2024) vs. winter periods (Nov-Feb) of the two years prior to go-live (2022-2023 and 2023-2024).

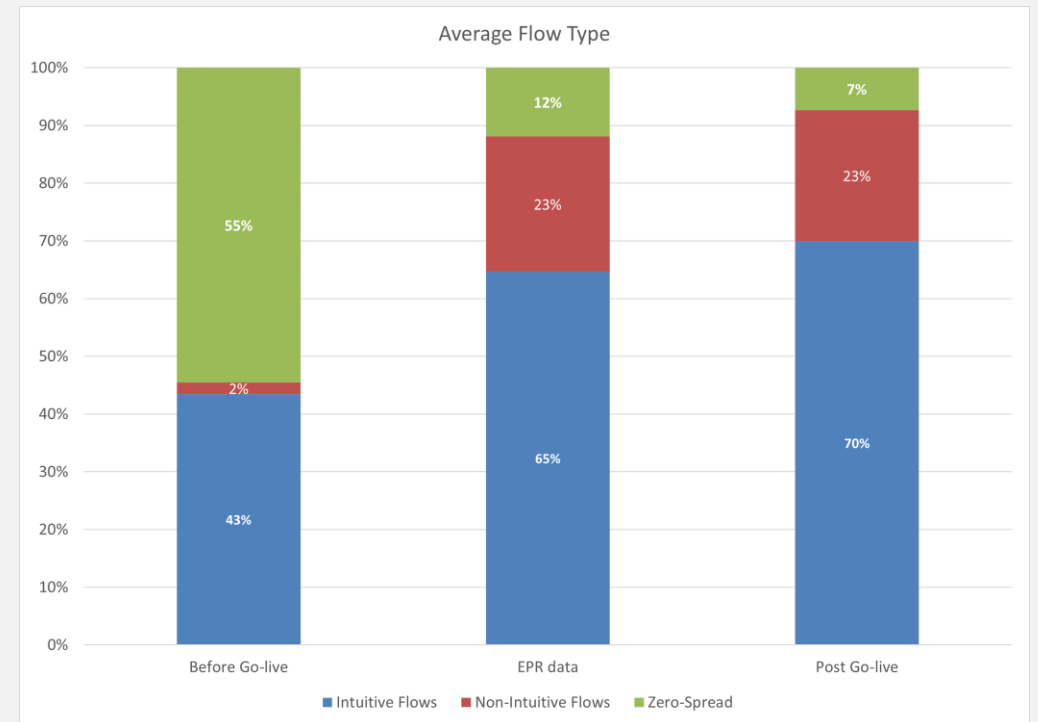
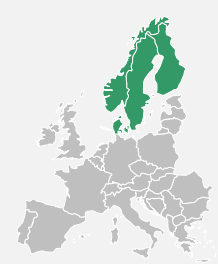


Figure: Average type of flow in the nordics before and after go-live and during EPR



Changes in flow

Flow-based enabled more flows through the Nordic system during the investigated (winter) periods.

North Cut:

Average southbound flow is decreased by 9% while the average northbound flow is increased.

Central Cut:

Average flow is increased by 22%
Maximum flow increased by 9% 7.994 → 8.692 MWh

South Cut:

Average flow is increased by 22%
Maximum flow increased by 7% 5.336 → 5.694 MWh

South Norway:

Average flow is increased by 173%
Maximum flow increased by 23% 2.565 → 3.156 MWh

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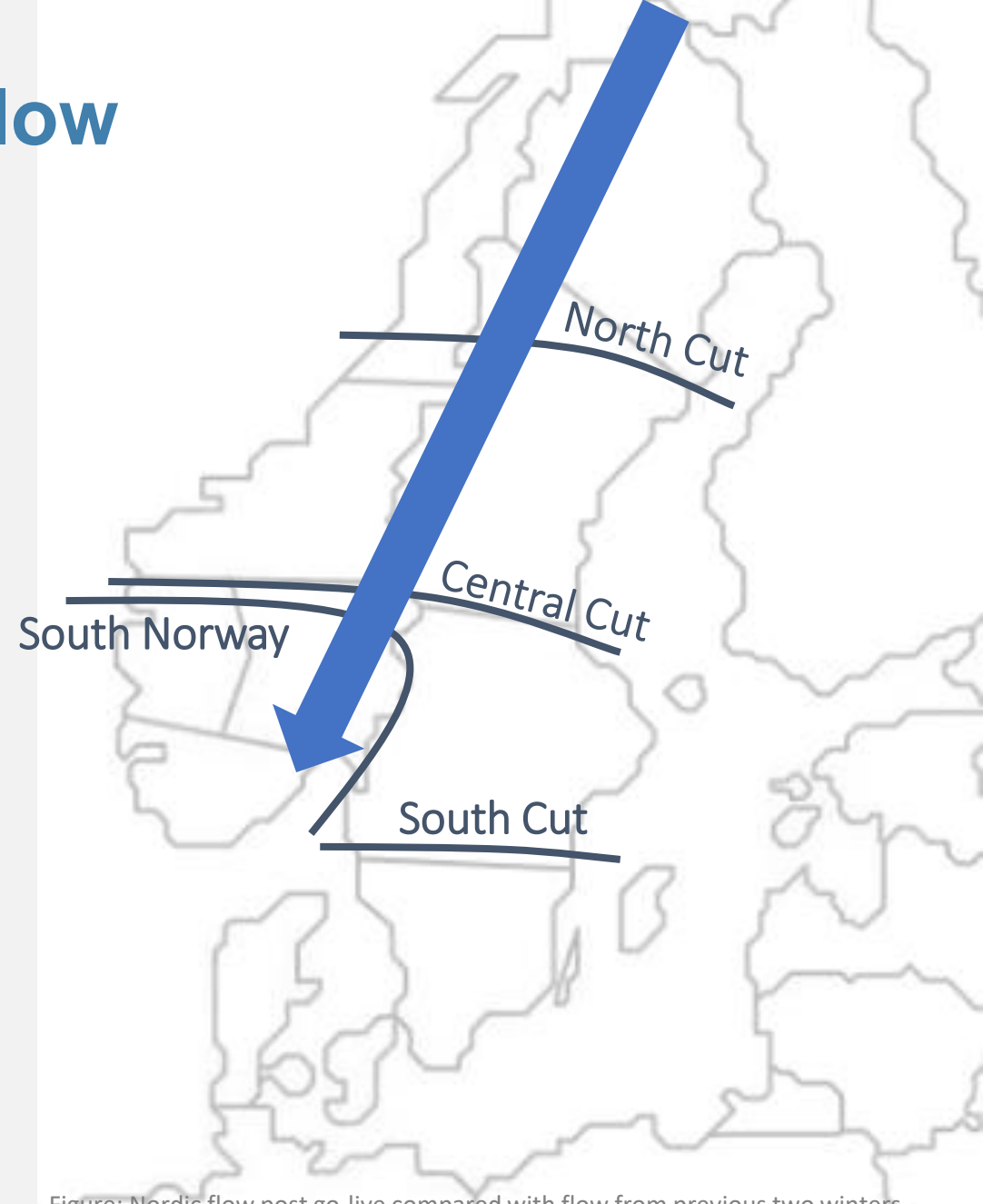


Figure: Nordic flow post go-live compared with flow from previous two winters.



Line Set vs. Flow-based

Before Flow-based a so-called Line Set between SE3 and NO1+DK1 limited the flow to maintain grid security. After Flow-based went live, these Line Sets were removed, and flow-based capacity calculation took over the responsibility of maintaining grid security.

Maximum flow increased by 60% 1.713 → 2.744 MWh

Post go-live the Line Set flow has been above the previous threshold (1.713 MWh) 499 times (~33%) during the first two months of Flow-based

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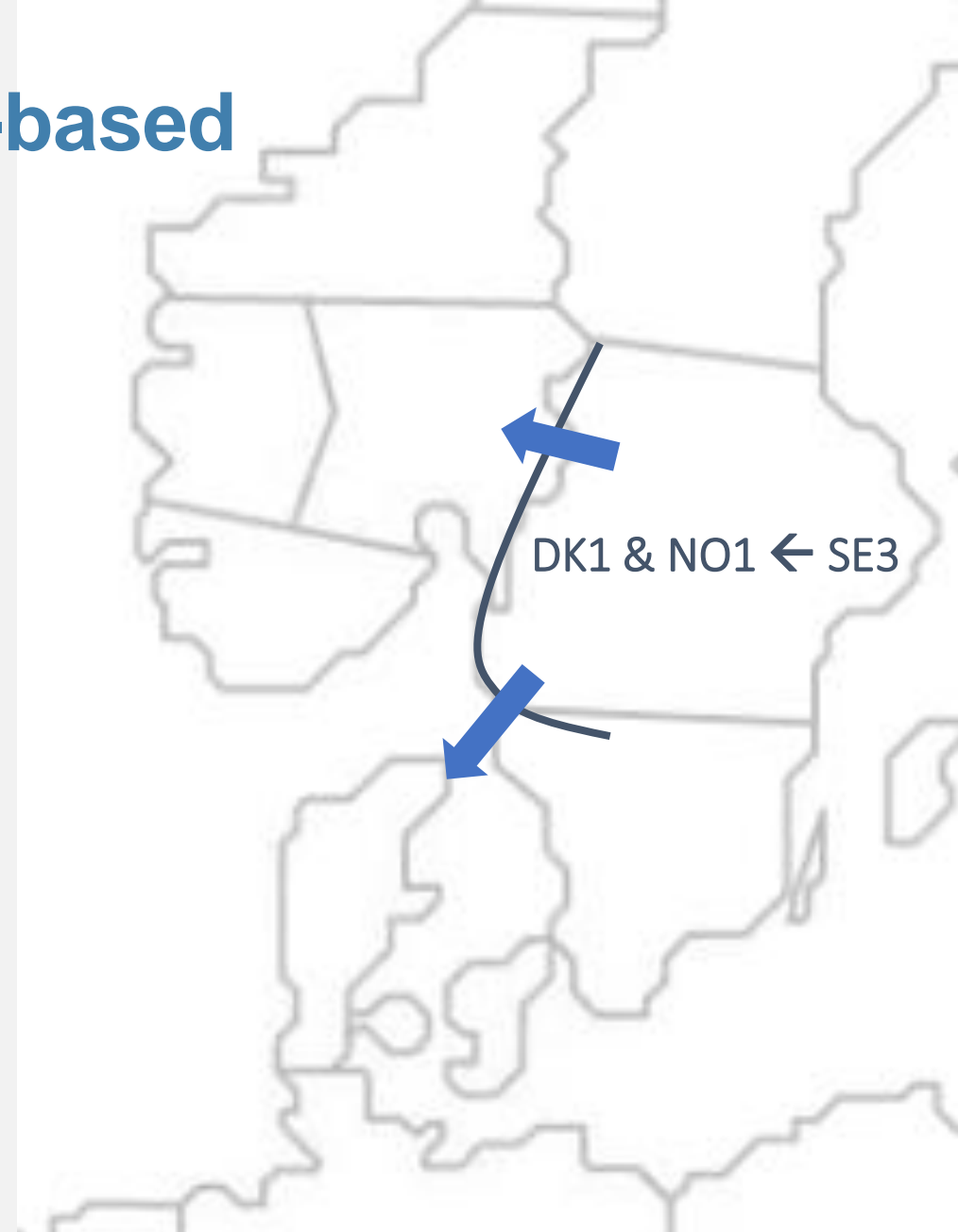


Figure: SE3 Line Set flow post go-live compared with flow from previous two winters.



Fenno-skan in Flow-based

- After Flow-based go-live, the flow-based capacity calculation allowed more East-West flow from Finland to SE3
- In 2024, before go-live the highest flow from FI to SE3 was 1.000 MW and it was reached for 11 hours. After go-live, maximum flow 1.200 MW have been reached for 154 hours.
- After the implementation of flow-based, significant number of non-intuitive flows have been observed, totaling 22% of hours during the 2024.

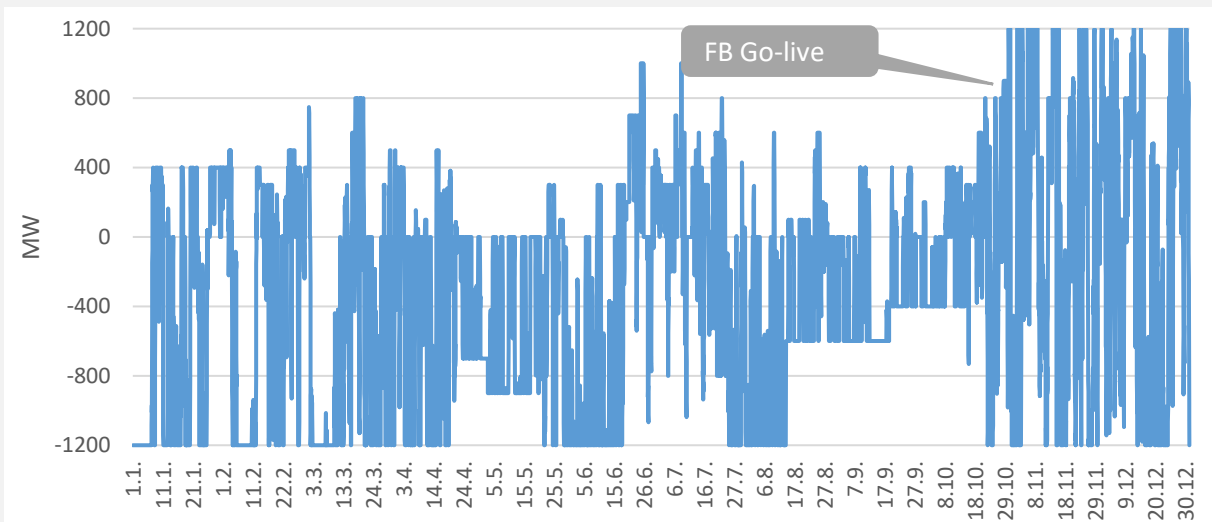


Figure: Physical flow on Fenno-skan during 2024 in the direction of FI->SE3. Higher utilization seen after FB go-live



Figure: Fenno-skan interconnector is a combination of HVDC lines between FI and SE3.



Kilanda maintenance before and after FB go-live

Similar maintenance on Kilanda substation took place right before and after FB go-live. Due to the first maintenance NTC-capacities were limited on several borders to SE3.

- Before FB go-live the NTC capacity during the maintenance
 - SE2->SE3 5.000-5.600 MW
 - SE3->SE4 3.600-3.700 MW
- After FB go-live the maximum of FB flow during the maintenance
 - SE2->SE3 7.567 MW
 - SE3->SE4 4.894 MW

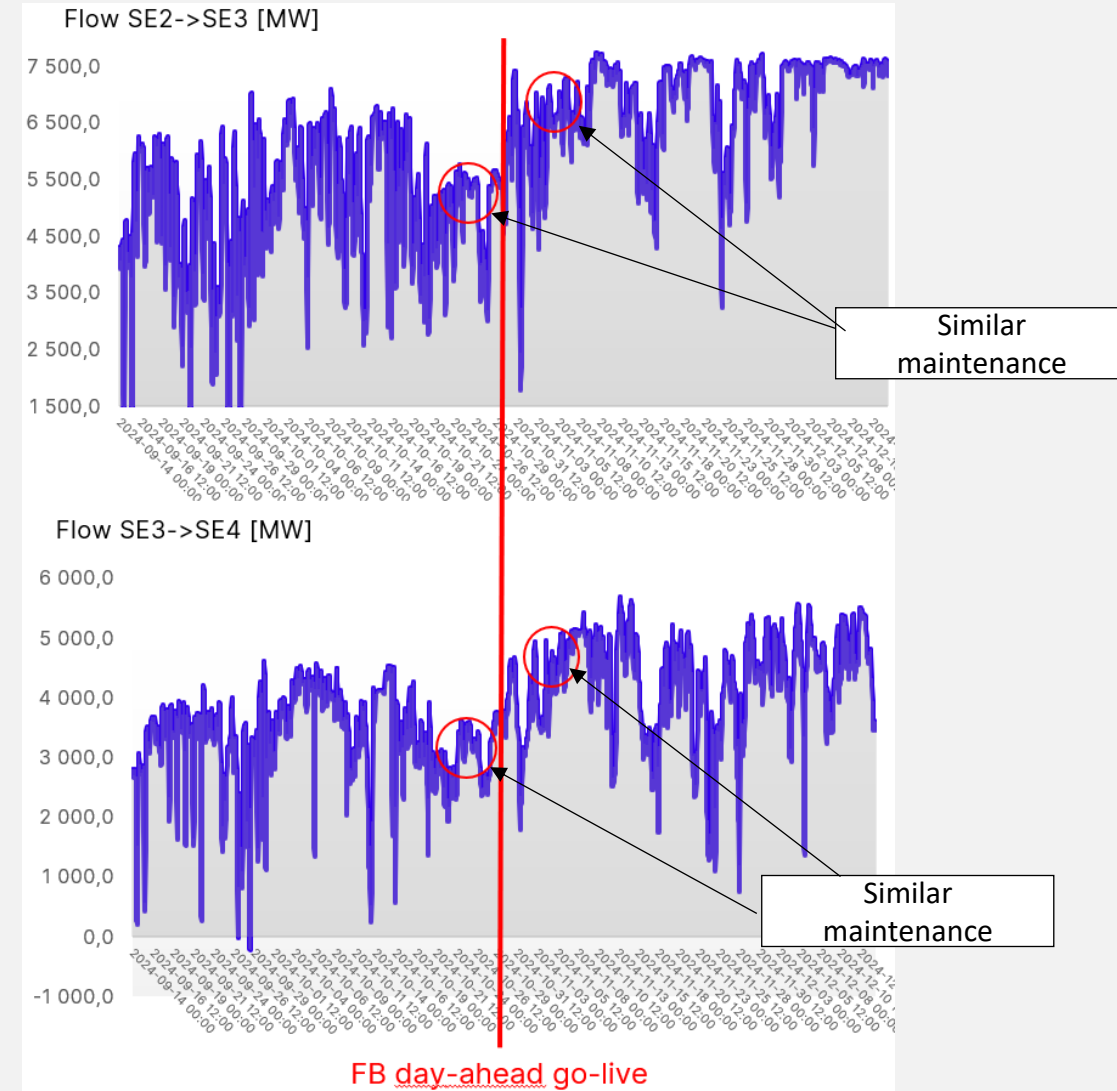


Figure: Flow on SE2->SE3 and SE3->SE4 borders before and after FB go-live



Better utilization of the grid

- But calibration of the boundaries is necessary

Flow-based is an iterative process that requires continuous improvements and adjustments to inputs.

- Calibration of the input variables
 - FRM
- Introduction of new needs
 - Balancing reserves (AAC)
 - Remedial actions (FRA).
- Adding and removing CNECs
- Increasing the quality on model inputs
 - Wind, solar, consumption forecast
 - Common grid model alignment (CGMA)
- And more...

The introduction of new changes must, of course, follow the methodology.

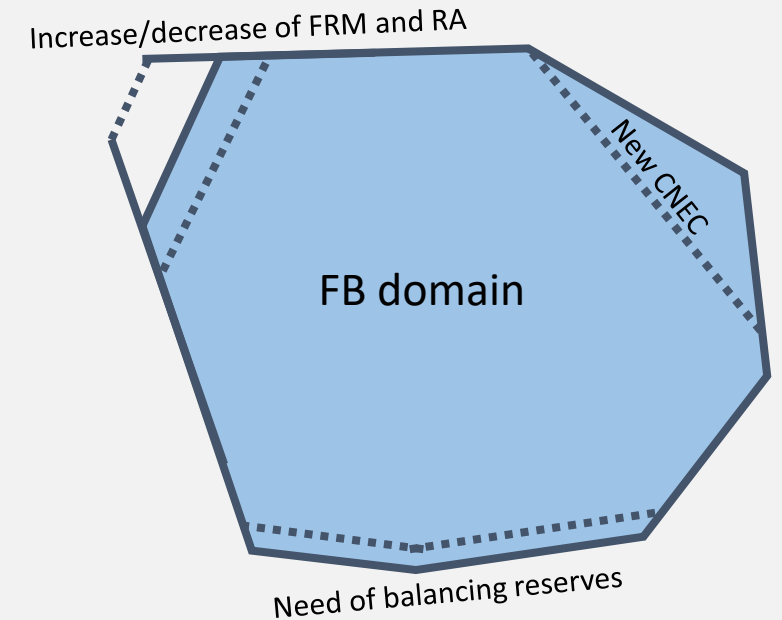


Figure: Depiction of FB domain and possible adjustments



Annex



Non-intuitive flows SE1 and SE2

- Flow direction SE1->SE2 as usual but the price for SE1 is higher than SE2
- Common during days where large transmission from north to south is needed, especially at times with low wind and high prices on the continent, Denmark and south of Sweden.
- Most limiting CNEC in Sweden, SE2
Higher PTDF for SE2 (and NO3, NO4) than SE1;
- Production in SE1 is less constraining than in SE2 for this CNEC → More expensive bids are activated in SE1 than in SE2
- Largest welfare for the market with large flow from North of the Nordic CCR southwards; optimization maximizes the flow on SE2-SE3 border
- Same pattern as seen for a large extent of the external parallel run

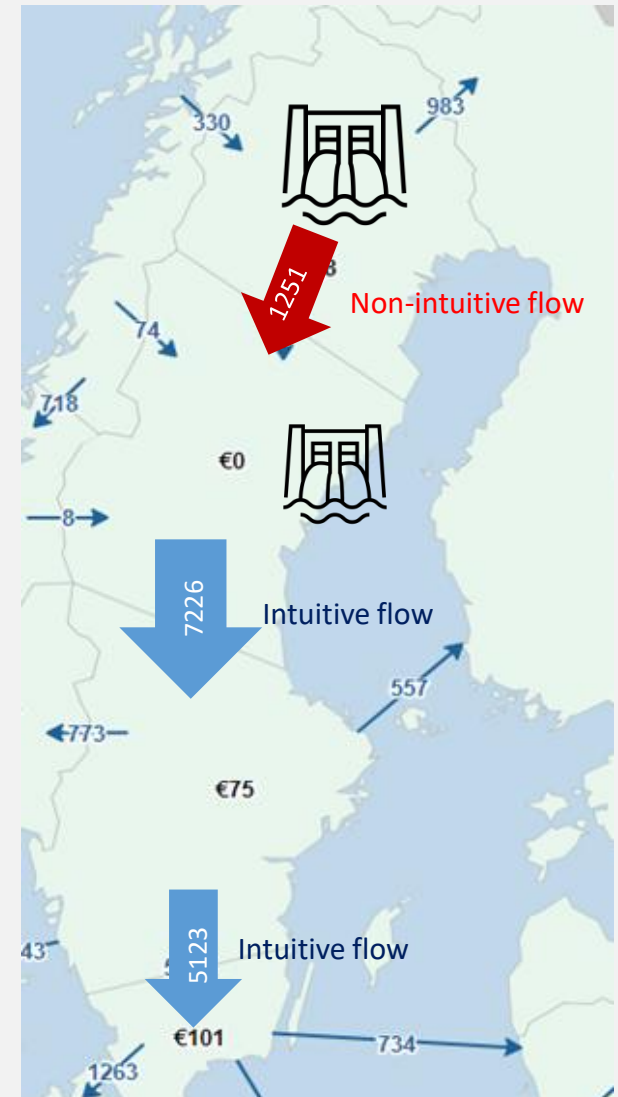


Figure: Non-intuitive flows on SE1-SE2



Specific hour with Non-intuitive flow between SE3-NO1

- Hour 17-18 on the 12th of November 2024
- Cold weather in the Nordic CCR and high prices on the continent results in high prices in SE3 and SE4
- Outage in western part of SE3 limits the transmission capacity within SE3
- Two Swedish CNECs limits the market in the Nordic
- The non-intuitive flow between SE3 and NO1 occurs to increase the flow on SE2-SE3 border. If there would have been an import from NO1 to SE3 a much lower flow would have been possible on the SE2-SE3 border.



*The marked position of the CNECs does not represent the exact geographic location

Figure: SE3 flow during hour 17-18 on 12/11-2024

Name of CNEC	Market flow	Capacity to the market	Shadowprice	ptdf_DK2	ptdf_FI	ptdf_NO1	ptdf_NO2	ptdf_NO3	ptdf_NO4	ptdf_NO5	ptdf_SE1	ptdf_SE2	ptdf_SE3	ptdf_SE4
CNEC 1	1155	1155	687.4	-0.0001	0.1417	0.13864	0.13504	0.19355	0.17272	0.14474	0.14181	0.17666	0.01934	-0.00676
CNEC 2	855	855	286.9	0.00042	0.2523	0.491	0.49855	0.37117	0.29138	0.47821	0.25269	0.26187	0.19506	0.02774