

Nordic CCM – External
Parallel Run Market Report
for Week 10

2022/05/6

Nordic CCM External Parallel Run

Abstract

This market report presents the comparison of the simulated market results between the current capacity calculation method (i.e. the NTC methodology) and the flow-based (FB) capacity calculation method for the day-ahead market timeframe.

Chapter 1 introduces the work on developing and implementing a common Nordic Capacity Calculation Methodology where the NTC methodology is replaced by the FB methodology.

Chapter 2 addresses the issue of data quality and the simplifications of the simulations as disclaimers that could potentially influence the simulation results.

Chapter 3 presents data reporting and TSO remarks regarding the FB domains.

Chapter 4 elaborates on the overall comparison of FB vs. NTC for the simulated period of week 12.

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Abbreviations

CCC – Coordinated Capacity Calculator

CCR – Capacity Calculation Region

CGM – Common Grid Model

CNEC – Critical Network Element with Contingency

EDD – Energy Delivery Day

ENDK – Energinet

FAV – Final Adjustment Value

FB – Flow-based

FG – Fingrid

Fmax – operational limits of the critical network elements

IGM – Individual Grid Model

IPR – Internal Parallel Run

IVA – Individual Validation Adjustment

JAO – Joint Allocation Office

LHF – Last Hour Flow

MTU – Market Time Unit

MAS – Modeling Authority Set

NEMO – Nominated Electricity Market Operator

NP – Net Position

NTC – Net Transfer Capacity

PTC – Power Transfer Corridor

PTDF – Power Transfer Distribution Factor

RAM – Remaining Available Margin

SA WG – Simulation & Analysis Working Group

SDAC - Single Day-Ahead Coupling

SEW – Socio-economic Welfare

SF – Simulation Facility

SN – Statnett

Svk – Svenska kraftnät

VBZ – Virtual bidding zone

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1 Introduction

The four Nordic TSOs work together in order to develop and implement a common Nordic Capacity Calculation Methodology (CCM). This common methodology is in line with the Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management (CACM). The flow-based (FB) methodology is being implemented by the Nordic Regional Security Coordinator (NRSC). Before going live with the new capacity calculation methodology for the day-ahead market, a few phases are foreseen along the implementation timeline, such as the internal and external parallel runs.

During the parallel runs the market outcome based on the NTC methodology is compared with a market simulation result using the FB methodology. The comparison is presented in a market report. The analysis presented in the market reports will focus on the socio-economic welfare (SEW) outcome of the Nordic power systems.

Capacity allocation in the Nordic CCM parallel runs

The new capacity calculation methodology (i.e. FB) differs in many ways from today's NTC methodology. However, both aim to maximize the socio-economic welfare, in terms of capacity allocation. Both in the NTC and the FB methodology, the network capacities are sent to the NEMOs. The NEMOs utilize Euphemia to maximize the socio-economic benefits of the market, while respecting the network constraints of the TSOs (being NTC or FB), which results in traded volumes and prices.

Where each TSO determines its NTC capacities, in the FB methodology it is a much more coordinated, formalized, and automated process. The input datasets provided by the TSO to the NRSC - that acts as a coordinated capacity calculator (CCC) - include critical network elements with associated contingencies (CNECs), power transfer corridors (PTCs) and the operational limits for these elements (Fmax). Those are sent for each market time unit (MTU), for each day, and are used by the CCC to calculate - based on an hourly common grid model (CGM) - the Remaining Available Margin (RAM) and Power Transfer Distribution Factors (PTDFs): the FB parameters that are sent to the NEMOs, after the TSOs have validated them.

When TSOs today calculate NTC capacities, they do this individually by looking at mostly its own grid constraints and critical network elements and by translating these into a capacity on the borders, subject to the market allocation. With FB the TSOs provide the critical network elements as is to the market allocation / optimization - being some kind of simplified grid model - instead of pre-calculating resulting capacities on the border in the form of a MW-value.

When the TSOs give capacity in the form of NTC values, all border capacities are available at the same time to the market for allocation, at least conceptually. One of the advantages with FB is that each TSO

does not have to make a distribution of the capacity between different bidding zone borders before the capacity is sent to the NEMOs. Instead, the maximum available capacity is given to the NEMOs and the market coupling algorithm. The capacity is then allocated to the energy transactions that provide the most socio-economic welfare, when prices and flows are calculated by the NEMOs.

Social economic welfare

Socio-economic Welfare (SEW) is calculated as the sum of Consumer surplus, Producer surplus and distributed Congestion income for each hour. SEW is used as the main optimization parameter and the Euphemia coupling algorithm tries to maximize the overall SEW gain among all bidding zones participating in Single Day -Ahead Coupling (SDAC).

Consumer and producer surplus are calculated by Euphemia and used as is without any further calculations.

Congestion incomes are calculated per border, based on the flows and price differences. Flows are calculated based on border PTDF's and the net positions and prices are calculated by Euphemia. Congestion incomes per border are then summed and to account for non-intuitive flows. The total is distributed among all borders based on the Congestion Income Distribution methodology¹.

Bidding zone prices

Prices for each bidding zone are calculated by Euphemia.

Net positions

Net positions of actual bidding zones are calculated by Euphemia and used as is. Euphemia does not calculate net positions for virtual bidding zones (which are used for modelling HVDC links) but it calculates the flows on these links. Net positions of virtual bidding zones are calculated based on these flows.

Border flow calculation

Border flows are calculated by summing the products of each bidding zone PTDFs and corresponding bidding zone net positions to the F_0 -flow. The F_0 -flow is defined as the reference flow on a certain CNEC when the NP is 0.

Flow for FB is calculated using the border CNEC PTDF's and net positions from FB market coupling and flow for NTC is calculated using the same border CNEC PTDF's but taking the net positions from

¹ [ACER Decision 07-2017 on CIDM.pdf \(europa.eu\)](#)

NTC market coupling instead. The results from these calculations are not the same as scheduled exchanges which are currently used as commercial border flows.

The flows presented here are the physical flows, calculated by:

$$\mathbf{Physical\ flow}_k = F_{0,k} + \sum \mathbf{PTDF}_k \times \mathbf{NP}$$

Where $F_{0,k}$ and $PTDF_k$ are the F_0 and PTDF parameters corresponding to the CNEC on Border k.

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Business process during parallel run

During the internal parallel run, the Nordic CCM project's Simulation and Analysis working group (SA WG) took the responsibilities of running the market simulations. In the external parallel run the market simulations are performed by the Nordic Regional Security Coordinator (NRSC) together with the NEMOs. The daily process, illustrated in Figure I, starts with each TSO creating and sending their IGMs, CNEs and CNECs (input data) to the NRSC. The NRSC merges the IGMs to one CGM and performs FB calculations based on the TSOs' input data. The NRSC, together with the NEMOs, then run FB simulations on a validated (by the TSO operators) FB domain (RAM and PTDF) in Simulation Facility. The FB domains are accumulated for a one-week period before running the simulations.

The NRSC then provide the SA WG with the market results from Simulation Facility for analysis. The market algorithm Euphemia provide prices, net positions, consumer and producer surplus for all bidding zones. The SEW is calculated by summing up consumer surplus, producer surplus and congestion income. The resulting SEW for the FB outcome is then compared to the NTC outcome, hour-by-hour, to evaluate the impact of the new capacity calculation and allocation.

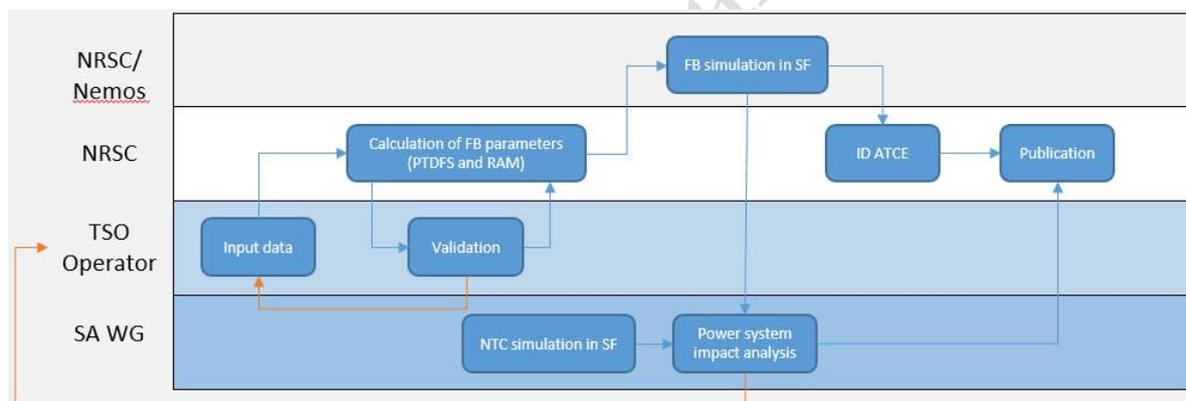


Figure I: The high-level business process illustrating the roles, responsibilities and interactions among the Nordic RSC, TSO operators and the Nordic CCM SA WG during the external parallel run

2 Disclaimers

Disclaimers for data publication at JAO during internal parallel run

Data quality

The capacity calculation tool and the data used for the capacity calculation is continuously being improved, and TSO operators are improving their processes by using the Domain validation tool in daily operations. The outcome of the FB calculations are considered valid for comparison with NTC even with some known disclaimers that are being continuously evaluated and improved by the TSOs.

Domain validation process

The TSO operators are in the 'learning-by-doing' phase in the parallel run process. The validation tool that is supporting the domain validation activities is still under active development.

SE1-FI border

The capacity calculation for FB calculates the wrong border capacity between SE1 -FI, 1390 MW in FB vs. 1520 MW in NTC.

SE4-DK2 border

Due to a problem with the PTC definition and the slack node in the model there was a discrepancy on the border between DK2 and SE4 where flowbased gave a too high capacity.

Disclaimers related to market analysis report (Nordic CCM)

The market analysis reporting is under development by the Nordic CCM project. Stakeholder inputs is gathered and improvements are being implemented. During the external parallel run weekly reports will be published along with supplementary data and in-depth additional documents.

The Nordic TSOs welcome comments and questions from the stakeholders. Please send an email to CCM@nordic-rsc.net.

Market results are calculated by Simulation Facility

The market coupling is calculated by Simulation Facility (SF) during the internal and external parallel runs. SF uses the same market coupling algorithm that is used for day-ahead market coupling. However, SF is a testing environment and therefore the availability of SF (e.g. impacted by content-wise and/or IT-wise changes in the SF) is not guaranteed. This may increase the necessary time to produce market analysis reports. Also, the simulation facility imposes a grace period, currently set to 2 weeks after the energy delivery date. The production of the market report will need to comply with the grace period.

NTC order books being used in the FB market simulations

The market simulations of the FB methodology use the NTC order books, due to the unavailable dedicated FB order books. This means that the bids (and also final market solution) of the FB calculations are based on the order books of the actual NTC-based electricity market.

Typically, a FB simulation results in a less-constrained power market and more production in areas with cheaper power production. This often means more hydro power production in the northern bidding zones in the FB simulations compared to the NTC simulations. The use of the NTC order books however, implies that a greater release of hydro power under FB is not reflected in the following order books and FB market simulations, potentially leading to a sustained greater production of “cheap” hydro power in FB compared to NTC.

If this effect is sustained over a longer period of time, and the cumulative difference in production is significant, this may lead to a biased cumulative SEW comparison between FB and NTC, benefitting the FB simulation with “cheaper bids” in relation to the underlying hydro reservoir situation.

Simulation set up in Simulation Facility - Last hour flow

The last hour flow is relevant for the ramping restrictions from one day to the next. When starting the SF simulations, as an input requirement, the market flows of the last hour of the previous day is needed from the SF as a starting point of simulating the first hour of the simulation batch. For consistency purposes, the last hour setting for Flow-based simulation as well as for the NTC simulations is set to zero. This is done because there are no historical data available in the production system of Euphemia for the Nordic Flow-based topology.

Additionally, when there is a (few) missing day(s) in the simulations, the LHF of FB and NTC are set to zero as default. Consequently, the simulated market results may not be strictly comparable to the market results from the production environment.

Simulation set up – Lineset ramping

A new FB topology had to be created in order to incorporate the previously missing South-West link and the newly formed bidding zone NO2A. NO2A was created in order to limit the total ramping on Norned and Nordlink. In the new topology, this is managed by introducing a lineset ramping – a ramping limitation for multiple line segments.

When performing the initial simulations with the new topology, an error occurred. The simulations failed applying both the individual line ramping and the lineset ramping. The reason why the simulations fails when applying both individual line ramping and lineset ramping is still under investigation. In the meantime, in order to produce any simulation results, the lineset ramping was removed from both FB and NTC. This means that the total ramping for Norned and Nordlink can exceed 900 MW as long as the individual ramping restrictions are respected.

Congestion income computation as post-processing of the market data

Market results require post-processing to create a readable format of the results and to calculate and share generated congestion incomes. Currently, congestion incomes are calculated by Nordic TSOs in accordance with the congestion income distribution methodology. Later this will be calculated by JAO with production-grade tools. FB and NTC congestion income methodologies are the same but the distribution of negative congestion incomes is different².

SEW comparison in the operational security perspective

Fair comparison between FB- and NTC-market results requires same level of operational security as a basis for the two methodologies. In other words, it is not fair to compare SEWs if FB respects the operational security and yields smaller SEW outcome, whereas NTC breaches the operational security and yields larger SEW outcome. Additionally, the remedial actions and the associated costs to solve the operational security issues in 'real-time' are not known to make a fair comparison.

Checks have been made comparing the NTC market outcome and the security domain. The TSOs recommend viewing the SEW comparison outcome both from a socio-economic and an operational security perspective.

² [Annex I - Congestion income distribution methodology](#)

3 Data reporting and TSO remarks

The following tables provides input to the quality of the submitted FB domains.

Below follows a description of what the numbers in the rows entails:

Invalid/missing IGMs (before subst.) - Number of IGMs that for any reason was labeled as invalid and/or number of IGMs that was missing at the initial data transfer from the TSOs

Substituted IGMs (MTUs*MAS) – Number of IGMs that was substituted before the capacity calculation.

Invalid/missing CGMs – Number of CGMs that for any reason was labeled as invalid and/or number of IGMs that was missing at the initial data transfer from the TSOs

FB domain back-up – Number of MTUs where back-up domains had to be used.

FAV provision (no. of TSOs) – Numbers of TSO's that applied FAV/IVA in the domain validation process.

Final domain acceptance (1 TSO = 25%) – The percentage of how many TSOs that accepted the final domain.

Energy Delivery Day:	Tue. 08.3.	Wed. 09.3.	Thu. 10.3.	Fri. 11.3.	Sat. 12.3.	Sun. 13.3.
Invalid/missing IGMs	0	0	0	0	0	0
Substituted IGMs	0	0	0	1	0	0
Invalid CGMs	0	1	0	0	0	0
FB domain back-up	0	0	0	0	0	0
FAV provision	1	0	1	0	2	0
Final domain acceptance (1 TSO =25%)	100	100	100	100	100	100
FB-domains sent to SA WG/SF	Yes	Yes	Yes	Yes	Yes	Yes

Table 1: Norcap reporting from the EPR process week 10

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EPR remarks

The 7th of March was excluded since it is in IPR (EPR started the 8/3). The 9th of March was excluded by RSC during the SF-simulation process since it caused the simulation to fail.

Nordic CCM remarks

The analysis in this report shows the SEW comparison between the current NTC methodology and the FB methodology approved for the Capacity Calculation Region (CCR) Nordic. Besides the congestion income generated for the bidding zone borders included in CCR Nordic, the figures in this report also include the SEW of the Nordic bidding zone borders connected to CCR Hansa (NO2-NL, NO2-DE/LU, DK1-NL, DK1-DE/LU, DK2-DE/LU and SE4-DE) and to CCR Baltic (SE4-LT, FI-EE) to have a full picture of the effect on the entire Nordic SEW.

In SF some HVDC cables are modelled to include the power transfer losses, and some are not.

- Norned, Nordlink, Skagerak, Baltic cable consider losses in SF.
- Cobra cable, Storebelt, Kontiskan, Swepol, Nordbalt, Fennoskan, Estlink and Kontek do not consider losses

4 Simulated Market outcome FB vs. NTC

This chapter presents a comparison of the market simulation for the week 10 (08-13 of March 2022) between Flow Based and NTC with regards to changes in socio-economic welfare gains along with individual bidding zone price changes.

The overall comparison in section 4.1. shows that the total change of Nordic socio-economic welfare was approx. 0.5 million euros lower with flow-based compared to NTC. This corresponds to a decrease of total SEW by less than 0.01% compared to the NTC case. More detailed market results of each Nordic country are presented the Appendix.

Aggregated results for week 10

Water in Nordic reservoirs were below average in March.

The comparison of the NTC and flow-based simulation shows that generally FB would have provided higher electricity prices in the Nordic benefitting electricity producers more than in NTC. The northern bidding zones of Sweden see the highest price increase weith FB with a 48.9% and 24.4% for SE1 and SE2 respectively.

But the areas with the highest prices in NTC NO1, NO2 and NO5 have a decrease in prices at around 8%.

Bidding zone	Price FB [€/MWh]	Price NTC [€/MWh]	Price FB-NTC [€/MWh]	Price diff (FB-NTC)*100/NTC [%]
DK1	197.6	197.9	-0.3	-0.2
DK2	193.0	187.4	5.6	2.9
FI	99.1	93.6	5.5	5.5
NO1	186.1	202.6	-16.5	-8.9
NO2	188.9	202.6	-13.7	-7.3
NO3	17.2	15.1	2.1	12.2
NO4	13.4	14.9	-1.5	-11.2
NO5	188.3	202.6	-14.3	-7.6
SE1	33.3	17.0	16.3	48.9
SE2	22.5	17.0	5.5	24.4
SE3	134.8	116.3	18.5	13.7
SE4	150.8	129.9	20.9	13.9

Table 2. Average price pr. bidding zone with NTC and FB, week 10

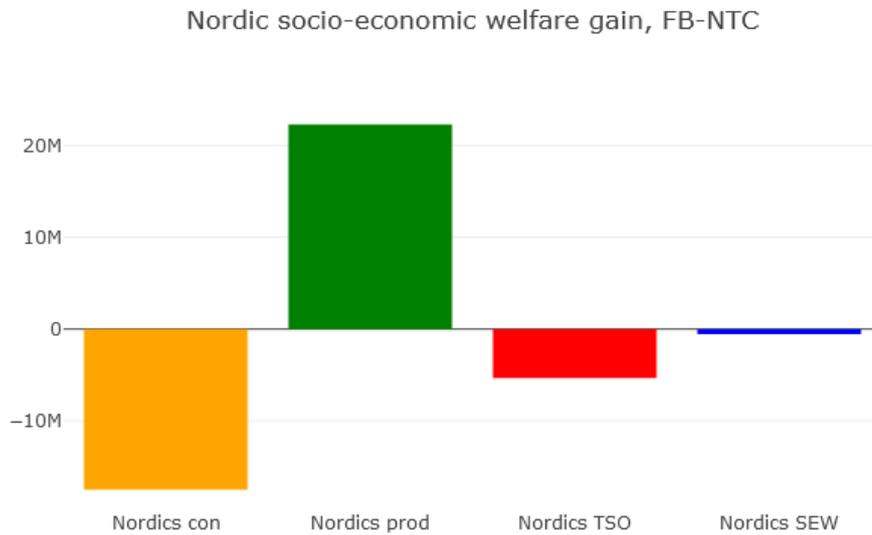


Figure II. Nordics consumer, producer and congestion income change. Total Nordic socio-economic welfare gain over the simulation period is the sum of the previous three.

Figure II presents the impact of introducing FB into the Nordics on the Nordics SEW. Overall, consumers see a net welfare loss of 17.5 M€, while producers see a net gain of SEW at 22.3 M€. The TSOs see the largest loss of welfare compared with NTC, as the loss is 1.7% (equating to 5.3 M€) of congestion income in the FB regime, compared to NTC.

Nordic socio-economic welfare per stakeholder and day

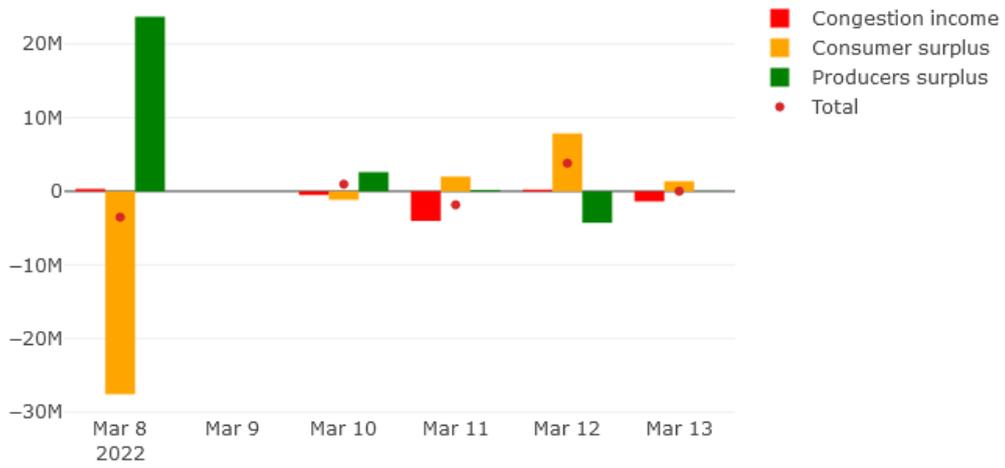


Figure III. Nordic socio-economic welfare per stakeholder and day

Total Nordic socio-economic welfare per country

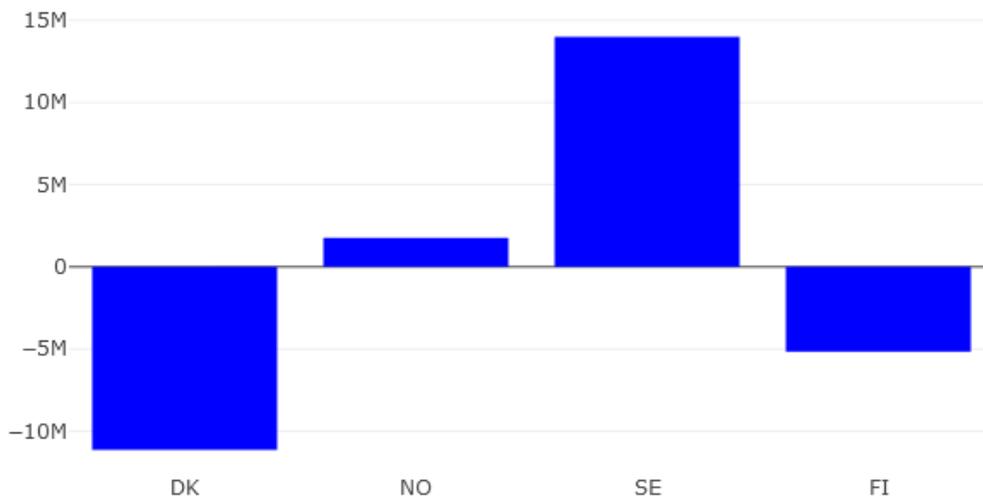


Figure IV. Nordic socioeconomic welfare pr. country – (FB-NTC) (€), week 10

Country level data show positive socioeconomic welfare gains in both Sweden and Norway while Denmark and Finland are facing negative SEW for the analyzed weeks. The socioeconomic welfare gain between FB and NTC is highest in Sweden with a positive SEW of 14.0 M€. The largest loss of SEW occurs in Denmark at 11.1 M€.

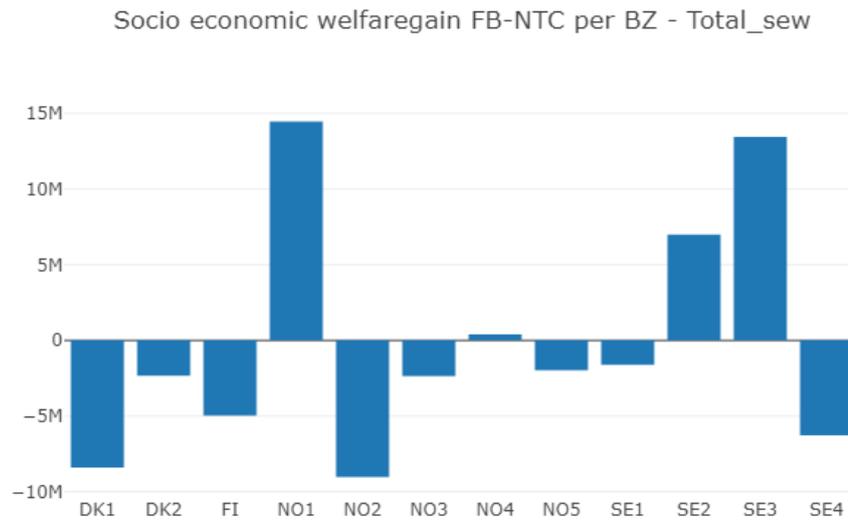


Figure V. Nordic socio-economic welfare pr. Stakeholder, week 10

Appendix:

The appendix provides simulation results presented in more detail for each country. The results presented are:

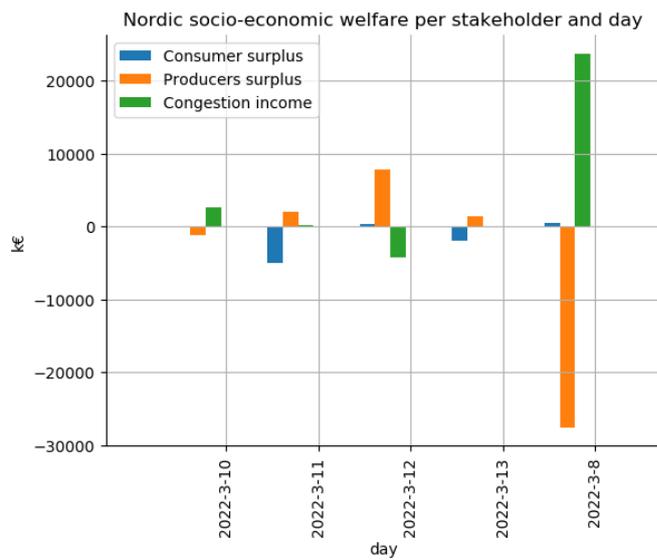
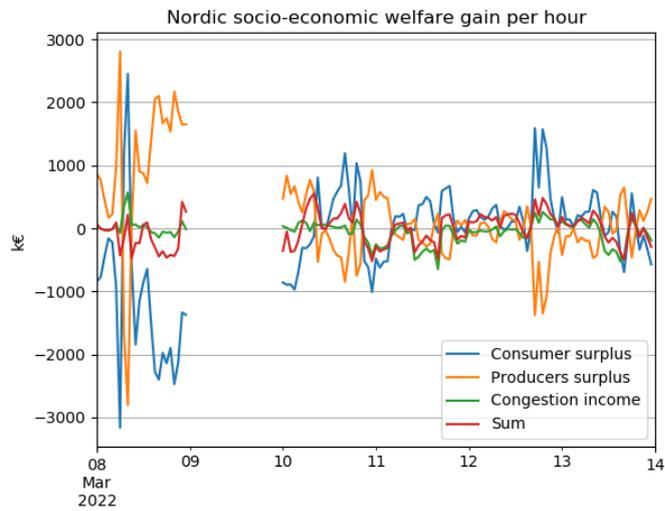
- Social economic welfare
- Prices per bidding zone
- Net positions
- Border flows

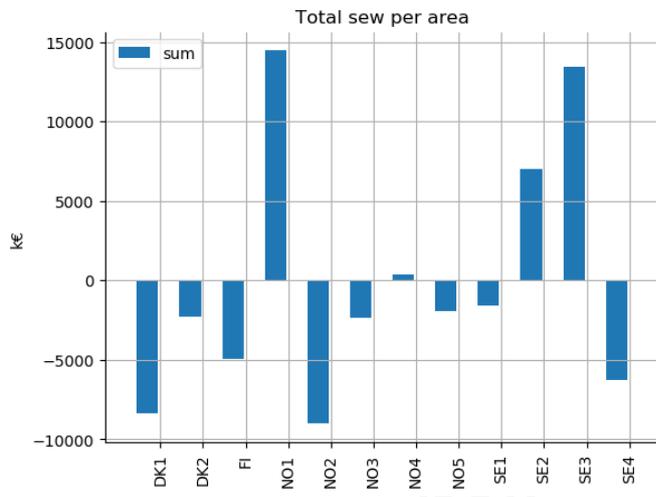
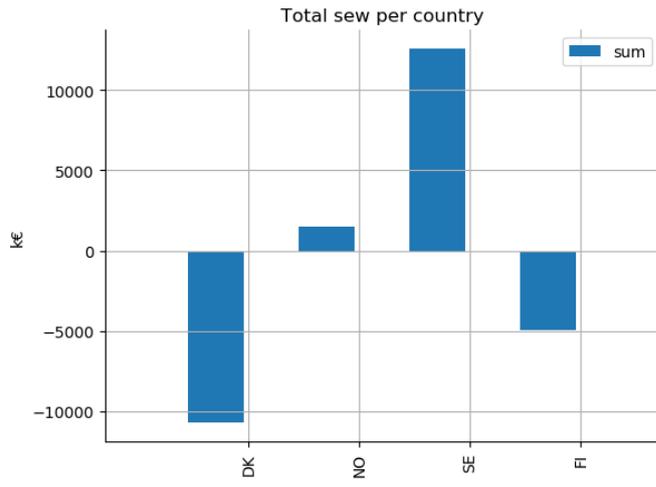
Nordic CCM External Parallel Run

4.1 Social economic welfare

4.1.1.1 Nordics

Nordic welfare gains.

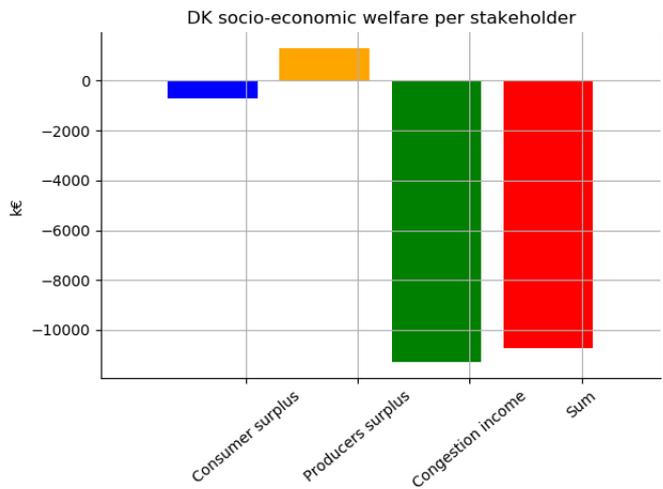
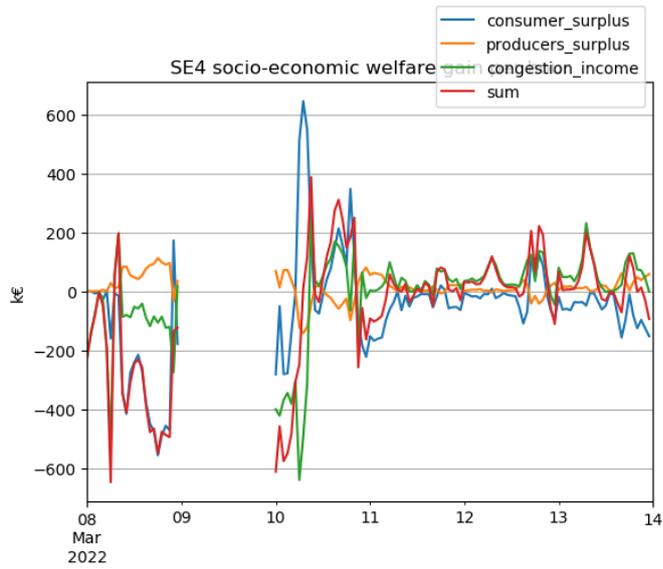
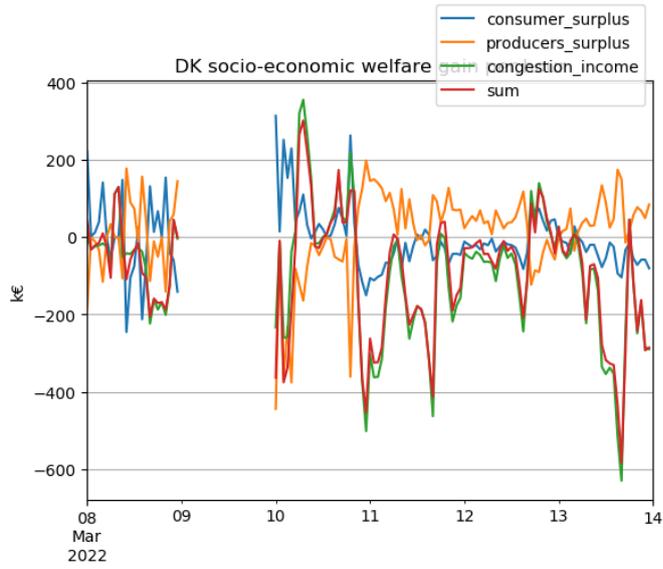




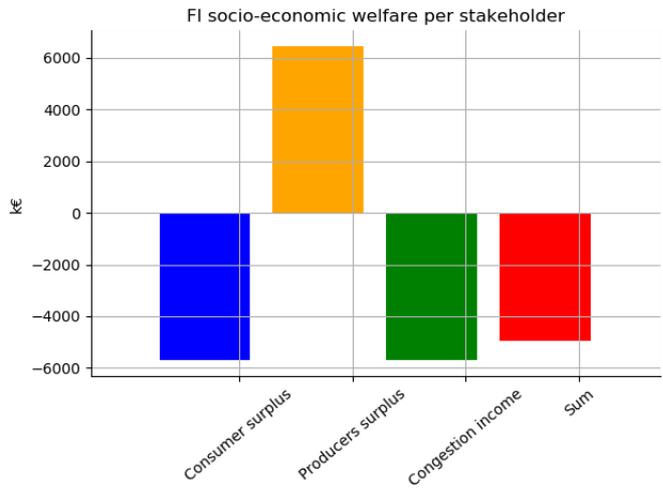
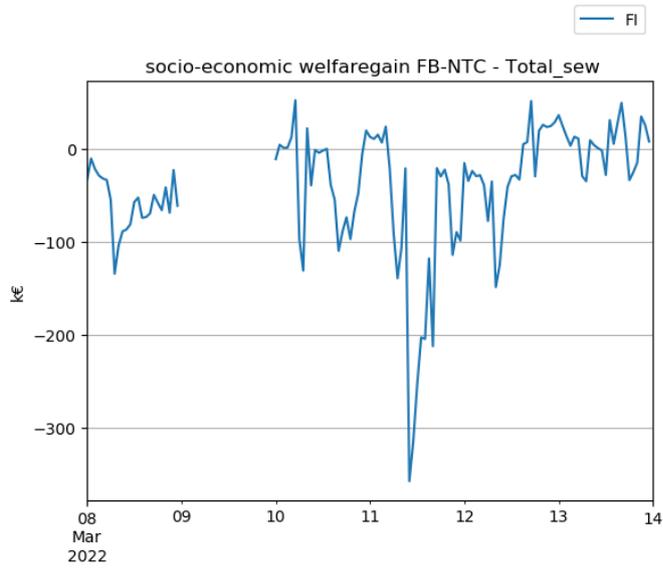
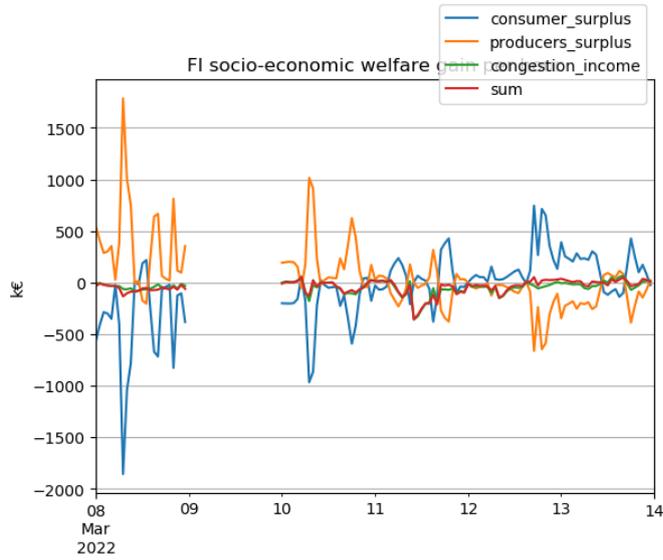
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4.1.1.2 Denmark

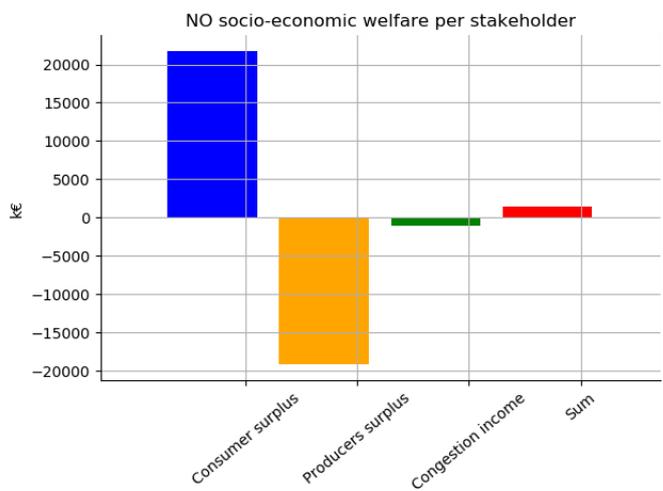
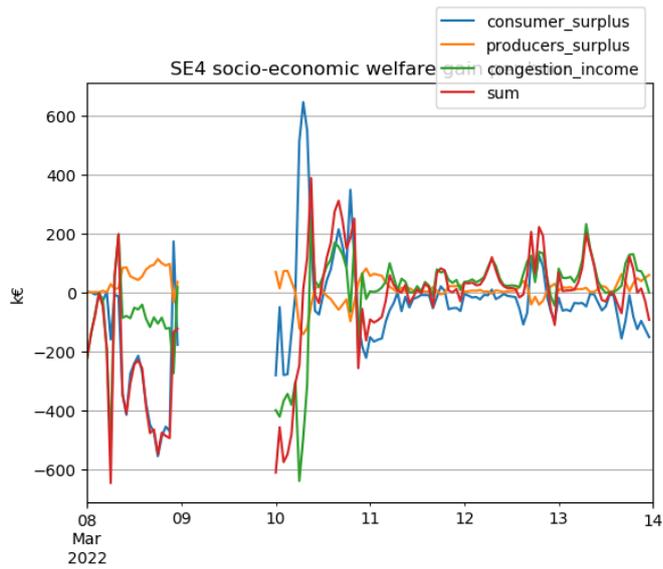
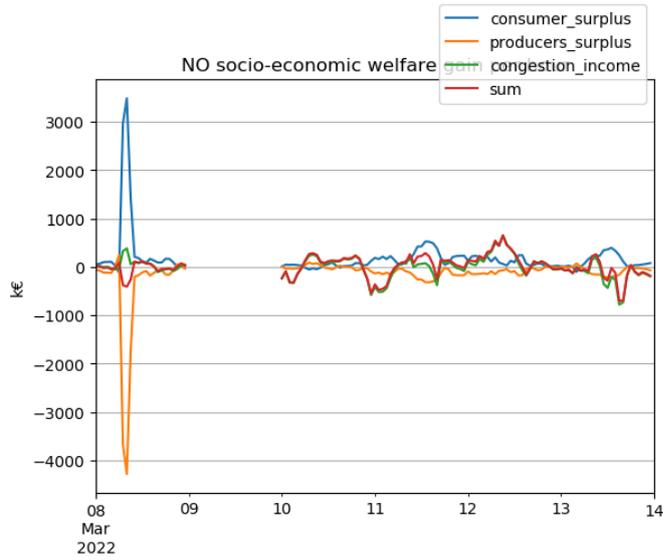


4.1.1.3 Finland

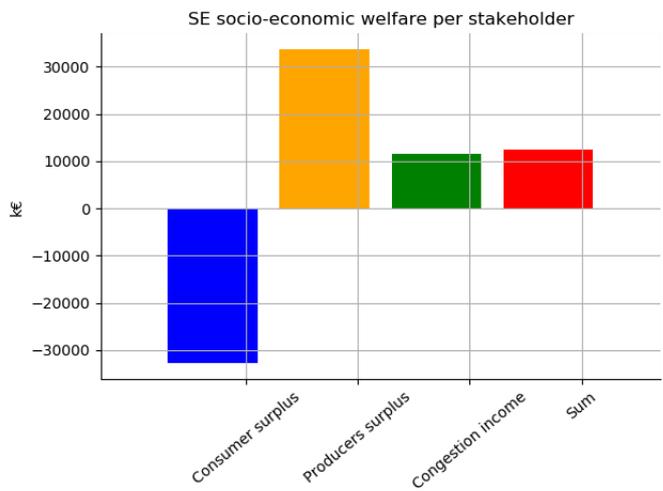
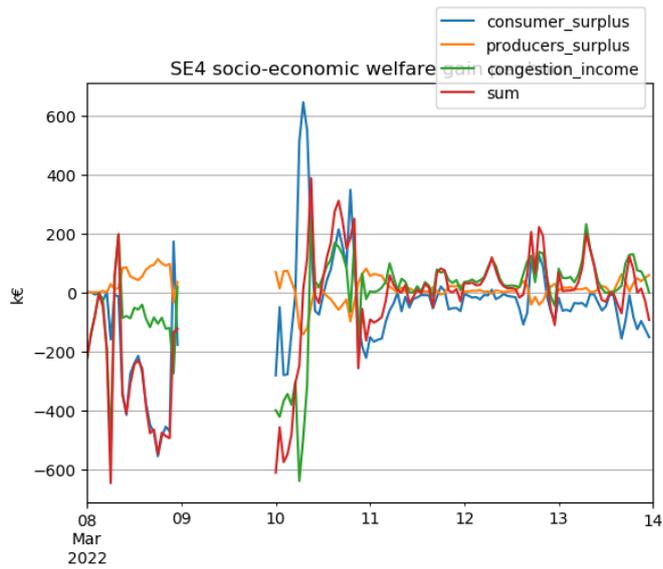
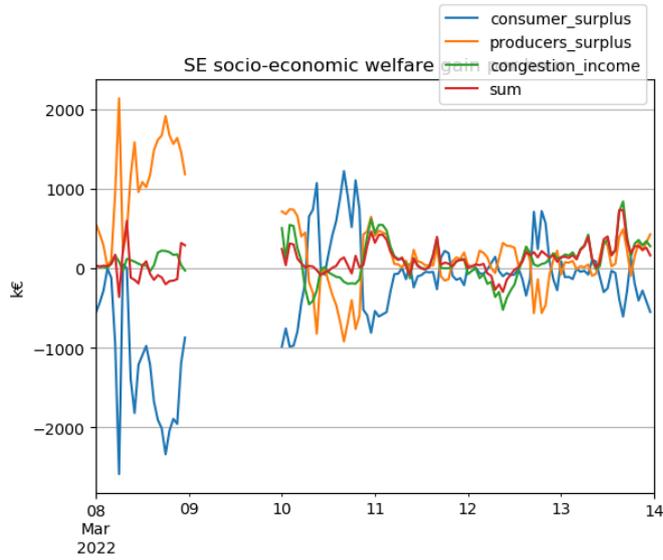


4.1.1.4 Norway

Statnett welfare gains. Add comments

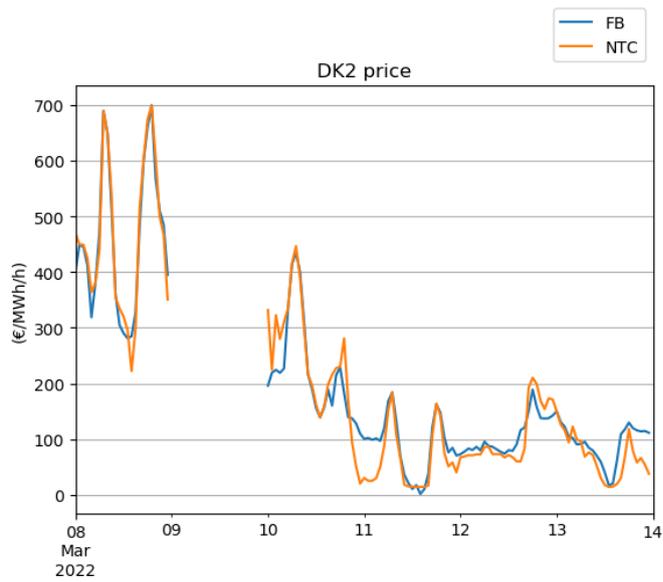
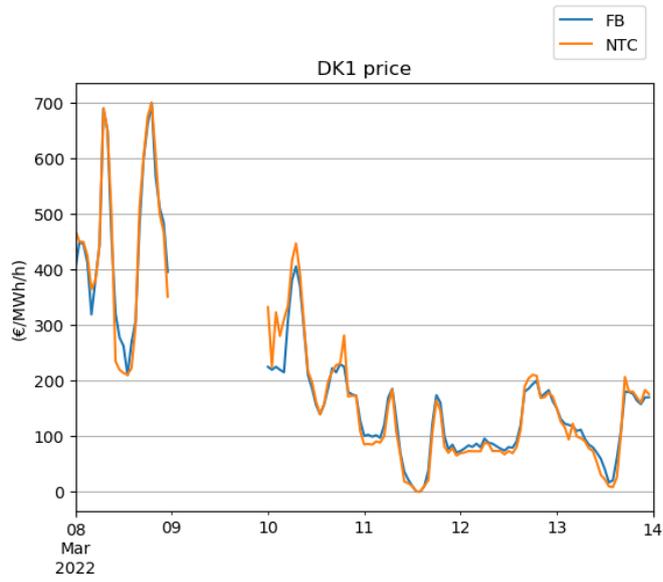


4.1.1.5 Sweden



Price

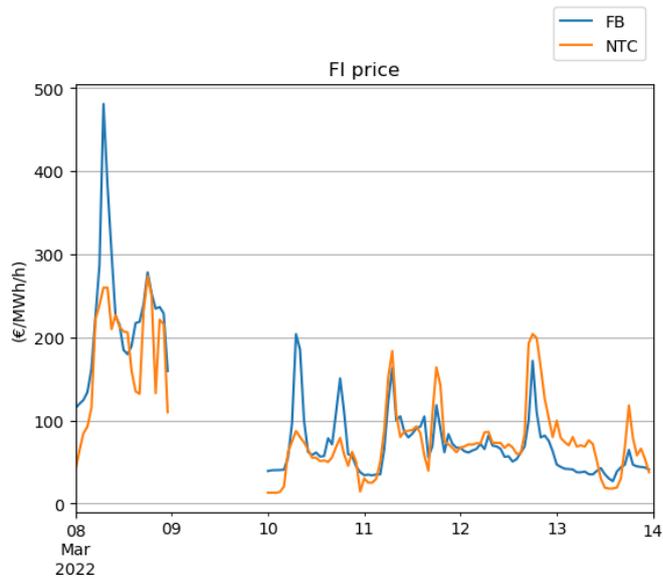
4.1.1.6 Denmark



Nordic

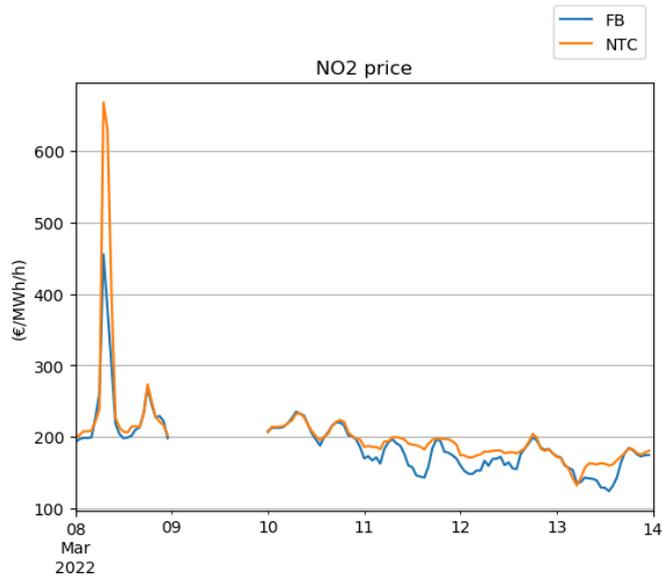
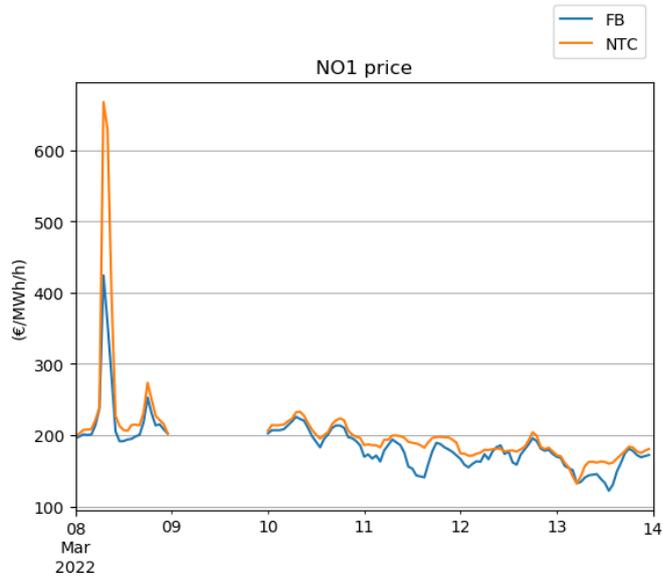
Parallel Run

4.1.1.7 Finland



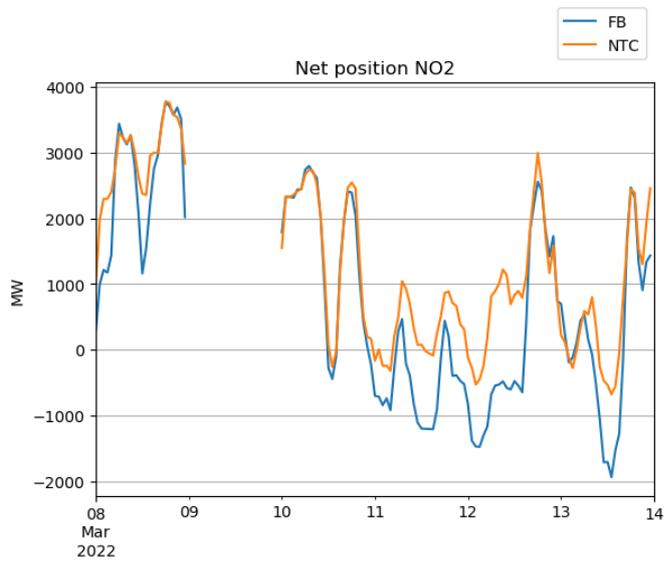
Nordic CCM External Parallel Run

4.1.1.8 Norway



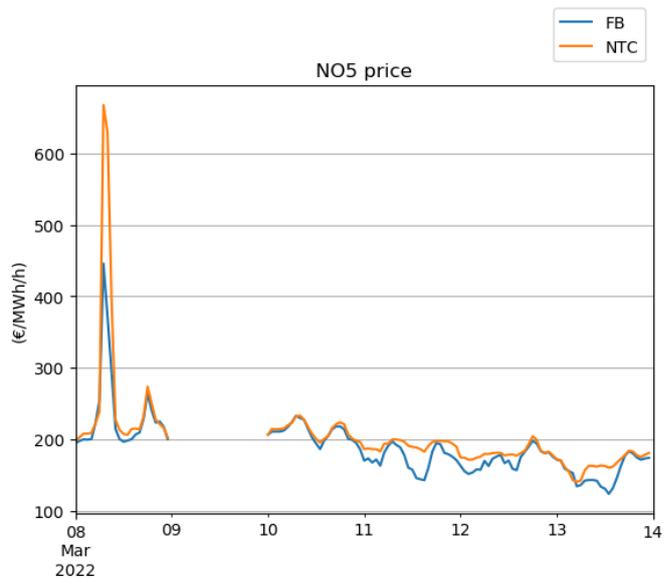
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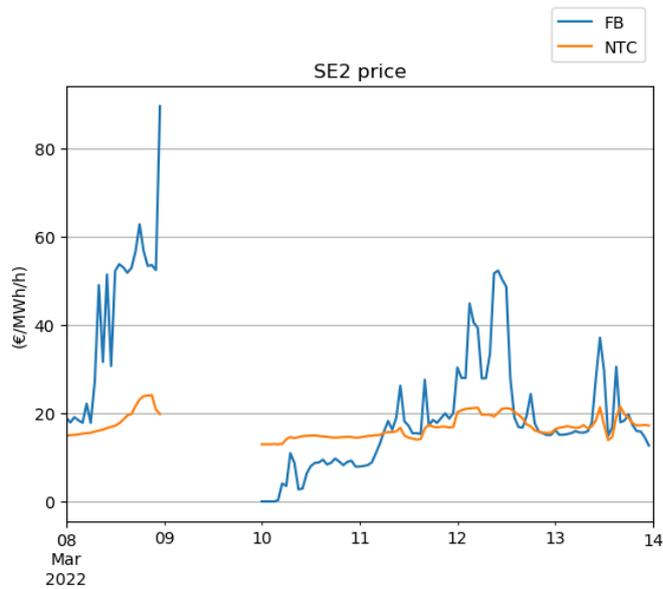
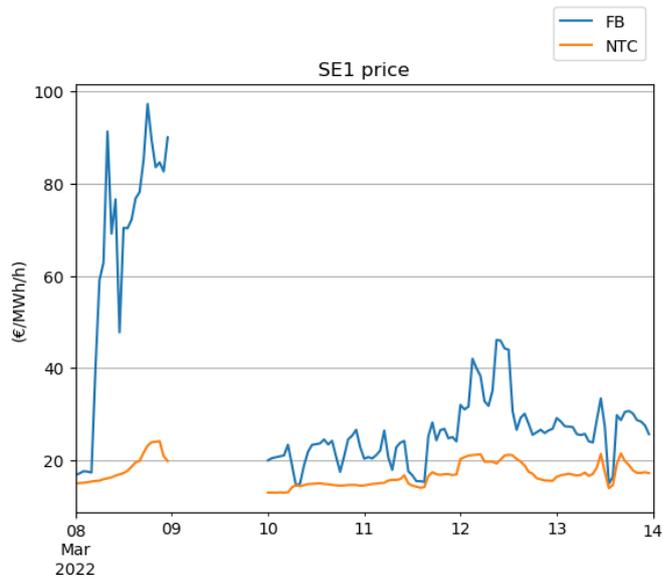
Nordic

Parallel Run



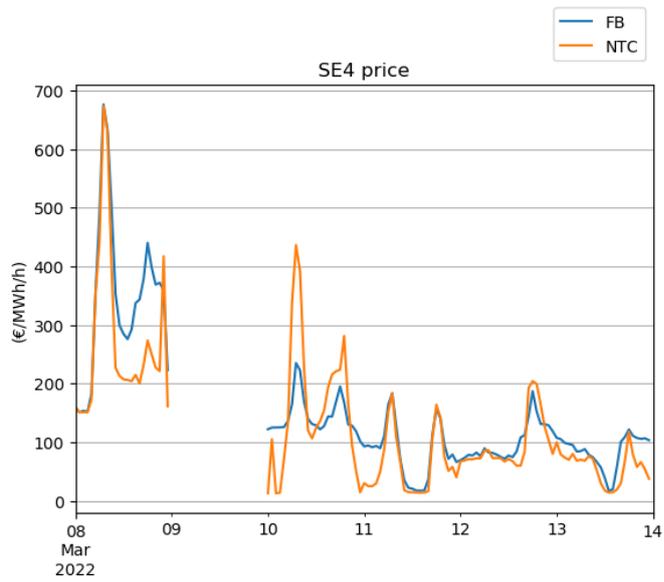
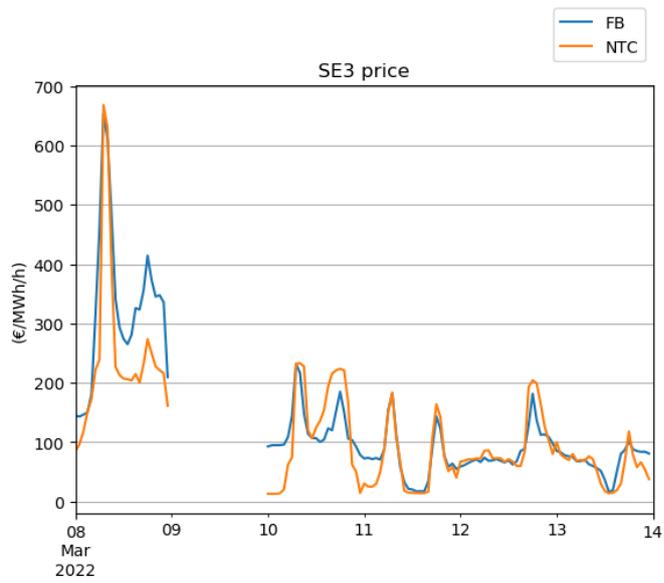
Nordic CCM External Parallel Run

4.1.1.9 Sweden



Nordic

Parallel Run

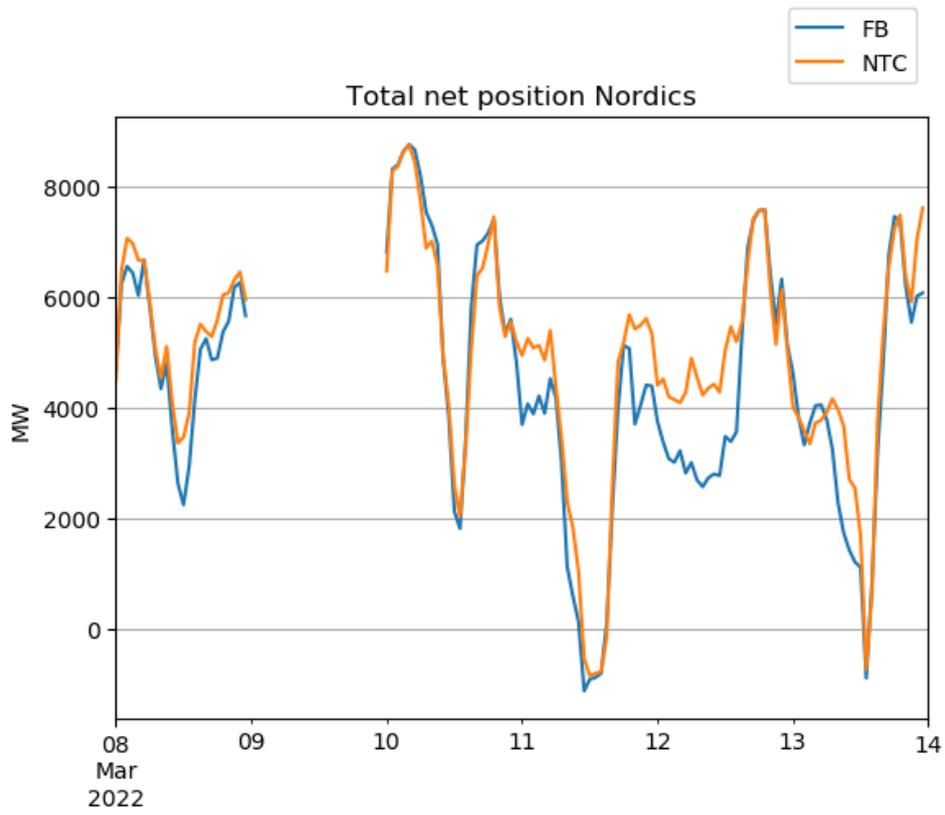


ual Parallel Run

Nordic

Netposition

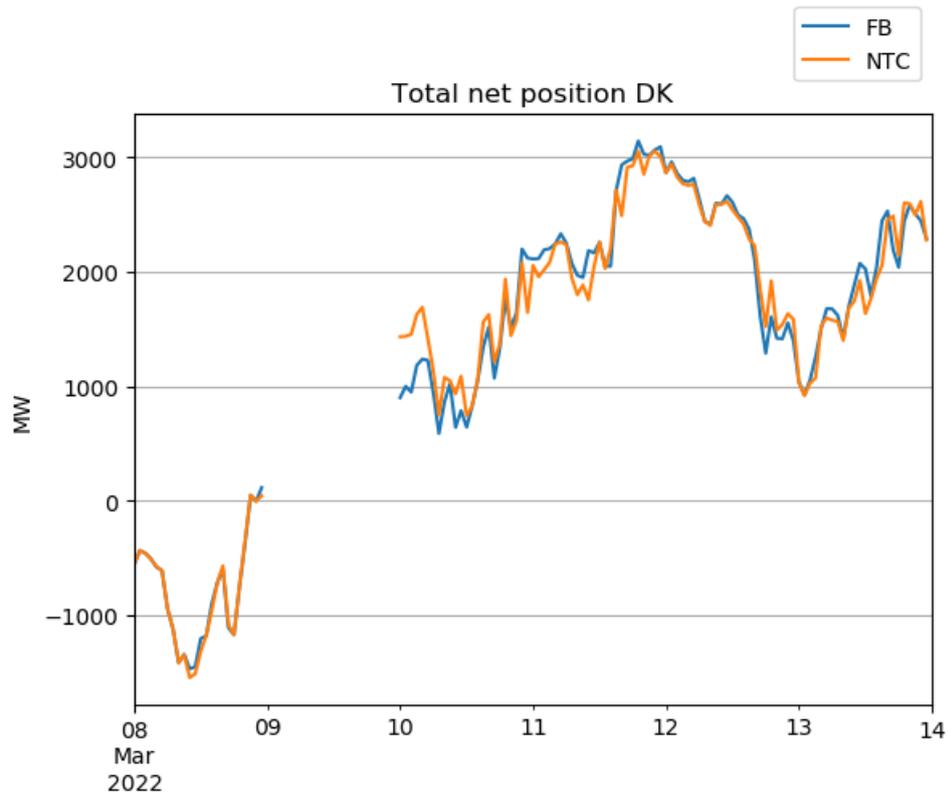
4.1.1.10 Nordics



Nordic CCM EX

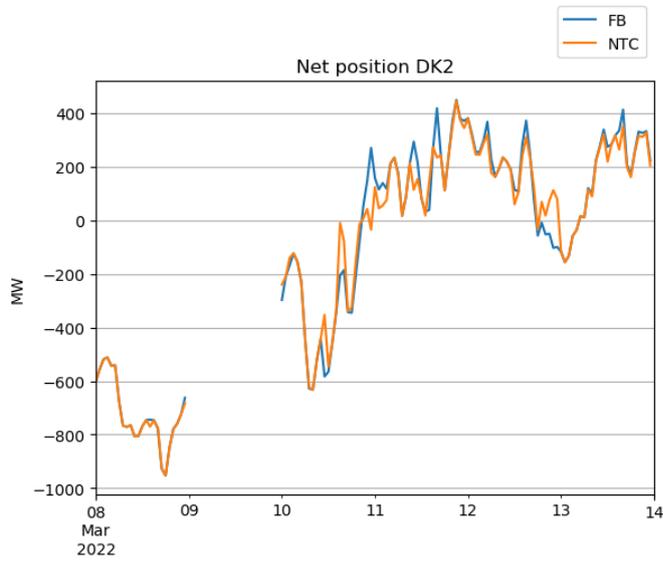
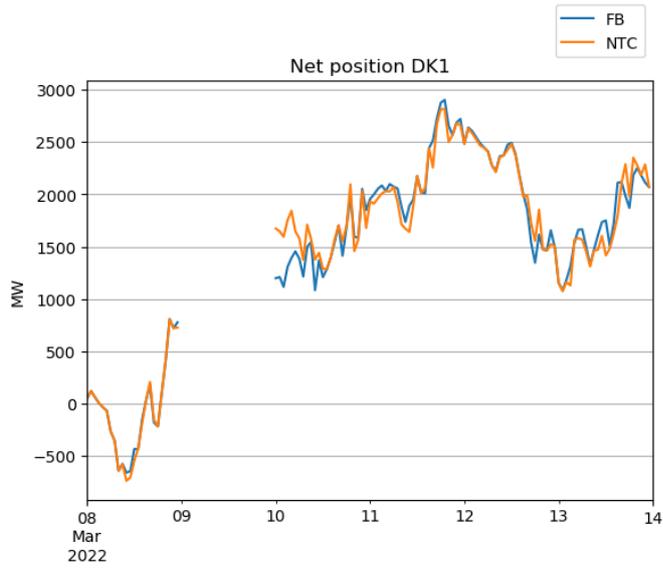
Rel Run

4.1.1.11 Denmark



Nordic CCM Exter

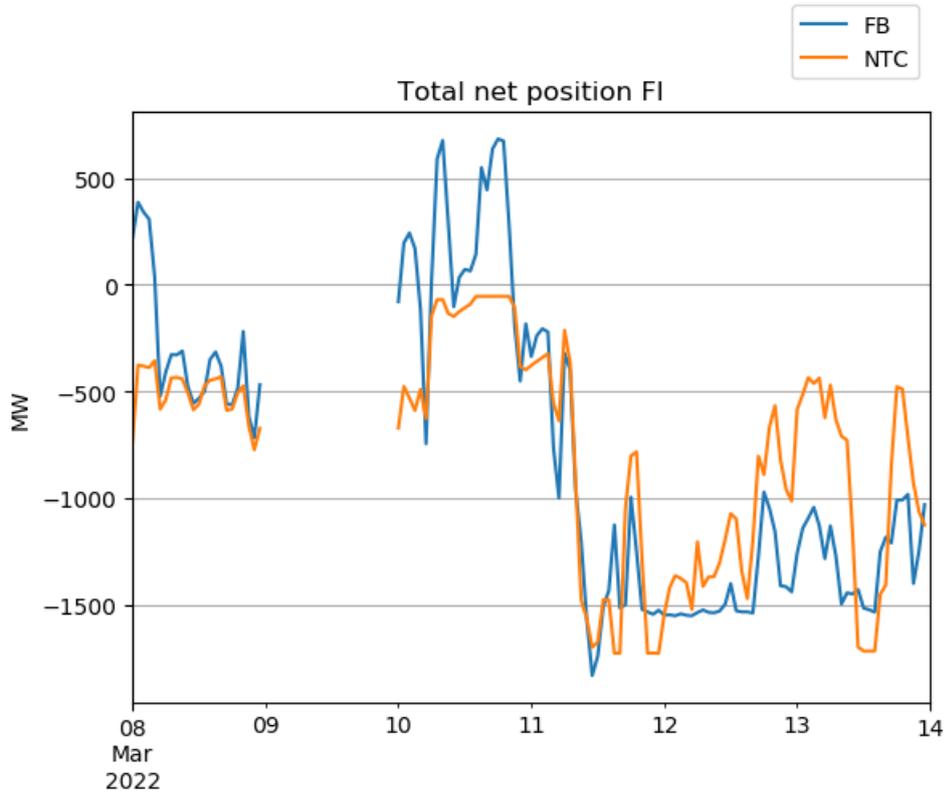
uel Run



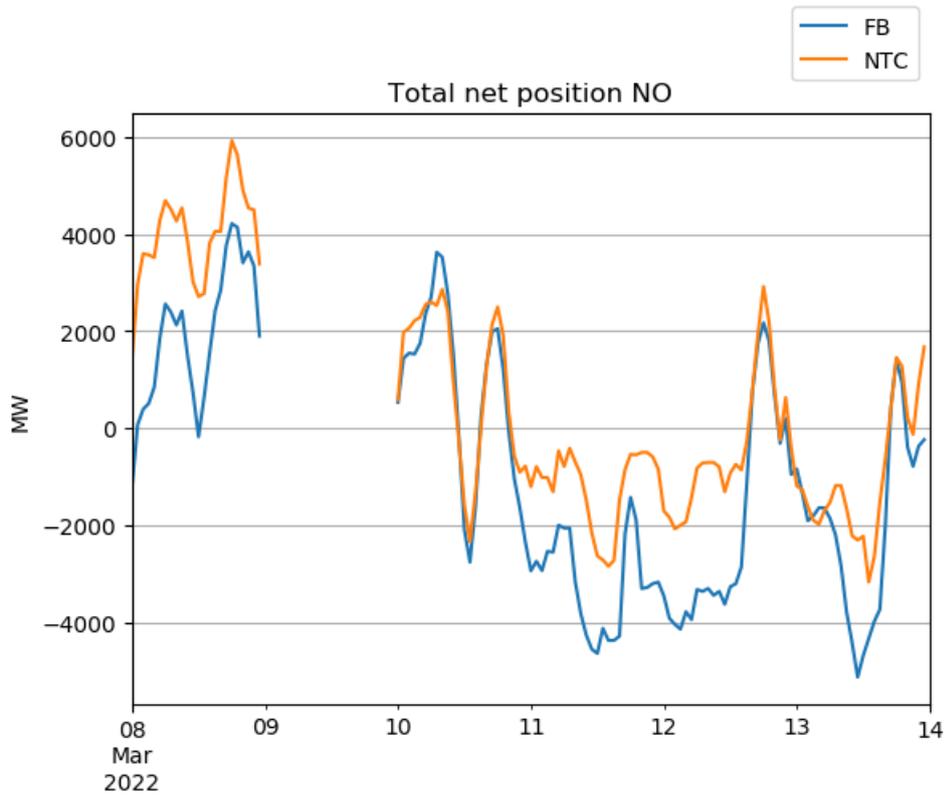
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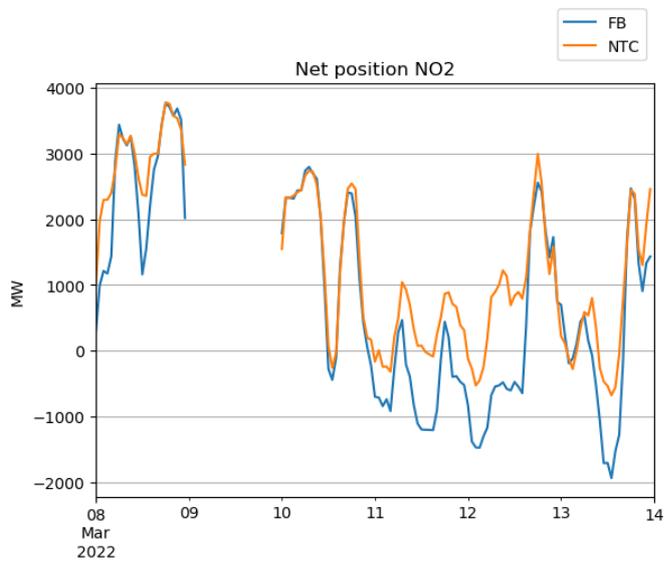
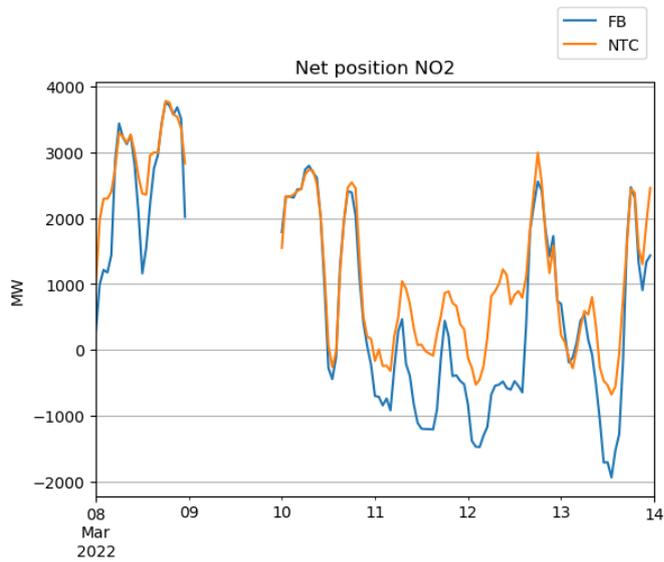
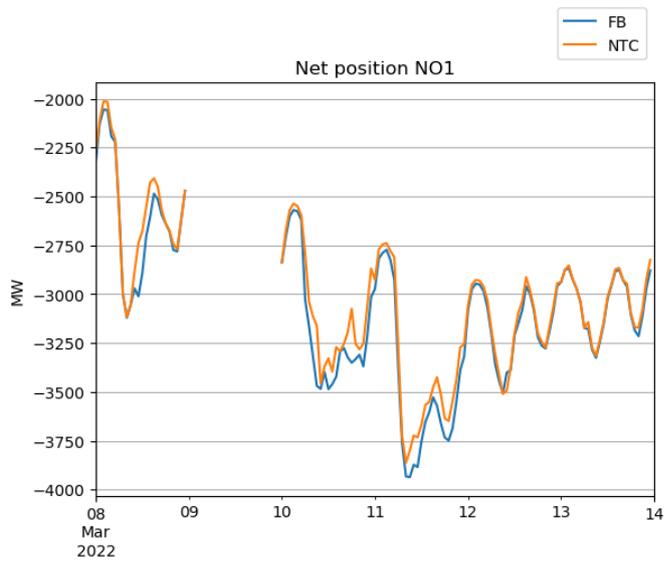
al Parallel Run

4.1.1.12 Finland
FINNP. Add comments

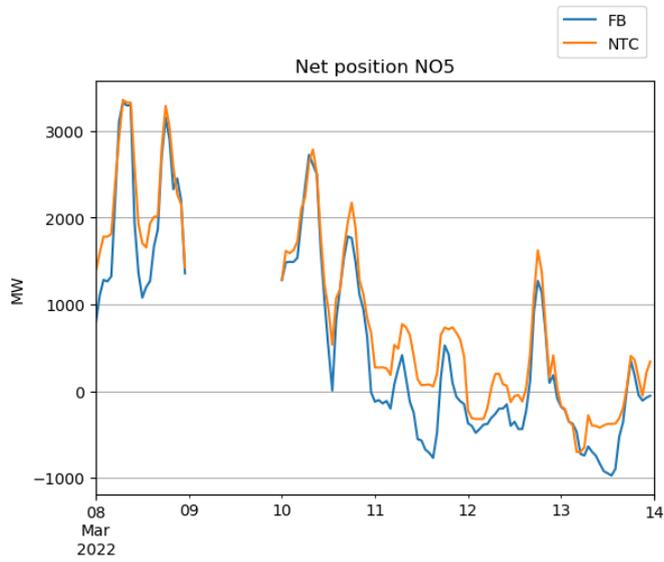
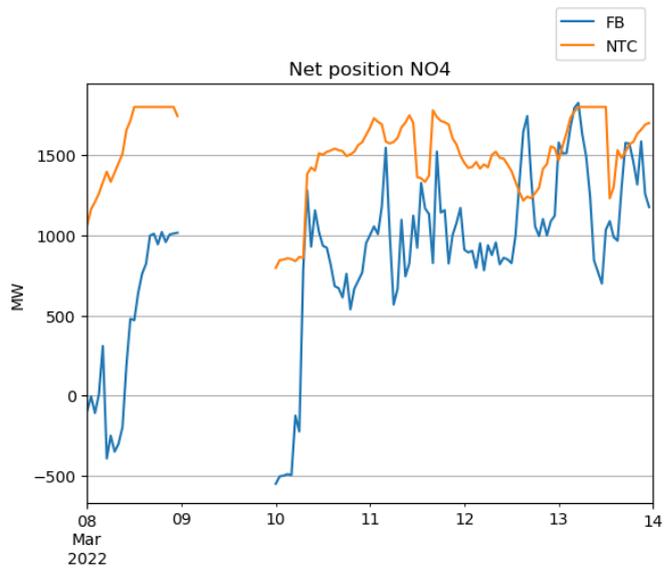


4.1.1.13 Norway





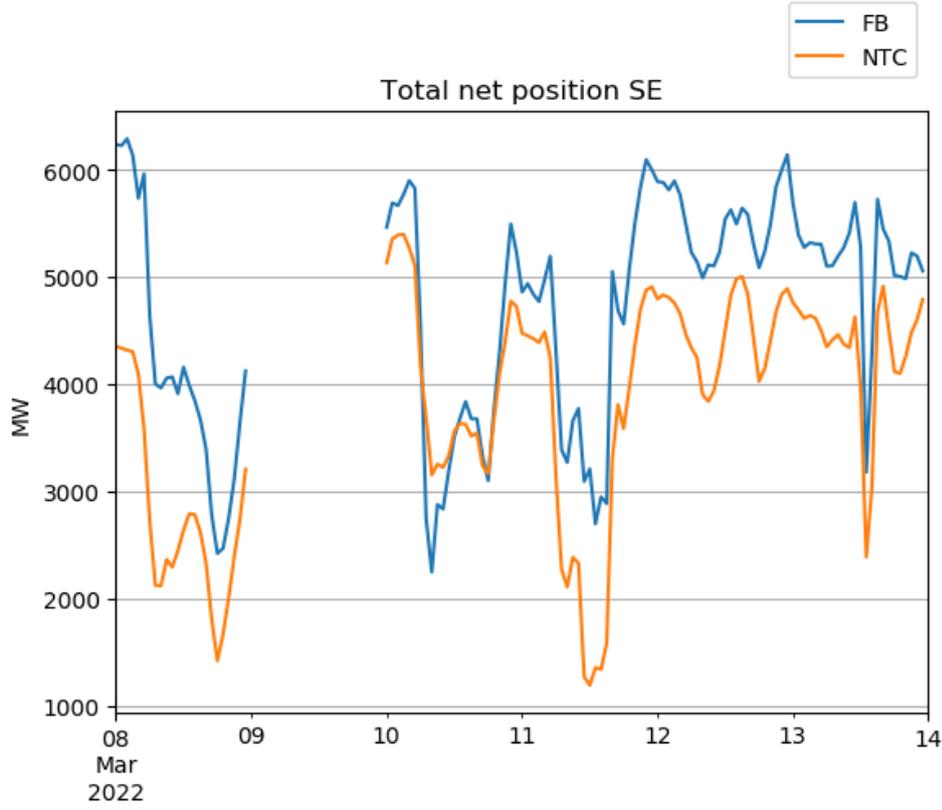
ual Parallel Run



Nordic C

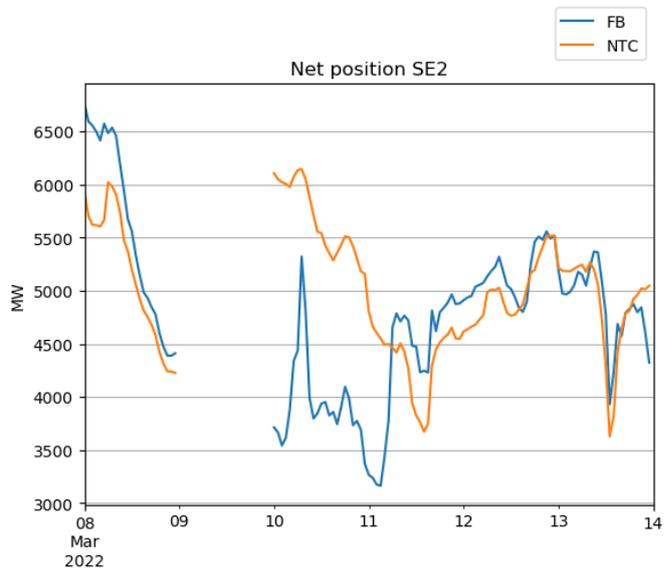
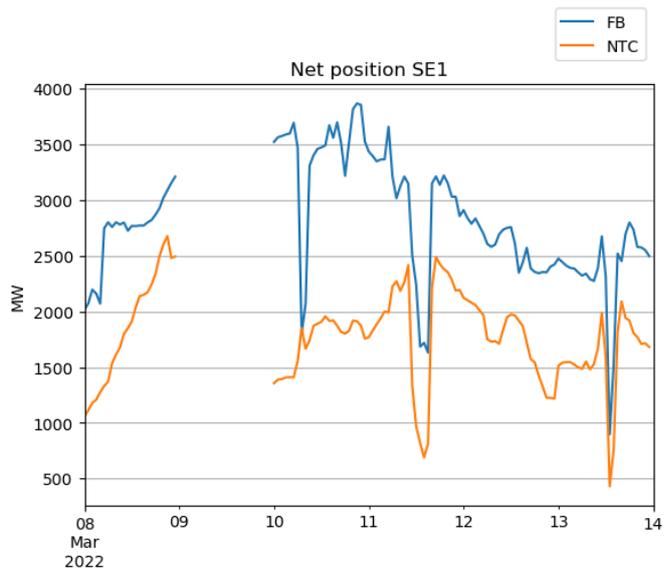
ual Parallel Run

4.1.1.14 Sweden



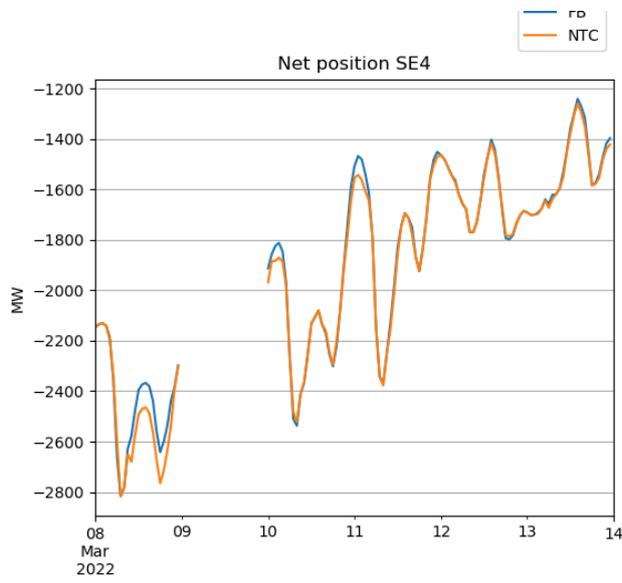
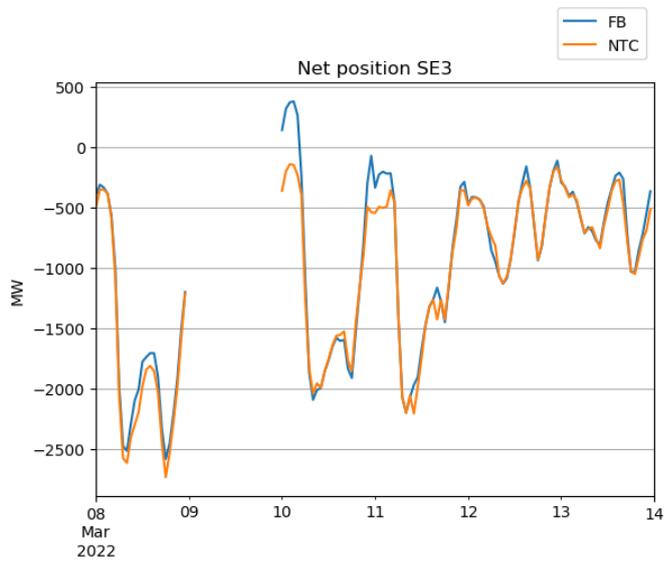
Nordic CCM Extension

Rel Run



Nordic C

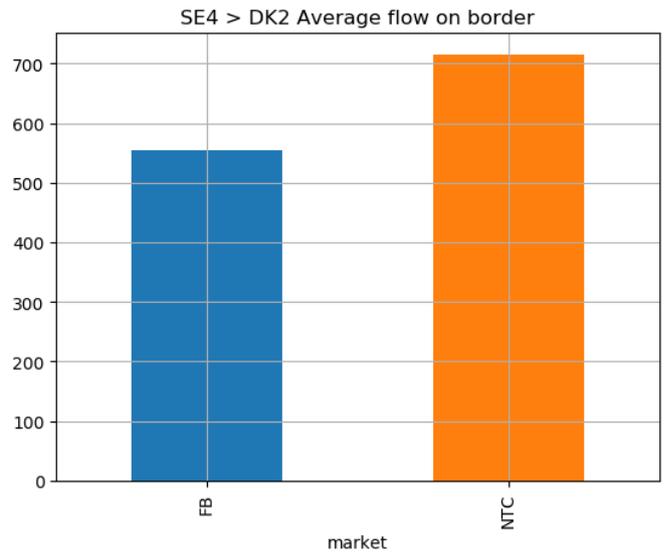
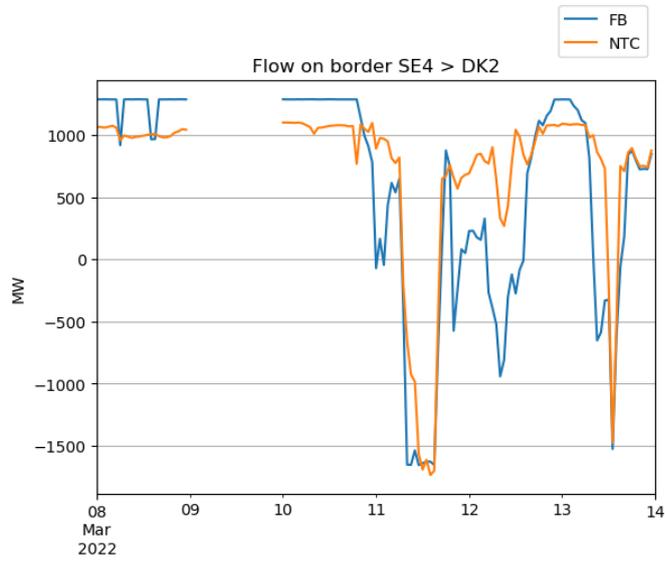
Parallel Run



ual Parallel Run

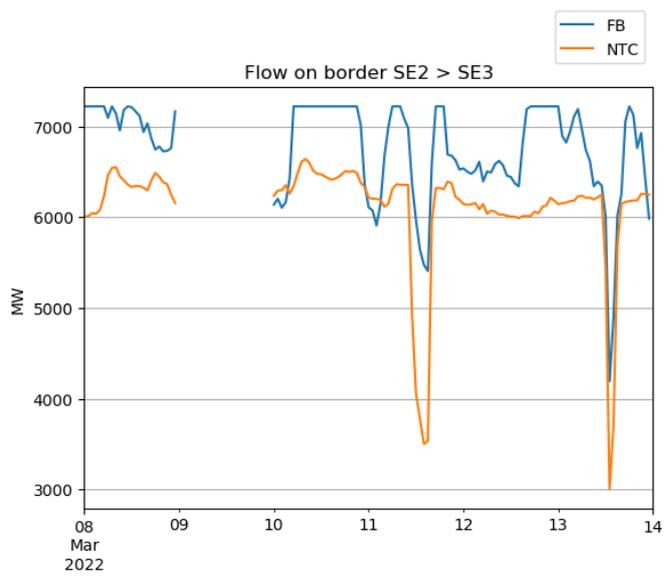
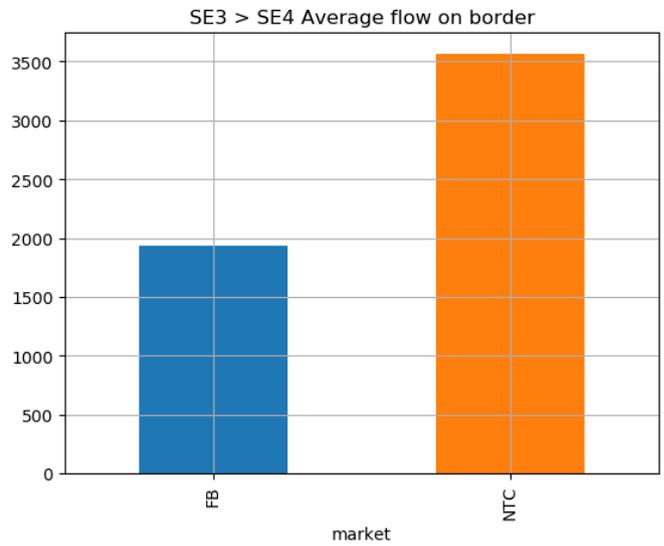
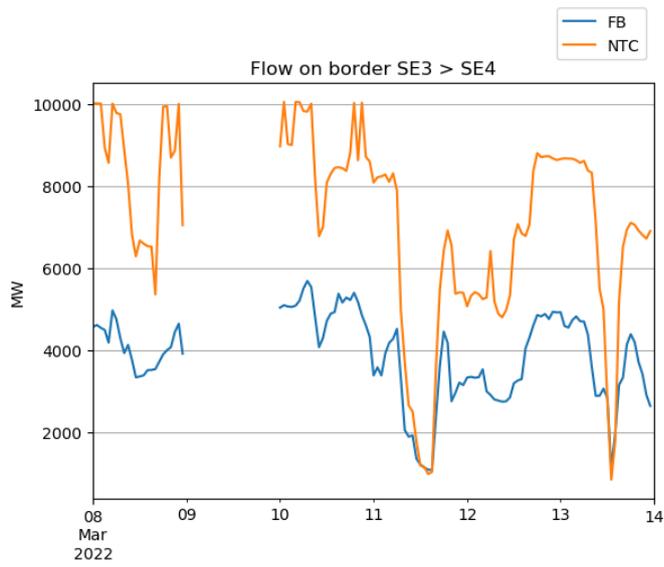
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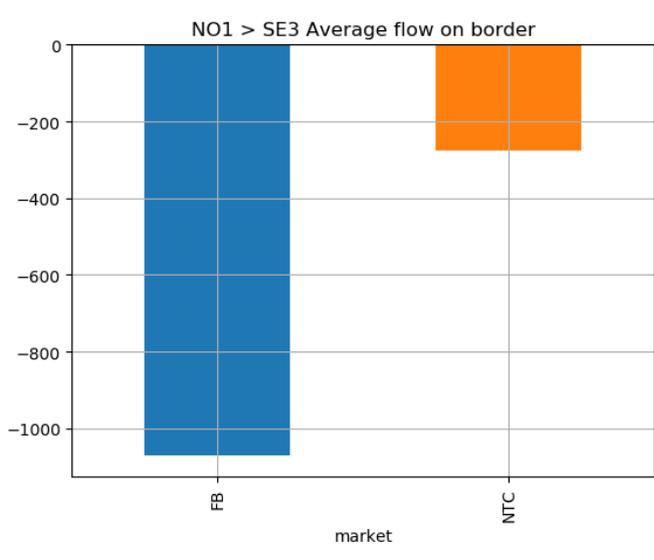
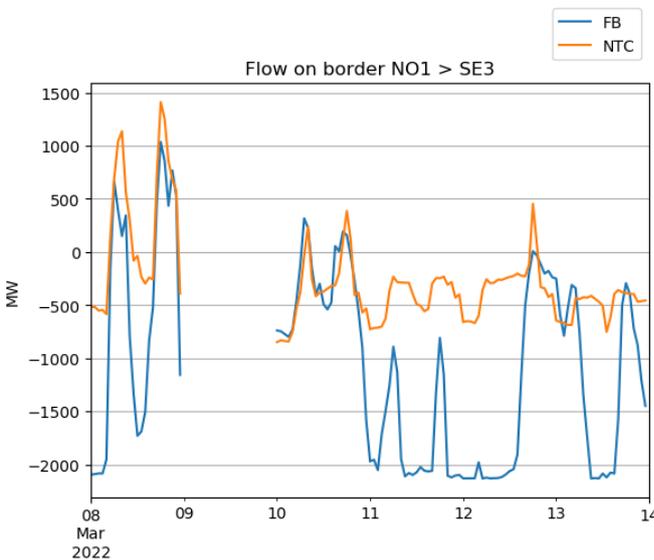
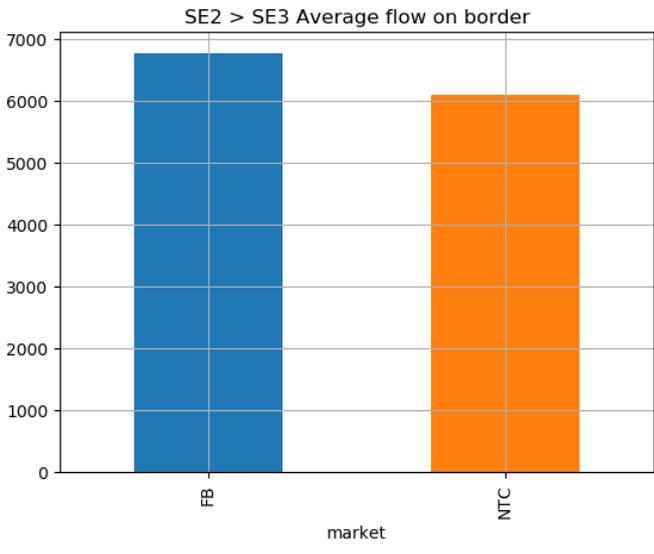
Border Flows



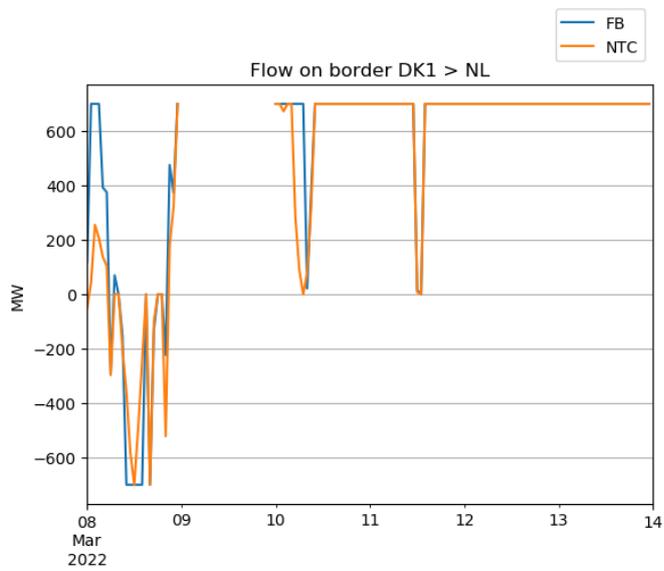
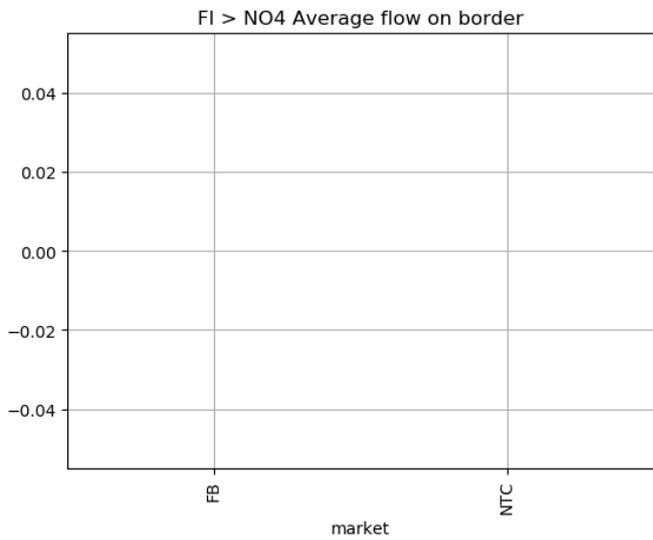
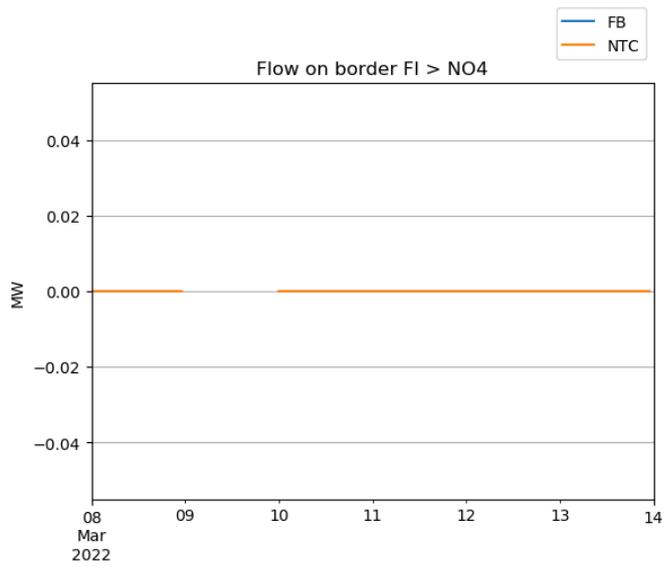
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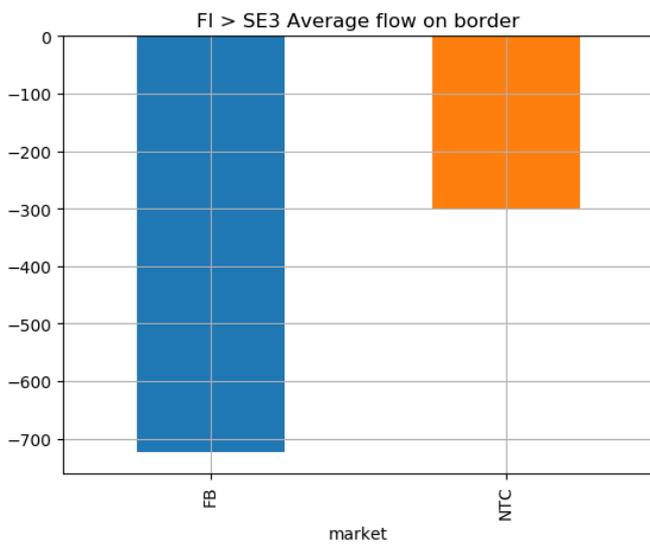
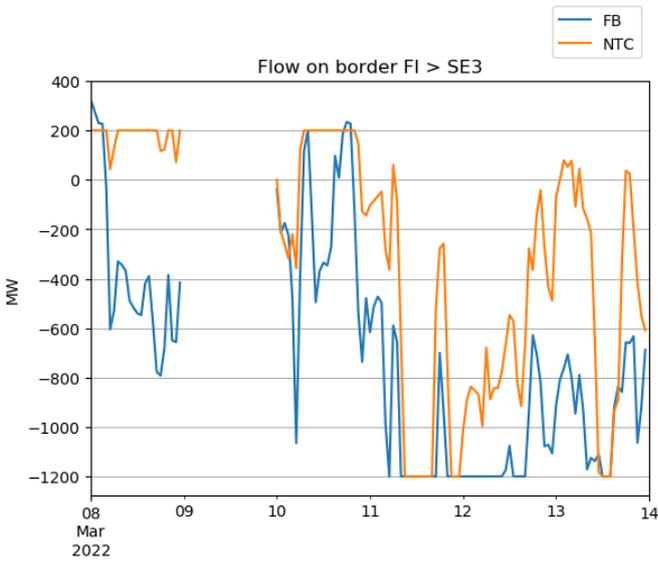
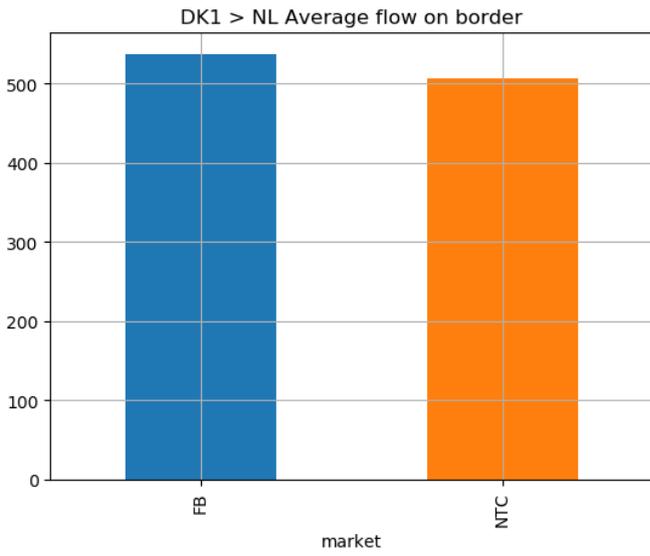
Parallel Run



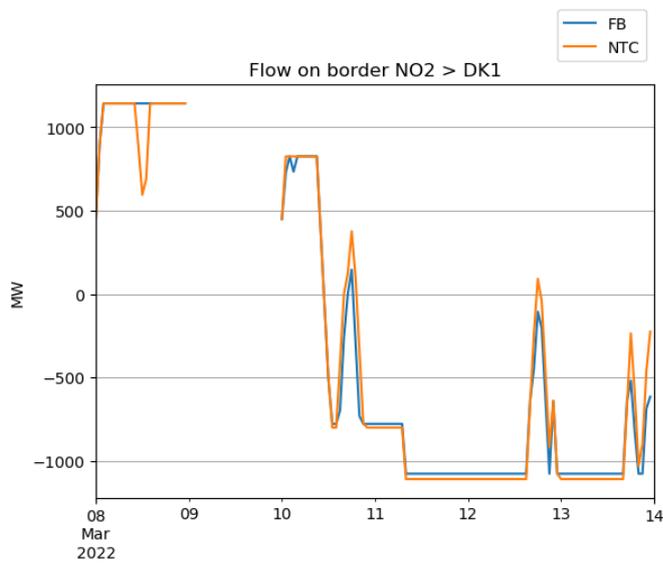
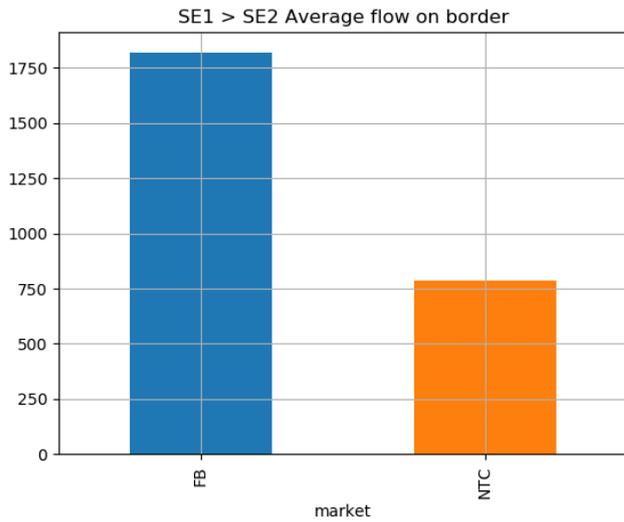
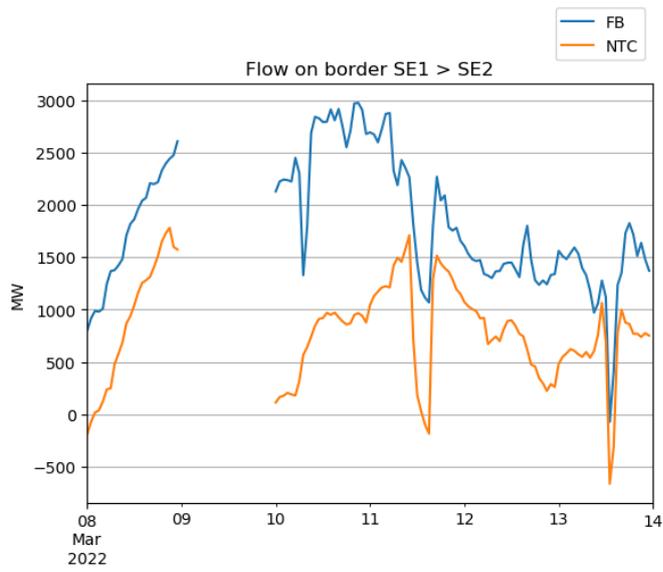


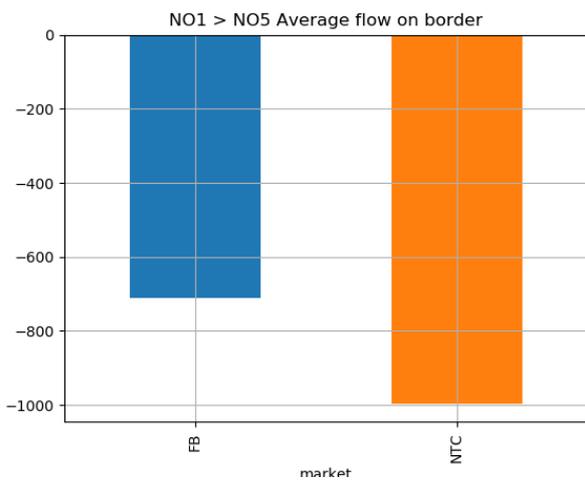
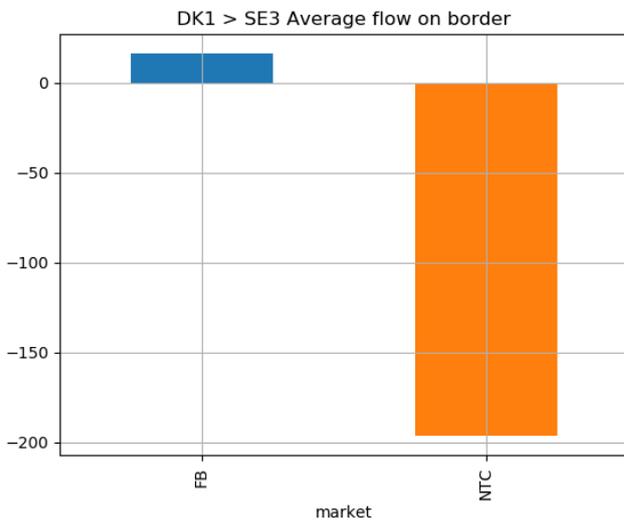
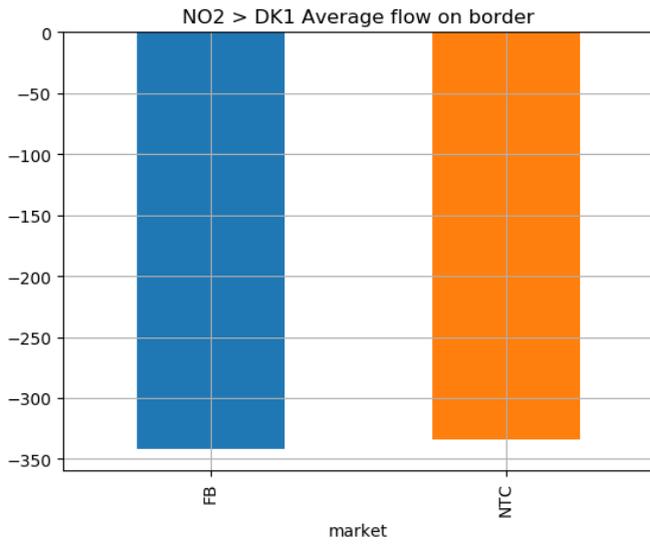
Parallel Run





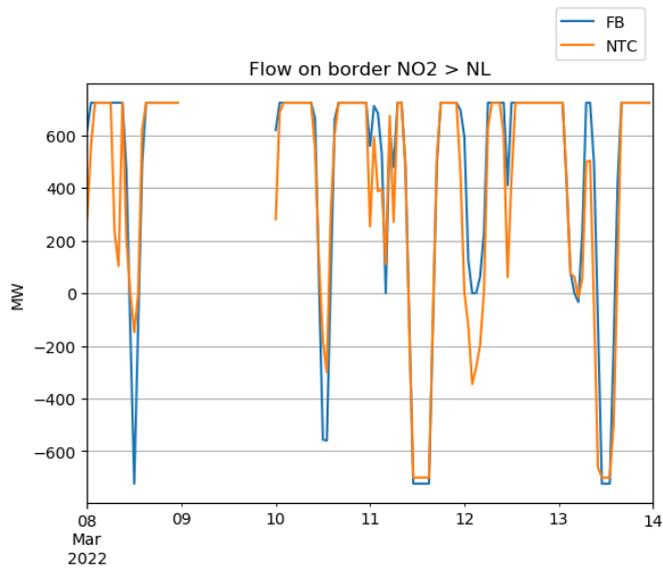
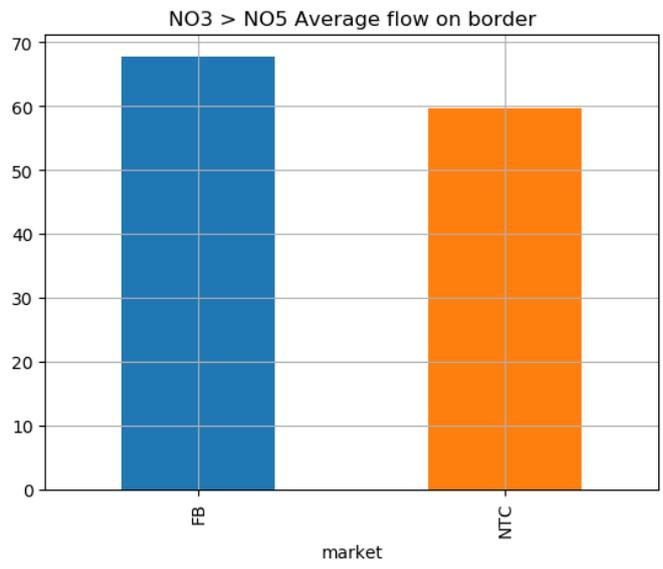
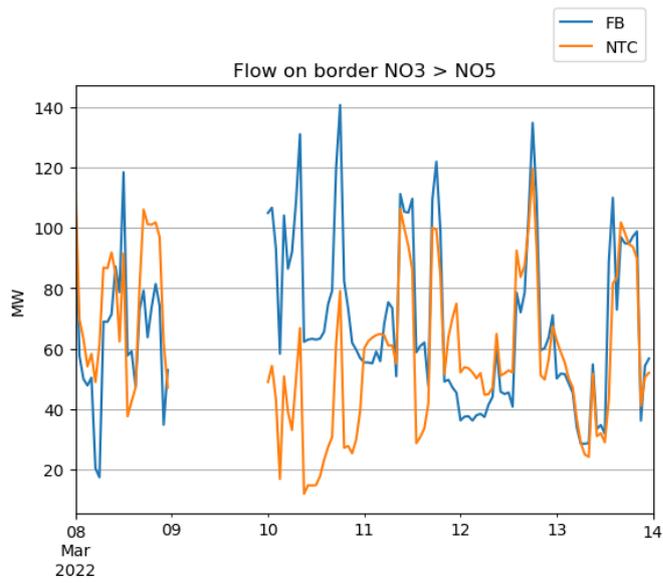
ual Parallel Run



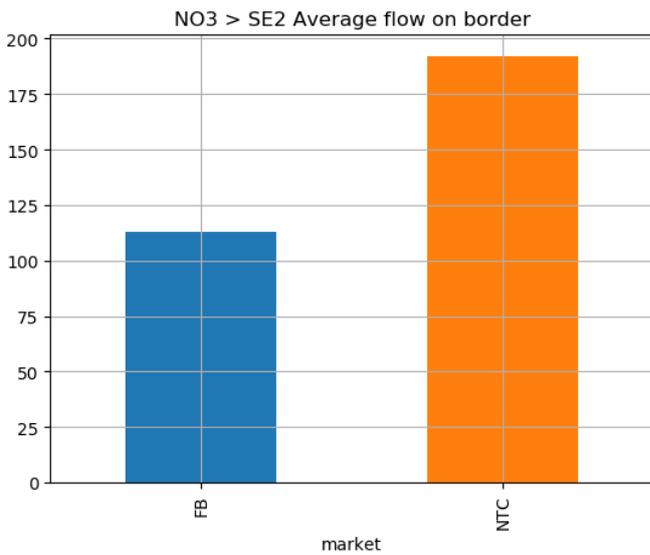
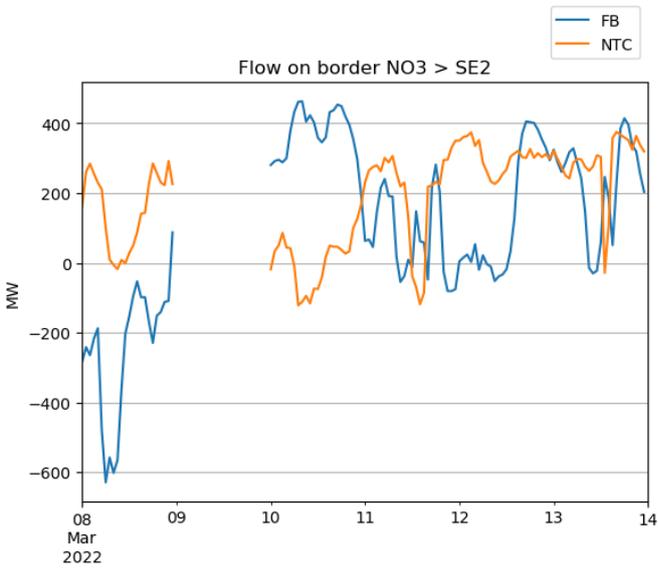
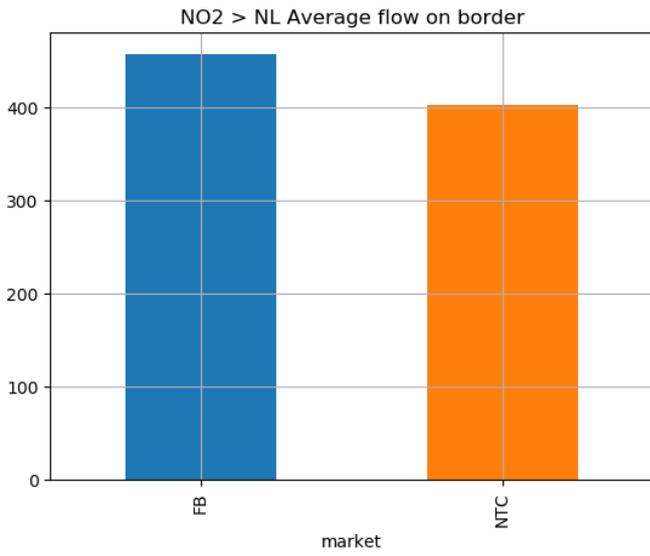


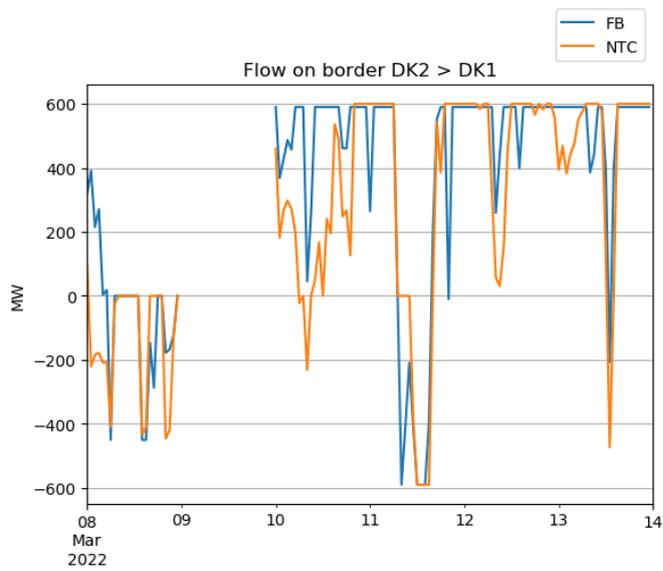
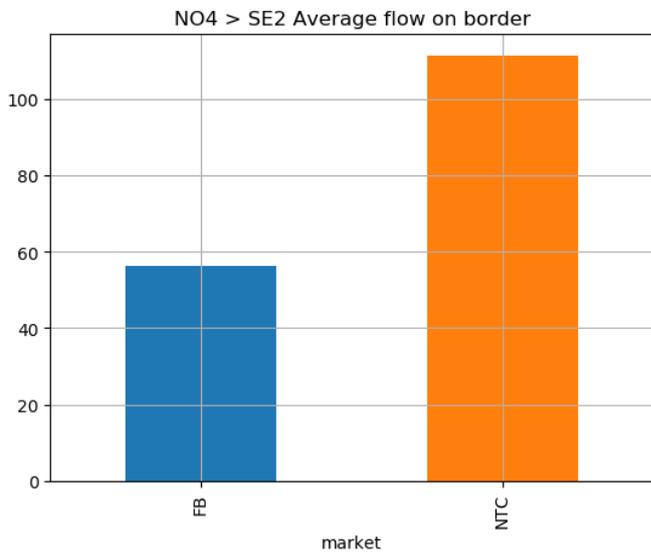
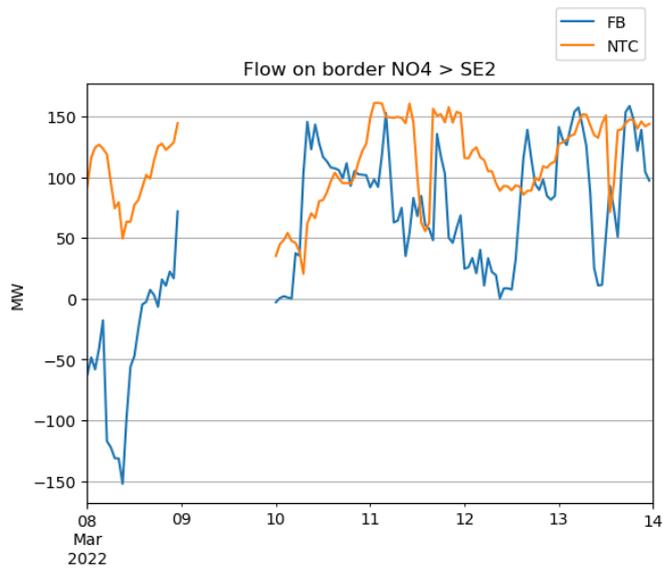
Final Parallel Run

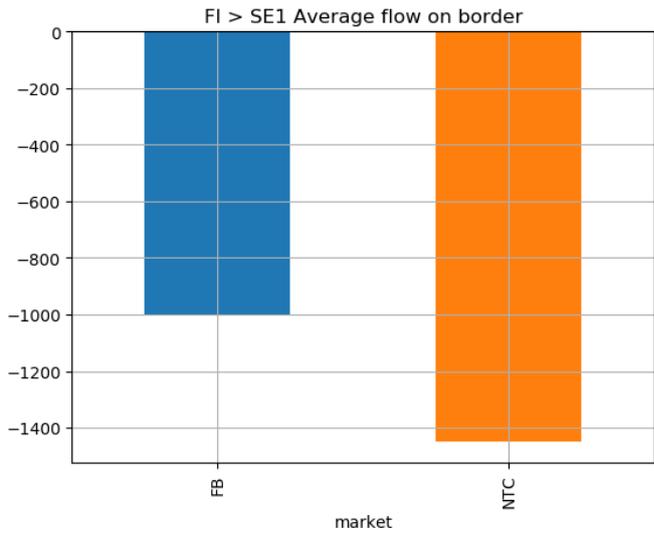
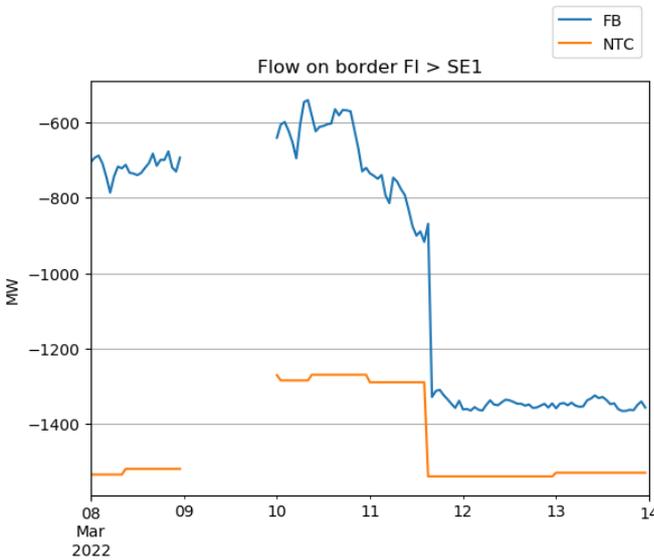
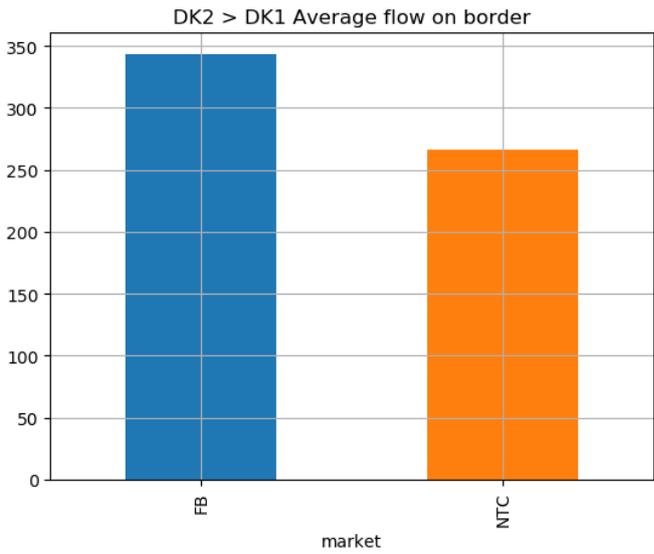




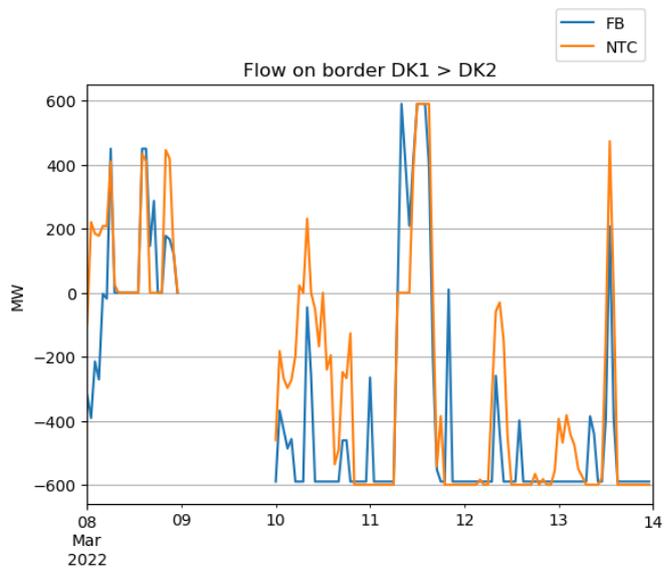
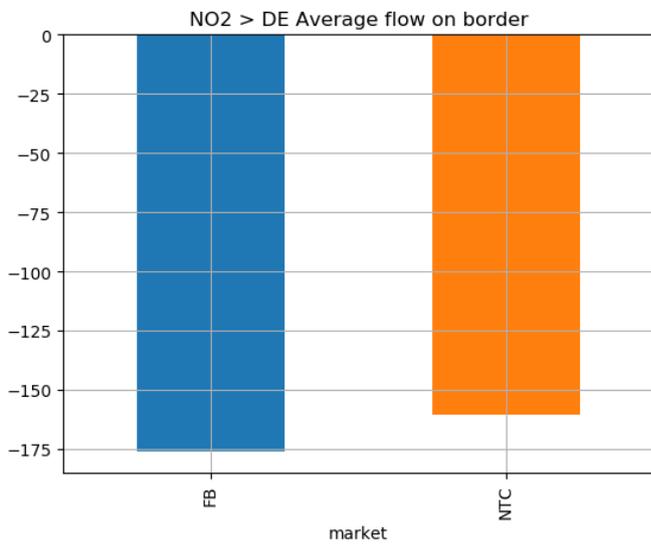
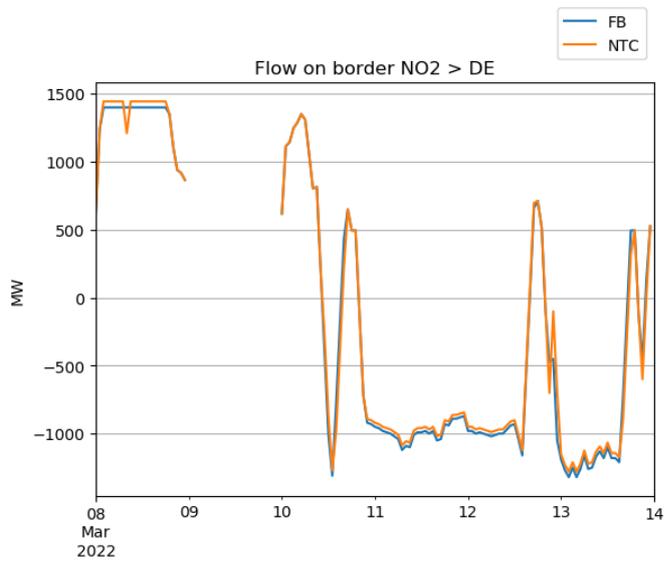
Parallel Run



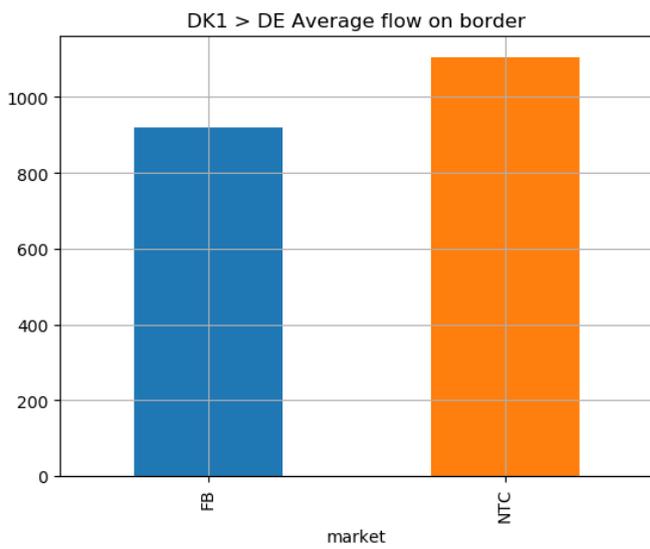
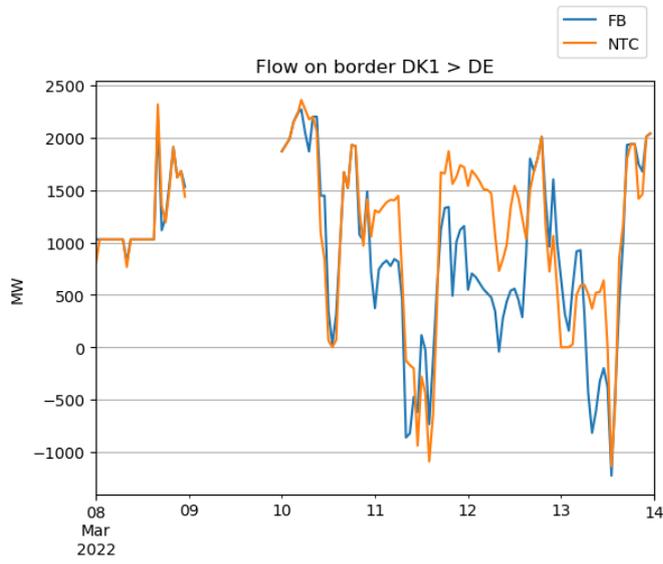
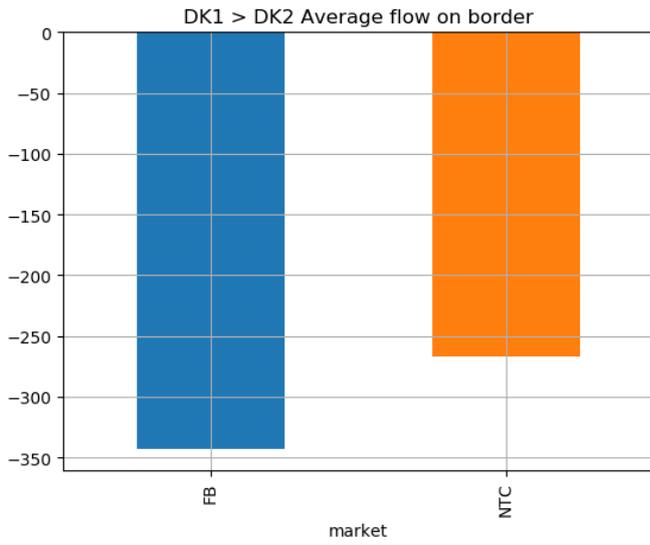


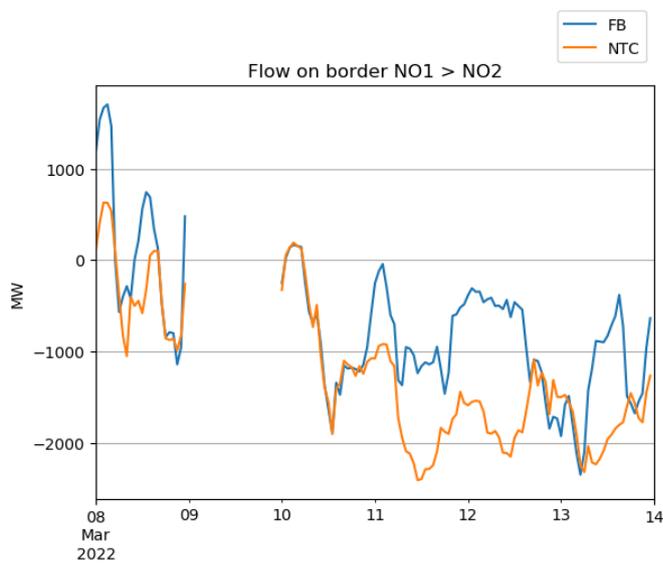
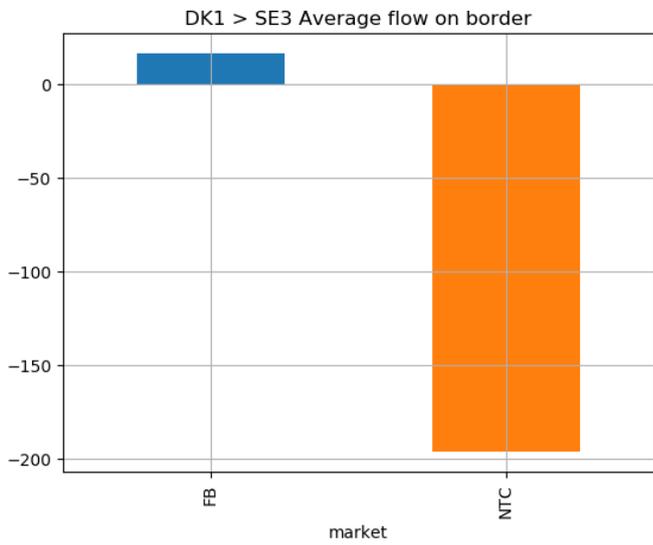
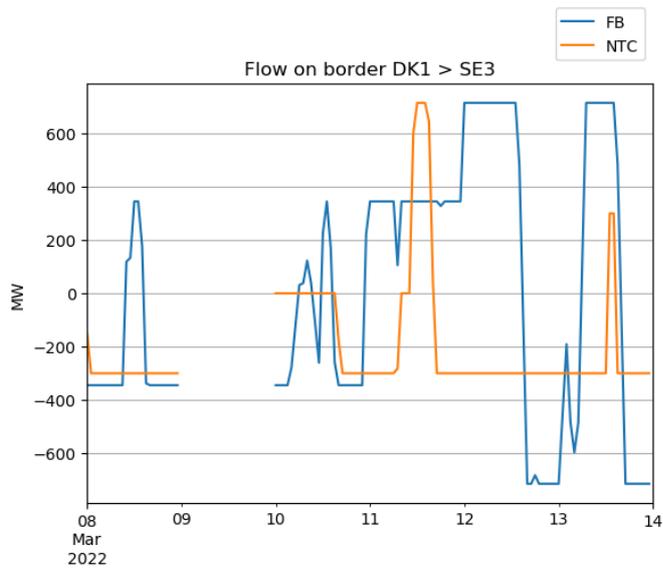


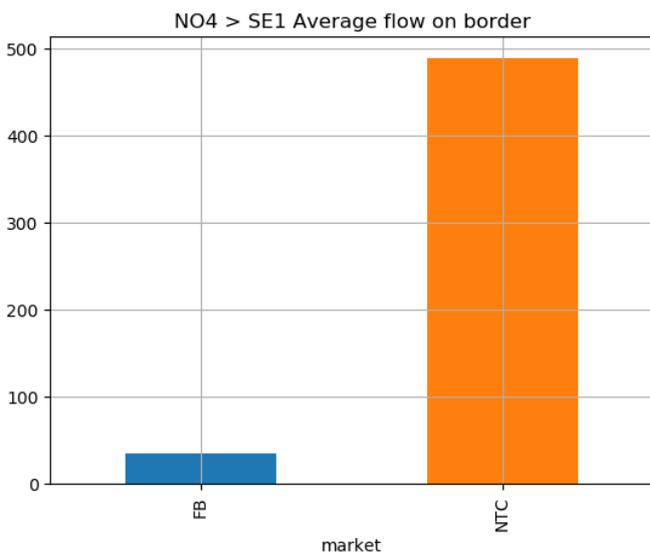
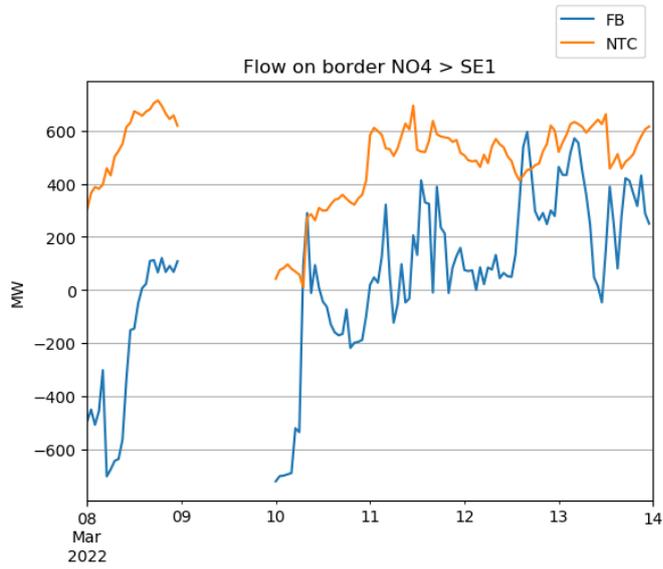
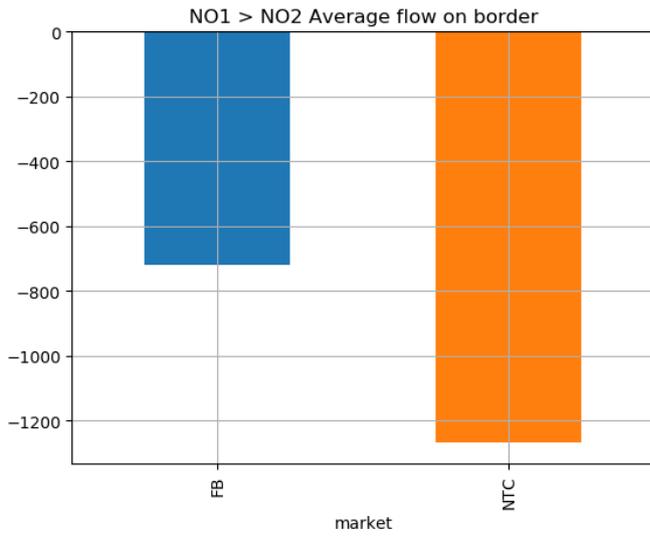
Parallel Run

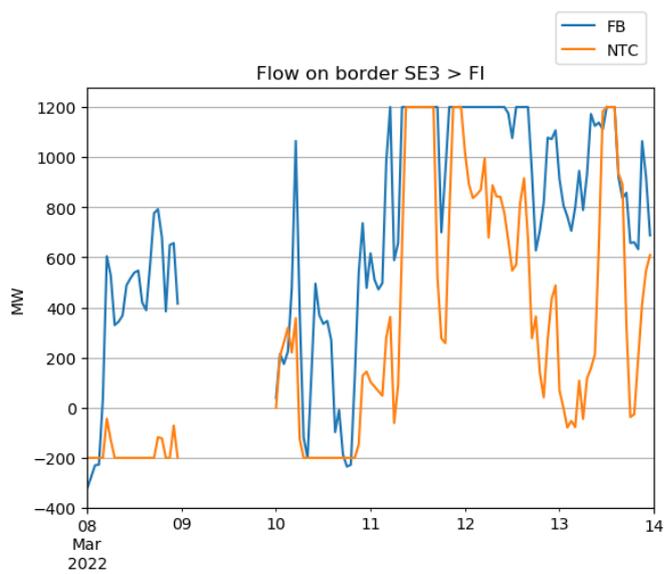
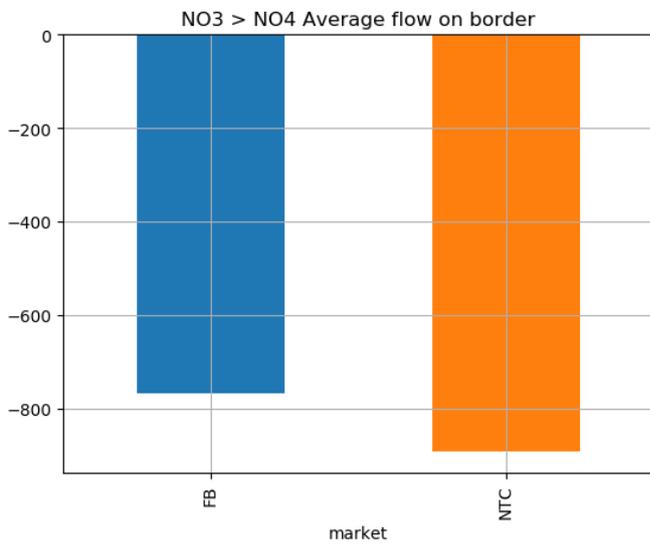
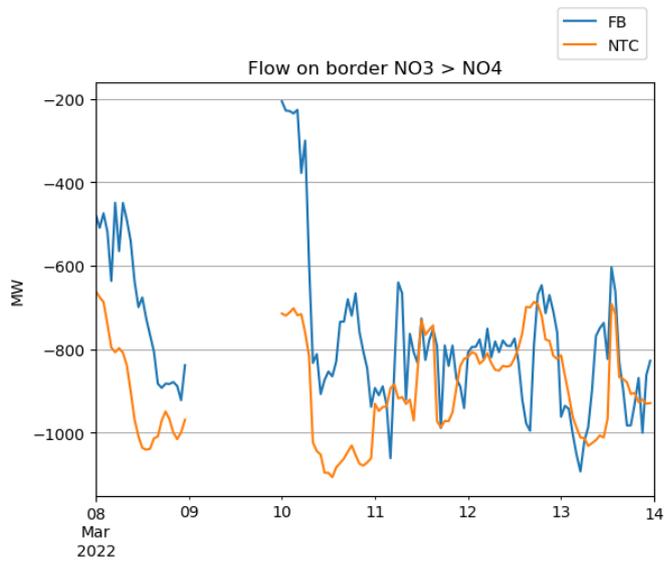


Parallel Run

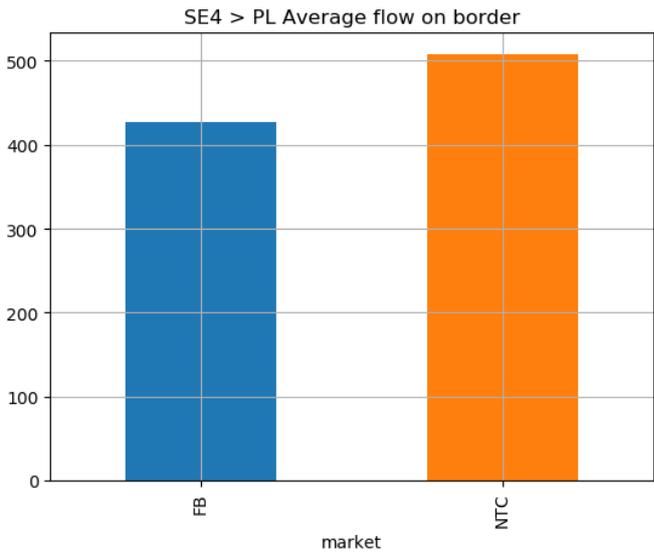
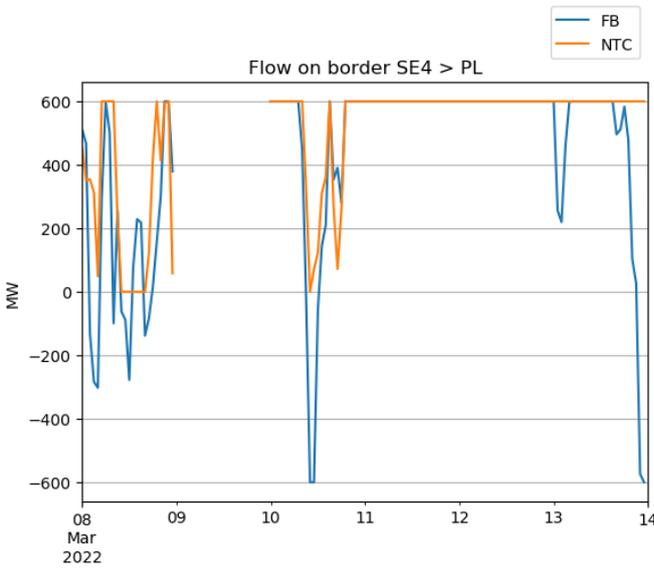
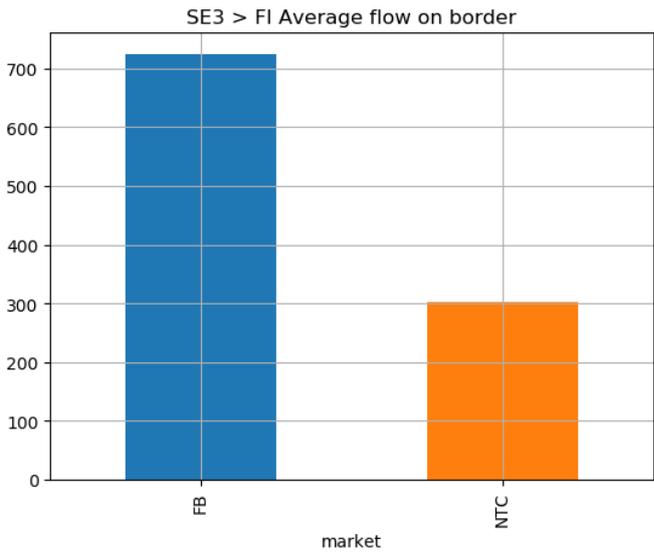


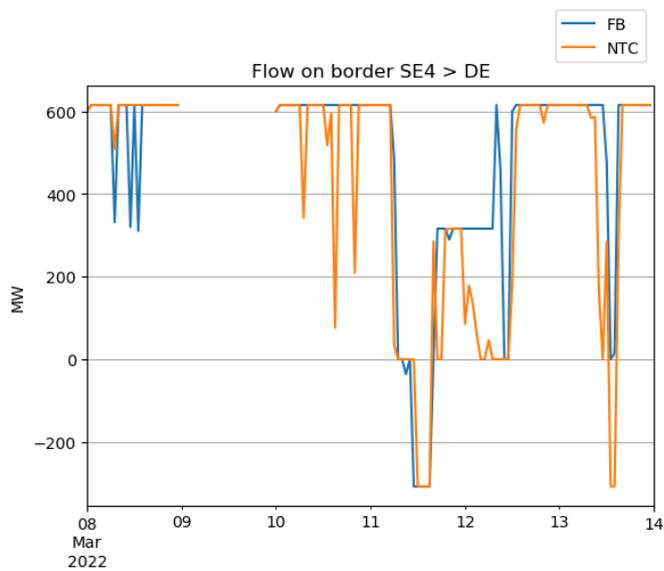
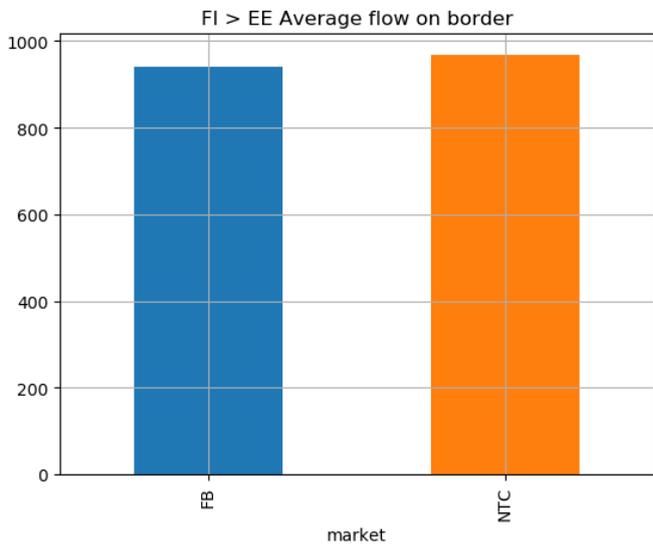
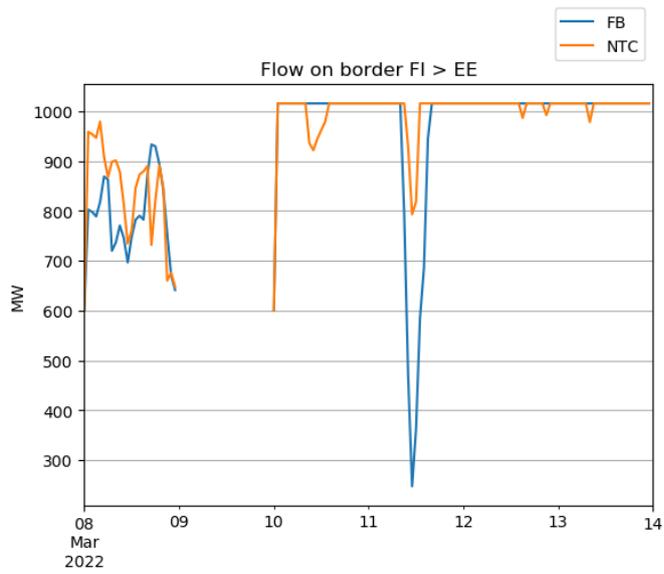




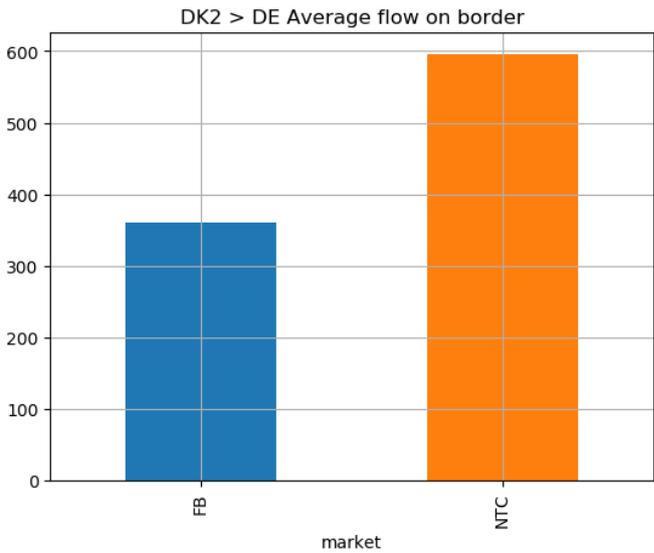
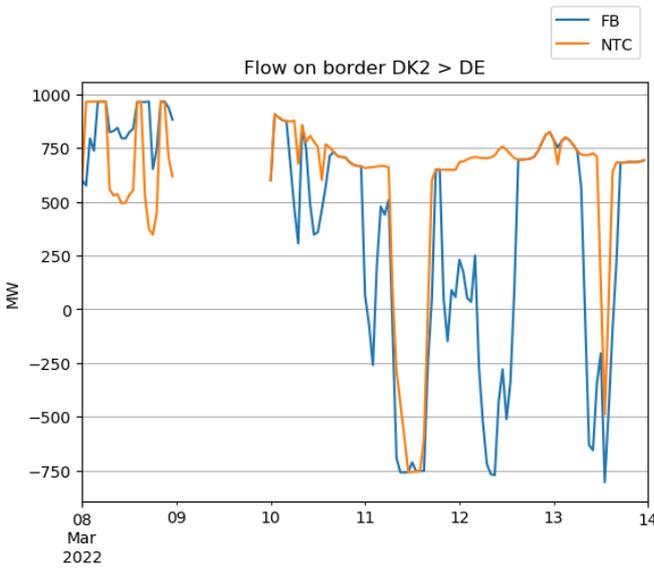
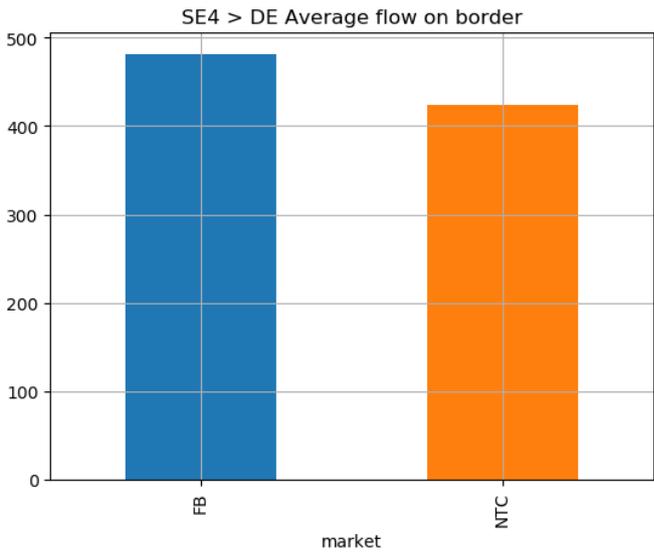


Parallel Run

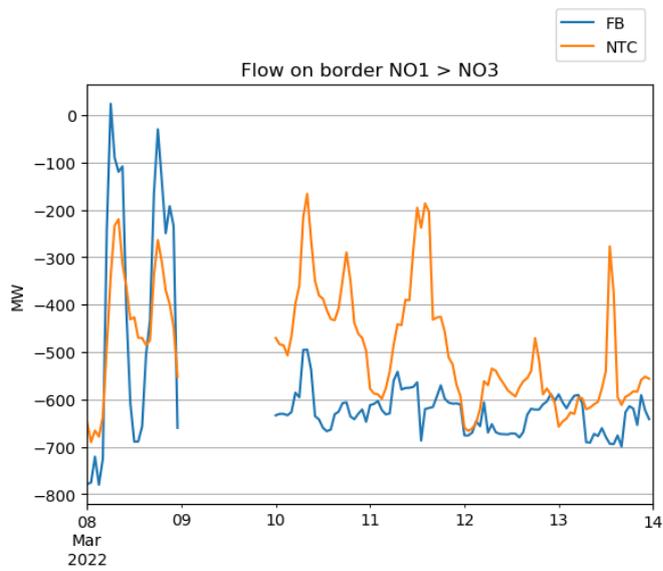
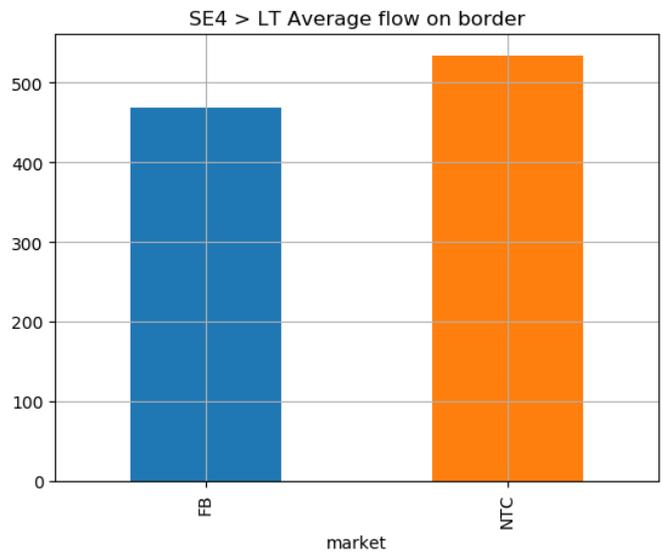
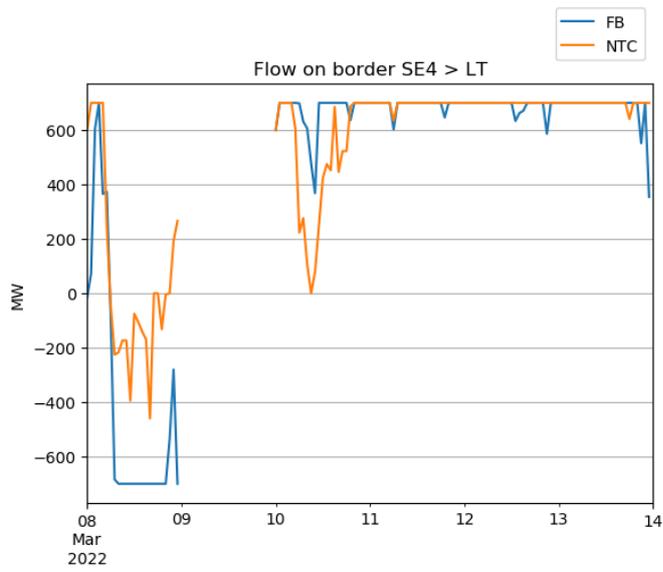




Parallel Run



Final Parallel Run



Parallel Run

