Version	1.2	
Date	16-12-2024	
Status	☐ Draft	☒ Final

Contents

1 Nomenclature

1.1 Abbreviations

Abbreviation	Description
FAAC	Already allocated capacity
AC	Allocation constraint
ac	Alternating current
AMR	Adjustment for minimum RAM
CCR	Capacity Calculation Region
CGM	Common Grid Model
CNE	Critical network element
CNEC	Critical network element and contingency
EIC	Energy information code
F0	Flow on CNE in case all bidding zones operate at zero net-position
FRA	Impact of remedial actions
Fref	Reference flow on the network element.
Fmax	Maximum allowed flow for the CNEC.
FRM	Flow reliability margin.
GSK	Generation shift key
IGM	Individual Grid Model
Imax	Maximum operational current limit.
IVA	Individual validation Adjustment
MTU	Market Time Unit
NP	Net position
OSL	Operational security limit
PTC	Power transfer corridor or combined dynamic constraint
PTDF	Power transfer distribution factor
RA	Remedial action
RAM	Remaining available margin
RM	Reliability margin
U	Voltage

1.2 Bidding zone definitions

Bidding zone definitions used in the Nordic flow-based capacity calculation methodology include market areas defined for the day-ahead market and virtual bidding zones that represent endpoints of HVDC interconnectors. The full list of bidding zones is provided below:

Table 1 Bidding zones in the Nordic flow-based market topology

Short name	Long name	Type	Synchronous area	HVDC within Nordic CCR	Opposite virtual bidding zone
DK1	Denmark West	Bidding zone	Central Europe		
DK2	Denmark East	Bidding zone	Nordic		
FI	Finland	Bidding zone	Nordic		
NO1	Norway 1	Bidding zone	Nordic		
NO2	Norway 2	Bidding zone	Nordic		
NO3	Norway 3	Bidding zone	Nordic		
NO4	Norway 4	Bidding zone	Nordic		
NO5	Norway 5	Bidding zone	Nordic		
SE1	Sweden 1	Bidding zone	Nordic		
SE2	Sweden 2	Bidding zone	Nordic		

SE3	Sweden 3	Bidding zone	Nordic		
SE4	Sweden 4	Bidding zone	Nordic		
NO2_SK	Norway 2 – Skagerak	Virtual bidding zone – Internal	Nordic	Skagerak	DK1_SK
DK1_SK	Denmark West - Skagerak	Virtual bidding zone – Internal	Central Europe	Skagerak	NO2_SK
DK1_SB	Denmark West – Storebælt	Virtual bidding zone – Internal	Central Europe	Storebælt	DK2_SB
DK2_SB	Denmark East – Storebælt	Virtual bidding zone – Internal	Nordic	Storebælt	DK1_SB
SE3_FS	Sweden 3 – Fennoskan	Virtual bidding zone – Internal	Nordic	Fennoskan	FI_FS
DK1_KS	Denmark West – Kontiskan	Virtual bidding zone – Internal	Central Europe	Kontiskan	SE3_KS
SE3_KS	Sweden 3 – Kontiskan	Virtual bidding zone – Internal	Nordic	Kontiskan	DK1_KS
FI_FS	Finland – Fennoskan	Virtual bidding zone – Internal	Nordic	Fennoskan	SE3_FS
SE3_SWL	Sweden 3 – SouthWestLink	Virtual bidding zone – Internal	Nordic	SouthWestLink	SE4_SWL
SE4_SWL	Sweden 4 – SouthWestLink	Virtual bidding zone – Internal	Nordic	SouthWestLink	SE3_SWL
SE4_SP	Sweden 4 - SwePol	Virtual bidding zone – External	Nordic		
SE4_NB	Sweden 4 – Nordbalt	Virtual bidding zone – External	Nordic		
SE4_BC	Sweden 4 – Baltic Cable	Virtual bidding zone – External	Nordic		
FI_EL	Finland – Estlink	Virtual bidding zone – External	Nordic		
DK1_DE	Denmark West – Germany	Virtual bidding zone – External	Central Europe		
DK2_KO	Denmark East – Kontek (incl. Kriegers Flak CGS)	Virtual bidding zone – External	Nordic		
DK1_CO	Denmark West – COBRA Cable	Virtual bidding zone – External	Central Europe		
NO2_ND	Norway 2 - NorNed	Virtual bidding zone – External	Nordic		
NO2_NK	Norway 2 – NorLink	Virtual bidding zone – External	Nordic		

Internal virtual bidding zones represent endpoints of HVDC links with both endpoints located in the Nordic capacity calculation region
External virtual bidding zones represent any connection (ac or HVDC) with other capacity calculation regions. See appendix 9.2 for EIC codes for all BZ's.

2 Background

The Nordic Day-ahead Capacity Calculation Methodology CCM Article 25 – "Publication of data" describes the publication obligations that TSOs need to fulfil. This encompasses the set-up of a dedicated online communication platform, and a handbook (this document) to enable market participants to have a clear understanding of the different published data.

The dedicated online communication platform is named the Nordic Publication Tool and can be accessed via the following link: https://publicationtool.jao.eu/nordic/

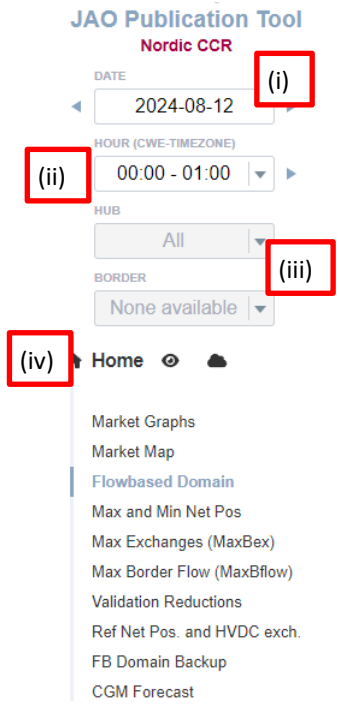
3 Navigation

The various publications are structured in multiple pages and listed in the vertical navigation bar. The navigation bar is always visible allowing users to switch between the different available publications.

Also present in the vertical navigation bar are filters which allow users to:

- Filter for a specific (i) business day and (ii) MTU
- Filter on specific (iii) bidding zones or (iv) borders

Note that not all filters may be relevant for a given view. When a filter is irrelevant for the displayed view, that filter is grayed out.



4 Downloading data

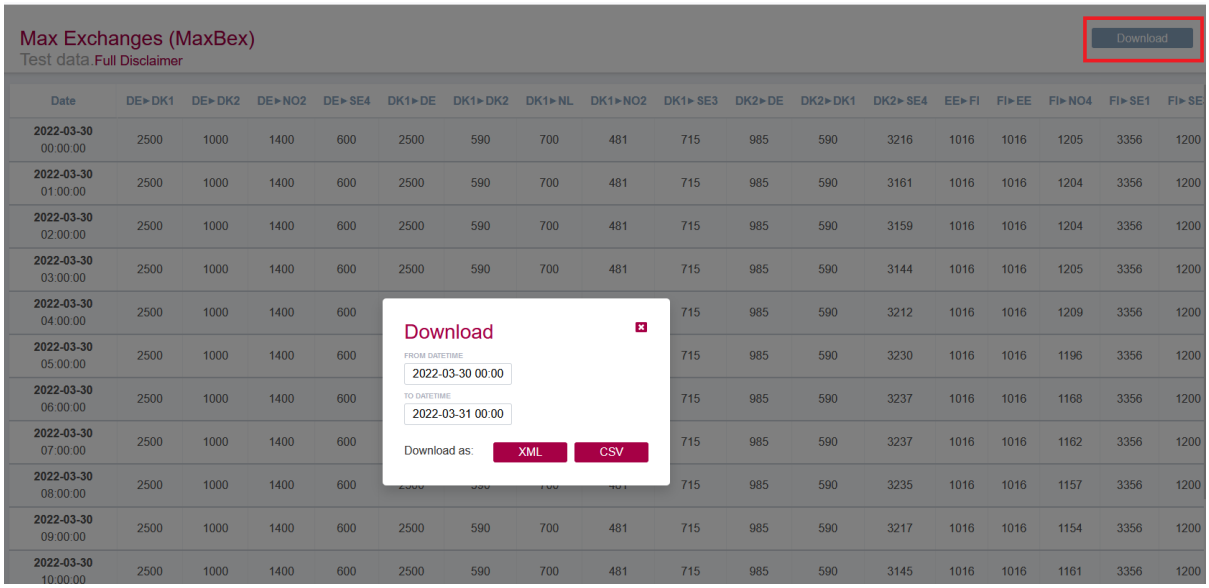
Users can download data in two formats (CSV or XML) via the “Download” button on the right upper corner of the page. Alternatively, data may be queried using the WebAPI as described in section 7 of this document.
Users may opt to download data covering a range of days or a single day. If preferred, further filtering option to download specific time interval is also possible.
Only source data can be downloaded using the Download button, these are the data displayed in the following pages:

- Flowbased Domain
- Shadow Price and Flow_FB
- Max and Min Net Pos
- Max Exchanges (MaxBex)
- Max Border Flow (MaxBflow)
- Validation Reductions
- Ref Net Pos. and HVDC exch.
- FB Domain Backup
- CGM Forecast

The main date filter in the navigation bar allows users to select and display data for a given day. Displaying multiple days in the GUI is not foreseen due to large volume of data (especially for domain pages).

The download option allows users additional filter functionality, users have an option to:

- Download a larger dataset (>24 hours)
- Download a shorter dataset (<24 hours)

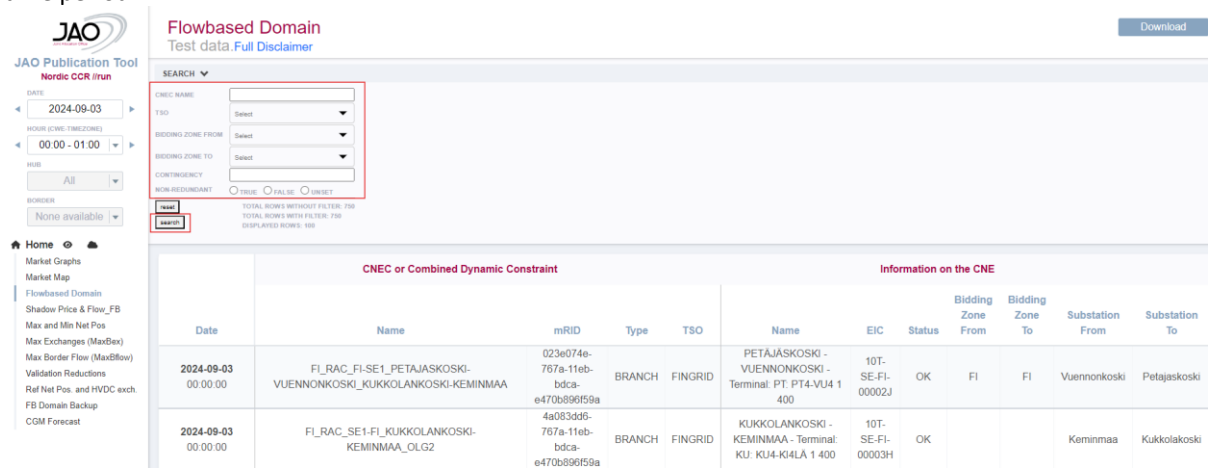


5 Filter functionality: Domain pages

In the Domain pages, users can filter within six specific columns:

- **CNE_Name** – Filter by CNE name
- **TSO** – Filter by one or more TSO(s). Select 'NONE' for only automatic generated CNEC's (Border and Netposition)
- **Bidding Zone From** – Filter by bidding zone from
- **Bidding Zone To** – Filter by bidding zones to
- **Contingency** – Filter by contingency name
- **Non-redundant** – Filter by redundancy

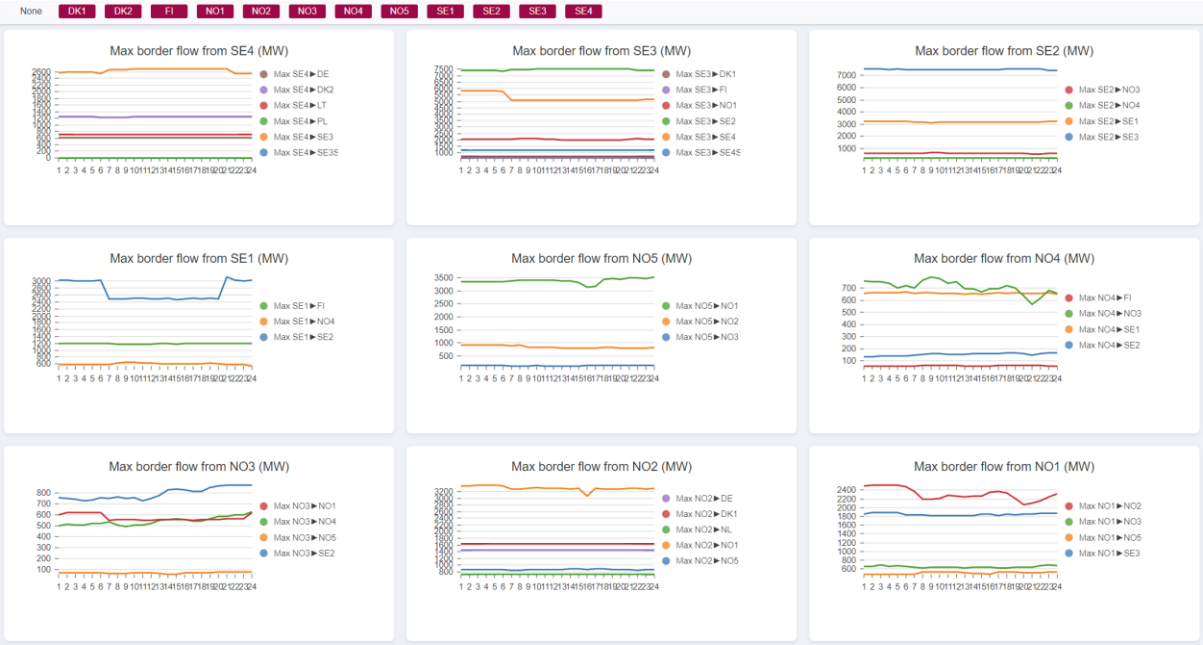
Enter the text to filter in the search field, to execute the filtering **click on the 'search' box.** The filter selection will not influence the downloading of data, here all the results are downloaded depending on the selected time period.

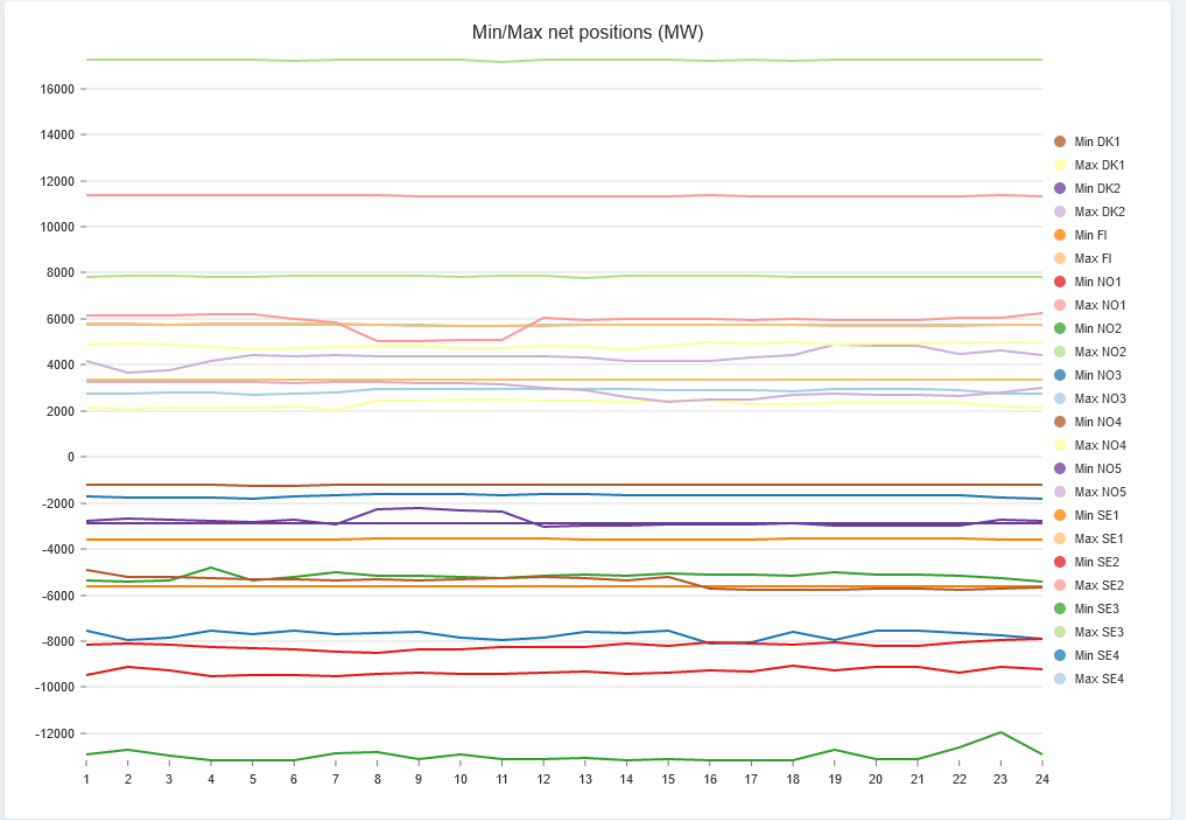


6 Publication Overview

6.1 Nordic Market Graphs

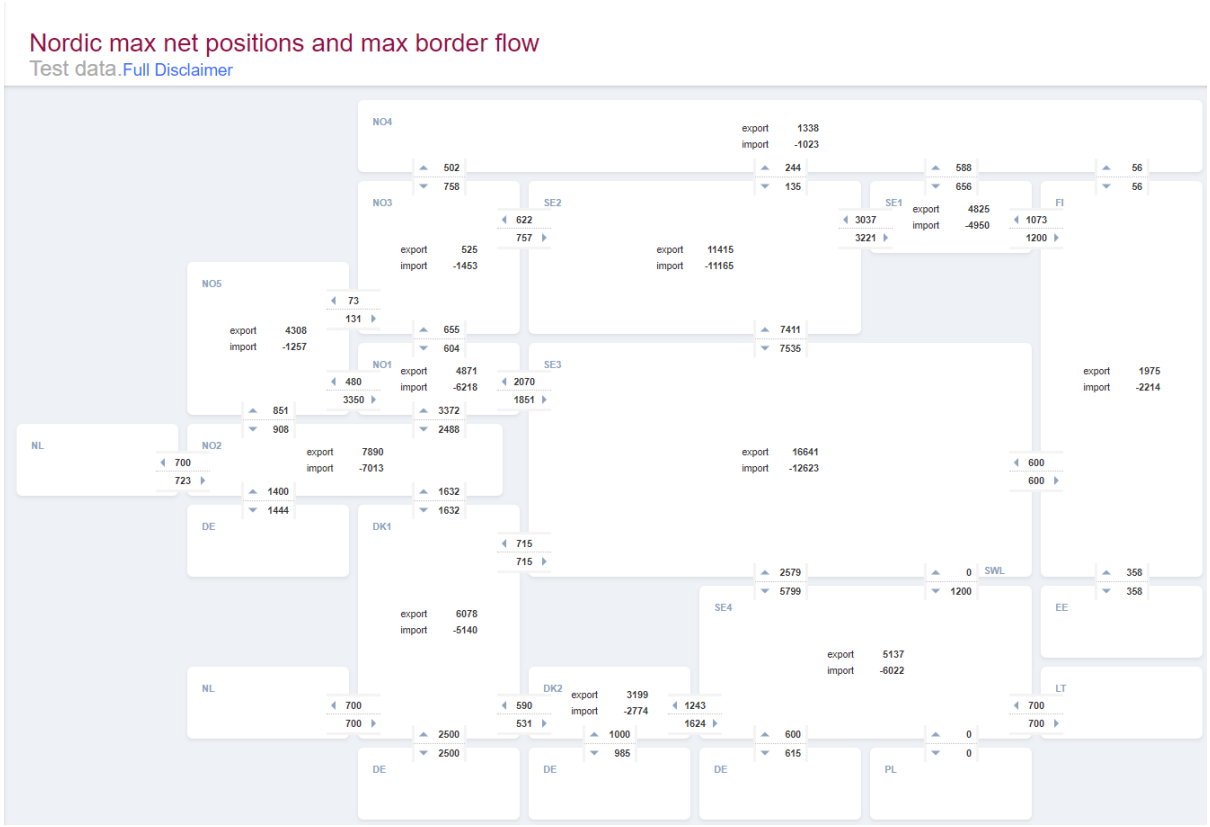
The “Nordic Market Graphs” illustrates for each Nordic real bidding zone, a graph with the Min/Max net positions and Max Border Flow (MaxBflow) for the 24 MTUs of the selected day. Users are able to de/select specific bidding zones on top of the page.





6.2 Market Map

The “Market map” displays the maximum possible flow on bidding zone borders (See Section 6.7) between adjacent bidding zones and the minimum and maximum net positions of each bidding zone (See Section 6.5) on a map representing the Nordic bidding zone configuration. The data corresponds to the MTU and Business Day as selected in the filter. Please note that each minimum or maximum net position and border flow is a unique extremum of the domain. Hence, simultaneous feasibility of e.g. maximum flow on two borders cannot be guaranteed.



6.3 Flow-based Domain

This page contains the flow-based parameters of the selected business day and MTU.

Description of table columns:

- **Date** – the energy delivery date and MTU for which the displayed data is valid
- **CNEC or Combined Dynamic Constraint:**
  - **Name** – Human readable identifier of the CNEC(*)
  - **mRID** – Unique CNEC ID(*)
  - **Type** – Critical branch type; Branch or Allocation constraint
  - **TSO** – The TSO which has defined the CNEC and submitted it for flow-based parameters calculation. If empty constraint automatic generated by system (e.g. Border_CNEC and Allocation Constraints).
- **Information on the CNE:**
  - **CNE_Name** – Human readable identifier of the network element(*)
  - **EIC –** Energy Information Code (see: https://www.entsoe.eu/data/energy-identification-codes-eic/eic-approved-codes/)
  - **Status** – Validity of CNEC; “OK” = valid, “OUT” = invalid
  - **Bidding Zone From** – Bidding zone associated with sending end (according to positive flow direction) of the CNE
  - **Bidding Zone To** – Bidding zone associated with receiving end (according to positive flow direction) of the CNE

- **Substation From** – Name of substation associated with sending end of CNE (not applicable for elements of type PTC)
- **Substation To** – Name of substation associated with receiving end of CNE (not applicable for elements of type PTC)
- **ElementType** – "CNE" refers to a real network element (e.g., line segment, transformer, …), "PTC" refers to a combined dynamic constraint defined for a group of network elements.

- **Information on the Contingency:**
  - **Contingency Name** – Human readable identifier of the contingency(*)
  - **EIC** – Energy Information Code of contingency
  - **Status** – "N": Parameters of the network element appear as in base case without any contingencies applied. "N-k": Parameters of the network element are shown for a case with one or more contingencies applied.
  - **Substation From** – Name or EIC of sending end substation of the contingency element
  - **Substation To** – Name or EIC of receiving end substation of the contingency element
- **Detailed breakdown**
  - **Imax method** – PATL: permanent admissible thermal loading, TATL: Temporary admissible thermal loading
  - **Non-redundant** – "True": The CNEC is constraining the flow-based domain. "FALSE": the CNEC represents a redundant constraint. (e.g., among the two constraints; x < 3 and x < 5, the latter is redundant as it is already captured by the former)
  - **Significant** – "True": The constraint has been considered in flow-based parameters calculation. "False": The constraint has been disregarded in the flow-based parameters calculation.
    CNEC significance is determined by evaluating the magnitude of the difference between smallest and larges zone-slack PTDF for the CNEC in question. CNECs for which the difference is smaller than the PTDF significance threshold are ignored in flow-based parameters calculation, as they have insignificant impact on cross-border exchange. The CNEC significance threshold is defined by the Nordic TSOs but must at least be 0.05 as per the Nordic Capacity Calculation Method.
  - **RAM** – Remaining available margin, i.e. spare transmission capacity available for trade:

$$\mathrm{RAM} = \mathrm{F_{max}} - \mathrm{F_{RM}} - \mathrm{F_0} + \mathrm{F_{RA}} + \mathrm{AMR} - \mathrm{F_{AAC}} - \mathrm{IVA}$$

  - **Min Flow** – The minimum flow possible for the CNEC (see section 6.3.4)
  - **Max Flow** – The maximum flow possible for the CNEC (see section 6.3.4)
  - **U** – The voltage used in Fmax calculation
  - **Imax** – Maximum operational current limit corresponding to the implicit Fmax value. If Fmax is defined explicitly (e.g for PTC) this value is not defined and is then set to zero.
  - **Fmax** – Maximum allowed flow for the CNEC. Value is stated in MW
  - **FRM** – Flow reliability margin accounts for uncertainties in flows (e.g. due to forecast uncertainties). See Appendix 9.1.1
  - **Fref**– Reference flow on the network element, i.e. the flow stated in the common grid model which was used as basis for the flow-based domain parameters calculation.
  - **F0** – Flow on the CNE in case all bidding zones operate at zero net-position
  - **FRA** – Impact of remedial actions on flow on the CNE
  - **AMR** – Adjustment for minimum RAM is used to ensure that RAM is always greater than or equal to 0
  - **FAAC** – Already allocated capacity on the CNE is used to represent allocations for frequency restorative reserves
  - **IVA** – Individual validation adjustment provided by TSOs during domain validation in case of unplanned outages of incorrect input data is detected.
- **PTDFs** – Power transfer distribution factors:
  - Zone to slack PTDFs – Values describe how much the flow on the CNE would increase in response to a 1MW increase of the net-position of a given bidding zone. A list of bidding zones is provided in section 1.2.

*) Note that names of certain network elements are anonymized in accordance with Article 2(d) of Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection. This means that the network element or contingency, in question, has been assigned a new unique and static identifier, which cannot be used to identify the physical location of the asset.

SEARCH

	CNEC or Combined Dynamic Constraint				Information on the CNE		
Date	Name	mRID	Type	TSO	Name	EIC	Status
2024-09-03 00:00:00	7d34e3a165ac4e31aaf305069d488603	64884fdc5599419d8aea01637741e3a2	BRANCH	SVK	ee1677381f184ecf8d7a0520da55deeb		OK
2024-09-03 00:00:00	e2618093d5ef409aac03850ed70c2ade	a299b964b21349c48e32bc6093bd0d89	BRANCH	SVK	c832ae01cffe4c9086187ad90dc309a5		OK
2024-09-03 00:00:00	8981407910d34025897ac2b83dd9ed86	020e8965a36440c88e3b1f06f5dc0fea	BRANCH	SVK	82e941f4712e441fa8b8bea2ecc52845		OK
2024-09-03 00:00:00	b85cf62bcacb470fb0ba242febe19db1	d9a3f012855b4b22934908b3968de8da	BRANCH	SVK	607e4a5a7c71486ea592d04c2b84eeae		OK
2024-09-03 00:00:00	d4d2492b244f4919bace33571de9ca31	f801cf5c95814a16a2ece038f974ee08	BRANCH	SVK	c10eba93ab434c7b8b639ec3444e39ff		OK
2024-09-03 00:00:00	7f03d41b40d54edeb1aa58fdeecc1acc	3a19988a8b064f6eabb11b44f0fff675	BRANCH	SVK	1396025bce604e528c5807eb71b1cc58		OK

6.3.1 Border CNECs

For each bidding-zone border and direction is a system-defined border CNEC. These may be identified by the CNEC name that follows the naming convention: “Border_CNEC_[BZfrom]-[BZto]”.
The border CNECs do not represent constraints of the operational security of the power system, and they have been assigned an arbitrarily high value of Fmax to ensure that they are redundant and do not impact trading capacities.
The Border_CNECs are used for monitoring purposes only. E.g. the Fref of a border CNEC indicates what flows are assumed on the bidding-zone border in the CGM base-case. Furthermore, the zone-slack PTDFs of Border CNECs may be used to assess cross zonal power flows resulting from a given set of net positions.
Border CNECs for borders between real and virtual bidding zones will have zero zone-slack PTDFs for all bidding-zones, except for the adjacent virtual bidding zone, where the PTDF is +1 or -1.

6.3.2 Netposition CNECs

For each bidding-zone is a system-defined Netposition CNEC. These may be identified by the CNEC name that follows the naming convention: “Netposition_[BZ]”.
The Netposition CNECs do not represent constraints of the operational security of the power system, and they have been assigned an arbitrarily high value of Fmax to ensure that they are redundant and do not impact trading capacities.
The Netposition CNECs are used for monitoring purposes and calculation of minimum and maximum net position of each bidding zone. Max and Min Flow of a Netposition CNEC corresponds to values in the “Max and Mn Net Pos” page.

6.3.3 Allocation constraints on virtual bidding zones

A subset of CNECs in the flow-based domain are labeled with names according to the convention “AC_maximum_[virtualBZname]” and “AC_minimum_[virtualBZname]”. These CNECs are furthermore defined with Type = ALLOCATION_CONSTRAINT.
This reflects that the constraints were submitted as an allocation constraint into the flow-based parameters calculation and was translated to a CNEC-like constraint by setting zone-to-slack PTDF of the associated virtual bidding zone to +1 or -1 and the RAM equal to the value of the allocation constraint. This approach is used to set capacities for HVDC lines and capacities for interconnectors to external CCRs.

6.3.4 Minimum and maximum flow on CNECs

The minimum and maximum flow on a CNEC, m, is calculated by maximizing or minimizing the sum-product of zone-to-slack PTDFs and bidding zone net positions, while respecting RAM on the CNECs and maintaining balance among the Nordic bidding zones. The optimization is performed using linear programming with the following objective function and constraints:

$$minFlow(c) \leftarrow min \sum_{\forall n \in N} [PTDF(c,n) \cdot NP(n)] + f_0(c)$$

$$maxFlow(c) \leftarrow max \sum_{\forall n \in N} [PTDF(c,n) \cdot NP(n)] + f_0(c)$$

Subject to

$$RAM(m) > \sum_{\forall n \in N} [PTDF(m,n) \cdot NP(n)] \quad \forall\, m \in M$$

And

$$0 = \sum_{\forall\, g \in G} NP(g) \quad \forall\ G \in \Gamma$$

Where

- $f_0(c)$ is the flow on CNEC c in case all net positions are zero
- $PTDF(c,n)$ zone-to-slack PTDF of CNEC c with respect to bidding zone n
- NP is the set of bidding zone net positions, being the decision variable in optimization
- Γ is the set of groups of bidding zones for which the sum of net positions must be zero. I.e. bidding zones belonging to the same synchronous area or virtual bidding zones belonging to the same HVDC link inside the Nordic region (see Table 1)
- G is the group of bidding zones belonging to the same synchronous area or to the same HVDC link inside the Nordic CCR.
- M is the set of CNECs in the flow-based domain
- N is the set of bidding zones in the Nordic flow-based market topology

6.3.5 Spanning Backup CNECs

In the case of an MTU with a spanning backup (see Section 6.10, FB Domain Backup, where two neighboring FB Domains are interlaced), all CNEC names will be extended with the reference MTU and mRID.

The picture below shows two CNECs for a spanning FB domain in MTU01. The CNEC name "AC_Minimum_DK1_KS" has been copied from neighboring MTU00 and MTU02 (highlighted with a red square) and appended with the original CNEC mRID (highlighted with a green square).

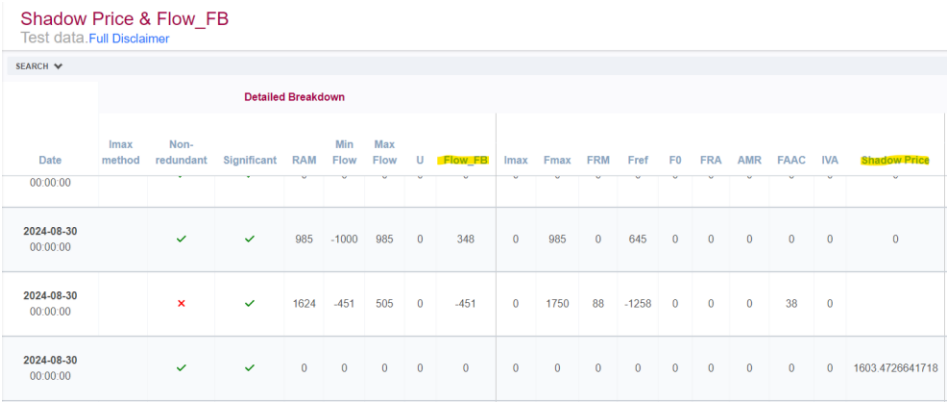
Date	Name
2024-11-16 01:00:00	AC_Minimum_DK1_KS_MTU00_31e0f644-1138-4d34-999b-e54d9a453b02
2024-11-16 01:00:00	AC_Minimum_DK1_KS_MTU02_31e0f644-1138-4d34-999b-e54d9a453b02

6.4 Shadow Price and Flow FB

This page contains a replica of the flow-based parameters for the given day and MTU (FB domain page), along with two additional columns that include the post-coupling parameters: Shadow Price and Flow_FB.

- **Shadow Price:** Shadow price on from the FB market coupling results
- **Flow_FB:** Expected Flow on the CNE including internal flow. Calculated from the FB market coupling results:

$$Flow\_FB(c) \leftarrow PTDF(c,n) \cdot NP(n) + f_0(c)$$

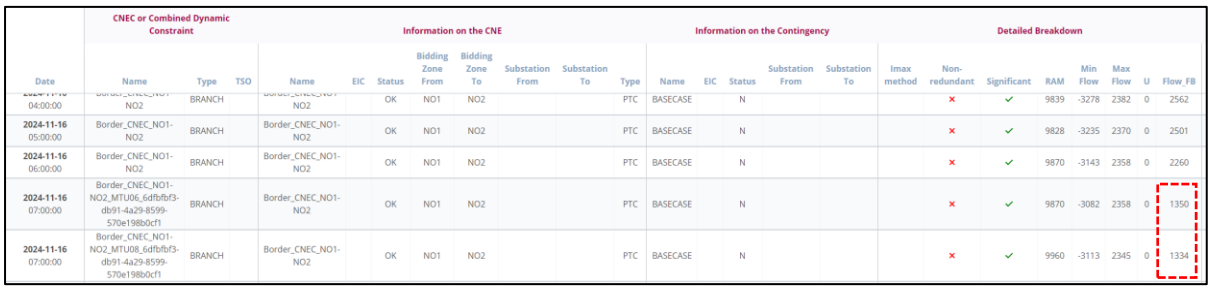


The BZ netpositions from FB market coupling result are found as 'Flow_FB'-values for the Netposition CNECs (described in section 6.3.2).

6.4.1 Border flow (Flow_FB) for spanning Backup

Described above (see Section 6.3.5 on Spanning Backup CNECs), there are two CNEC entries for the same border in a spanning backup scenario. As a result, no explicit expected physical flow (FLOW_FB) is calculated for specific borders in a spanning backup. This means that the FLOW_FB values for these two border CNEC entries may differ depending on the Zone-to-Slack PTDFs of the respective MTU border CNECs.

In the figure below, an example of such a situation is illustrated. For MTU07, which was a spanning backup MTU, the FB calculation system used FB parameters from the previous MTU06 and the next MTU08 as the interlace. The respective border CNEC FLOW_FB values for NO1-NO2 differ by 16 MW (1350 MW vs. 1334 MW) due to differences in the Zone-to-Slack PTDFs.



FLOW_FB value of the border CNECs that were used in a spanning backup MTU.

Border flow for ATCE process

Spanning backup cases also impact the ATCE process, as these border CNECs are used to assess the already allocated flows (AAF) on the borders. In the current ATCE system implementation, the system considers the border CNECs and their FB parameters from the earlier MTU and not the MTU to which the respective result applies. Therefore, in the case described above, for the MTU07 ATCE process calculations, the system would use the MTU06 border CNEC instead of the MTU08 one.

6.5 Max and Min Net positions

This page displays the minimum and maximum net positions in MW of each bidding zone for each MTU of the day.

Min and Max Net Positions

Test data.Full Disclaimer

Date	Min DK1	Min DK1_CO	Min DK1_DE	Min DK1_KS	Min DK1_SB	Min DK1_SK	Min DK2	Min DK2_KO	Min DK2_SB	Min FI	Min FI_EL	Min FI_FS	Min NO1	Min NO2	Min NO2_ND	Min NO2_NK
2024-09-03 00:00:00	-4941	-700	-2500	-700	-531	-1632	-2774	-985	-590	-2215	-358	-600	-6556	-6780	-723	-1444
2024-09-03 01:00:00	-4707	-700	-2500	-700	-531	-1632	-2787	-985	-590	-2214	-358	-600	-6551	-6859	-723	-1444
2024-09-03 02:00:00	-4188	-700	-2500	-700	-531	-1632	-2787	-985	-590	-2213	-358	-600	-6506	-6887	-723	-1444
2024-09-03 03:00:00	-4111	-700	-2500	-700	-531	-1632	-2787	-985	-590	-2213	-358	-600	-6505	-6876	-723	-1444

6.6 Max Exchanges (MaxBex)

This page displays the maximum bilateral exchanges between two Nordic bidding zones with the assumption that net positions of all other non-virtual bidding zones are zero.
Note that maximum bilateral exchange is the total amount of power transfer, between two adjacent bidding zones, that can be realized within the secure domain, provided that the entire Nordic transmission system capacity is available for this exchange only. This means that the maximum bilateral exchange between two bidding zones typically will be significantly larger than the transmission capacity of the border between the same two bidding zones.

Max Exchanges (MaxBex)

Test data.Full Disclaimer

Date	DE►DK1	DE►DK2	DE►NO2	DE►SE4	DK1►DE	DK1►DK2	DK1►NL	DK1►NO2	DK1►SE3	DK2►DE	DK2►DK1	DK2►SE4	EE►FI	FI►EE	FI►NO4
2024-09-03 00:00:00	2500	1000	1400	600	2500	531	700	1632	700	985	590	1583	358	358	725
2024-09-03 01:00:00	2500	1000	1400	600	2500	531	700	1632	700	985	590	1596	358	358	677
2024-09-03 02:00:00	2500	1000	1400	600	2500	531	700	1632	700	985	590	1602	358	358	650
2024-09-03 03:00:00	2500	1000	1400	600	2500	531	700	1632	700	985	590	1600	358	358	623

6.6.1 Calculation of maximum bilateral exchange

The maximum bilateral exchange is calculated as a linear programming problem wherein the net position of the exporting bidding zone is maximized under the constraint that only the importing bidding zone may absorb the excess power. The formulation is given below:

$$maxBex(x \rightarrow y) : max\ NP(x)$$

Subject to

$$0 = NP(x) + NP(y)$$

$$0 = NP(z) \quad \forall z \in B$$

$$RAM(m) > \sum_{\forall n \in N} [PTDF(m,n) \cdot NP(n)] \quad \forall\, m \in M$$

$$0 = \sum_{\forall\, g \in G} NP(g) \quad \forall\ G \in \Gamma$$

Where

- x is the exporting bidding zone for maximum bilateral exchange calculation
- y is the importing bidding zone for maximum bilateral exchange calculation
- NP is the set of bidding zone net positions, being the decision variable in optimization
- B is the set of real bidding zones in the Nordic market topology, excluding bidding zones x and y

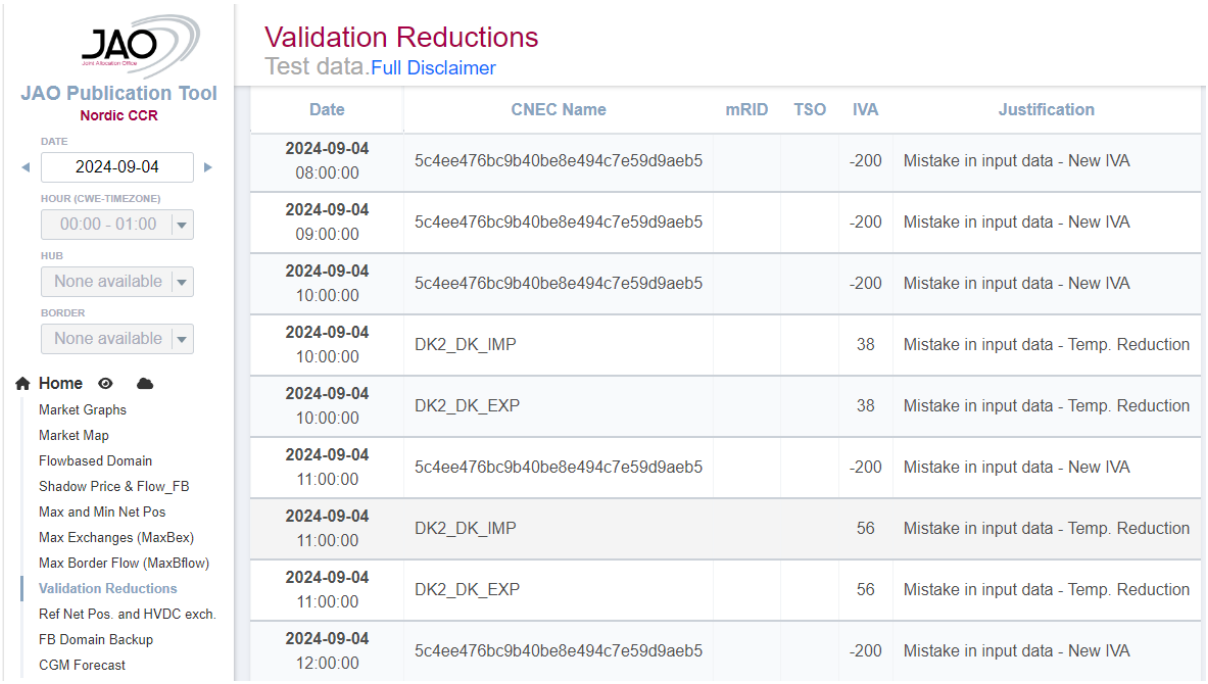
- Γ is the set of groups of bidding zones for which the sum of net positions must be zero. I.e. virtual bidding zones belonging to the same HVDC link inside the Nordic region.
- G is the group of bidding zones belonging to the same HVDC link inside the Nordic CCR.
- M is the set of CNECs in the flow-based domain
- N is the set of bidding zones in the Nordic flow-based market topology

6.7 Max Border Flow (MaxBflow)

This page lists the maximum flows across bidding zone borders. For each CNEC in the flow-based domain, the maximum flow which may be realized is calculated using linear programming. The maximum border flow corresponds to the maximum flow found for related border_CNECs.

6.8 Validation Reductions

This page lists CNECs for which capacity has been adjusted as an outcome of the validation process. For each validation reduction (or increase) justification is provided by the TSO operator.



Date	CNEC Name	mRID	TSO	IVA	Justification
2024-09-04 08:00:00	5c4ee476bc9b40be8e494c7e59d9aeb5			-200	Mistake in input data - New IVA
2024-09-04 09:00:00	5c4ee476bc9b40be8e494c7e59d9aeb5			-200	Mistake in input data - New IVA
2024-09-04 10:00:00	5c4ee476bc9b40be8e494c7e59d9aeb5			-200	Mistake in input data - New IVA
2024-09-04 10:00:00	DK2_DK_IMP			38	Mistake in input data - Temp. Reduction
2024-09-04 10:00:00	DK2_DK_EXP			38	Mistake in input data - Temp. Reduction
2024-09-04 11:00:00	5c4ee476bc9b40be8e494c7e59d9aeb5			-200	Mistake in input data - New IVA
2024-09-04 11:00:00	DK2_DK_IMP			56	Mistake in input data - Temp. Reduction
2024-09-04 11:00:00	DK2_DK_EXP			56	Mistake in input data - Temp. Reduction
2024-09-04 12:00:00	5c4ee476bc9b40be8e494c7e59d9aeb5			-200	Mistake in input data - New IVA

Please note that the justification is sent by the TSOs themselves. The TSOs Energinet, Fingrid, Statnett and Svenska Kraftnät run the individual validation process commonly with a centralized tool thus resulting in common justifications.
In case a TSO operator find that the flow-based domain does not accurately represent the operational reality, the domain is adjusted by IVAs. IVAs are provided per CNEC to restrict or relax the limits they impose on the domain. The reason may be a forced outage, outages ending sooner than anticipated during IGM creation or errors in input data. A TSO can apply IVA only on its own CNECs. The provision of IVAs for a CNEC may alter the redundancy status of that CNEC, i.e. IVA can be used to define if a CNEC will restrict the flow-based domain or not.

6.9 Reference Net Position and HVDC Exchange

This page displays the reference net position assumed for creating the CGM. Net positions are provided for all Nordic bidding zones including virtual bidding zones that represent endpoints of HVDC connections.

Note that the sign of net positions for virtual bidding zones is positive when power is flowing from the virtual bidding zone to the adjacent real bidding zone and negative otherwise.

For example: in the below figure, the net position of virtual bidding zone NO2_SK (NO2 side of Skagerrak HVDC) is -1688W for hour 00:00. This means that Skagerrak is receiving 1688MW from NO2, i.e. NO2 is exporting to DK1.

Reference Net Position and Reference HVDC Exchange

Test data.Full Disclaimer

Date	DK1	DK1_CO	DK1_DE	DK1_KS	DK1_SB	DK1_SK	DK2	DK2_KO	DK2_SB	FI	FI_EL	FI_FS	NO1	NO2	NO2_ND	NO2_NK	NO2_SK
2024-09-03 00:00:00	262	-700	-1604	196	215	1630	-460	-626	-219	-29	-367	4	-20	1331	-640	-1167	-1688
2024-09-03 01:00:00	279	-700	-1666	196	261	1630	-455	-585	-265	-29	-367	3	-25	1369	-640	-1197	-1688

6.10 FB Domain Backup

This page displays if a flow-based backup process was triggered in the preparation of the published flow-based parameters. There are two kinds of flow-based backup processes:

- **Spanning backup** – The flow-based parameters from two different MTUs will be interlaced. This forms a backup domain as the intersection of valid operating points in the two reference domains. When spanning backup is applied, the reference time interval will include two entries, referring to the two MTUs that were interlaced.
- **Reference MTU Backup** – The flow-based parameters from one previous MTU is used in place of the flow-based parameters of the failed MTU

FB Domain Backup

Date	Type	Reference Time Interval (2 reference times = spanning)
2024-08-08 00:00:00	backup	2024-08-06T22:00Z/2024-08-06T23:00Z
2024-08-08 01:00:00	backup	2024-08-06T23:00Z/2024-08-07T00:00Z

6.11 CGM Forecast

This page holds information of the TSO's forecast of load and generation that were used for creating the CGMs.

- Vertical load is the load (per bidding zone and per TSO) included in the CGM for a given MTU
- Generation is the sum of production (per bidding zone and per TSO) included in the CGM for a given MTU

CGM Vertical Load and Generation Forecast

Test data.Full Disclaimer

	Vertical Load												Generation											
Date	DK1	DK2	FI	NO1	NO2	NO3	NO4	NO5	SE1	SE2	SE3	SE4	DK1	DK2	FI	NO1	NO2	NO3	NO4	NO5	SE1	SE2	SE3	SE4
2024-09-03 00:00:00	2112	1175	7274	2476	3174	2628	1740	1576	868	957	6389	1615	-2985	-769	-7527	-2552	-6058	-2520	-1771	-4035	-2579	-4841	-5394	-536
2024-09-03 01:00:00	2031	1149	7139	2379	3103	2587	1699	1558	841	940	6207	1654	-2742	-747	-7378	-2447	-6025	-2478	-1729	-4017	-2548	-4820	-5224	-578

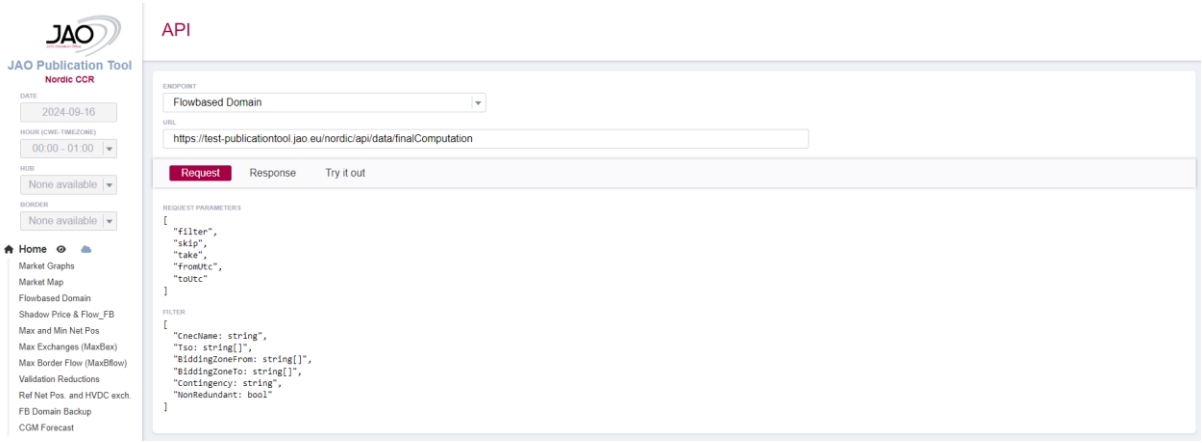
7 Web API

A Web API is provided for retrieving the published data. A graphic user interface to the web API may be accessed through the navigation bar.

Or by using the following URL: https://publicationtool.jao.eu/nordic/api

On this page the user can choose which database to retrieve data from.

- **Endpoint:** List of databases to choose from
- **URL:** Specific URL for the chosen endpoint



Following databases may be queried through the web API:

Data base	URL
Flow-based domain	https://publicationtool.jao.eu/nordic/api/data/finalComputation
Shadow Price & Flow_FB	https://publicationtool.jao.eu/nordic/api/data/fbDomainShadowPrice
Max Exchange (MaxBex)	https://publicationtool.jao.eu/nordic/api/data/maxExchanges
Max Border Flow (MaxBflow)	https://publicationtool.jao.eu/nordic/api/data/maxBorderFlow
Min and Max Net Positions	https://publicationtool.jao.eu/nordic/api/data/maxNetPos
Ref Net Pos. and HVDC exch.	https://publicationtool.jao.eu/nordic/api/data/referenceNetPosition
Validation reductions	https://publicationtool.jao.eu/nordic/api/data/validationReductions
CGM Vertical Load and Generation Forecast	https://publicationtool.jao.eu/nordic/api/data/maxBorderFlow
FB Domain Backup	https://publicationtool.jao.eu/nordic/api/data/fbDomainBackup

7.1 Querying the web API

The database may be queried using URL requests. Below example demonstrated how a query may be implemented using the Python programming language.

```
#!/usr/bin/python
'''
Example query to the JAO publication tool.
'''

import requests
import pandas as pd

def get_fb_data(start_time_str, end_time_str):
    start_time = pd.to_datetime(start_time_str)
    end_time = pd.to_datetime(end_time_str)
    url = "https://publicationtool.jao.eu/nordic/api/data/finalComputation"
    header = {"Authorization": "Bearer ***token*** (will be implemented in future release)"}
    query = {"filter":[],
             "skip":0,
             "take":40000,
             "FromUtc":start_time,
             "ToUtc":end_time}

    r = requests.get(url, headers=header, data=query)
    if r.status_code >= 200 and r.status_code < 300:
        j = r.json()
```

```
        df = pd.DataFrame.from_dict(j['data'])
    else:
        HTMLResponseError = "HTML query returned an unexpected respone. Status_code: " +
str(r.status_code)
        raise Exception(HTMLResponseError)

    df["dateTimeUtc"] = pd.to_datetime(df["dateTimeUtc"], format="%Y-%m-%dT%H:%M:00Z",
utc=True)
    df = df.sort_values(by='dateTimeUtc',ascending=True)

    return df


if __name__=='__main__':

    # sample query for EDD 7th September, 2024
    fbdf = get_fb_data('2024-09-06 22:00', '2024-09-07 22:00')
    print(fbdf)
```

7.2 Understanding request responses

Note: With the current implementation, responses will follow the structure of the JAO API for Core region. This means that the field names in responses may differ from the ones seen in the Nordic publication tool.

- 'id': id of entry in JAO database
- 'dateTimeUtc': CET time stamp (yes… CET?!)
- 'mrId': mrID of constraint
- 'tso': Sending TSO (if any)
- 'cnecName': name of CNEC
- 'cnecType': type of CNEC (BRANCH, ALLOCATION_CONSTRAINT)
- 'cneName': name of CNE
- 'cneType': type of CNE (CNE, PTC, [blank for Allocation constraints])
- 'cneStatus': CNE status (OK, OUT)
- 'cneEic': EIC of CNE (if any)
- 'BiddingZoneFrom': sending end bidding zone
- 'BiddingZoneTo': receiving end bidding zone
- 'minFlow': minimum flow possible on the CNEC
- 'maxFlow': maximum flow possible on the CNEC
- 'substationFrom': sending end substation
- 'substationTo': receiving end substation
- 'contName': name of contingency
- 'contEic': EIC of contingency (if any)
- 'contStatus': status of contingency (N or N-k)
- 'imaxMethod': PATL – permanent limit or TATL – temporary limit
- 'contingencies':
    - 'number': 1
    - 'substationFrom':
    - 'substationTo':
- 'nonRedundant': if true: CNEC is limiting the domain (i.e. non-redundant constraint), if false: CNEC is not limiting the domain (i.e. redundant constraint)
- 'significant': True
- 'ram': remaining available margin of CNEC
- 'imax': current limit provided for CNEC
- 'u': voltage, at which Fmax was calculated
- 'fmax': Highest permissible flow of active power on CNEC
- 'frm': Flow reliability margin
- 'fnrao': Remedial action contribution to RAM
- 'fref': flow on CNEC at base case net position
- 'fall': F0 – flow on CNEC in case of zero net positions in all bidding zones

- 'amr': Adjustment for negative RAM (zero if RAM is positive)
- 'aac': Already allocated capacity
- 'cva': N/A
- 'returnedBranch': N/A
- 'justification': N/A
- 'iva': individual value adjustment
- 'ptdf_DK1': zone-slack PTDF towards DK1
- 'ptdf_DK1_CO': zone-slack PTDF towards DK1_CO
- 'ptdf_DK1_DE': zone-slack PTDF towards DK1_DE
- 'ptdf_DK1_KS': zone-slack PTDF towards DK1_KS
- 'ptdf_DK1_SK': zone-slack PTDF towards DK1_SK
- 'ptdf_DK1_SB': zone-slack PTDF towards DK1_SB
- 'ptdf_DK2': zone-slack PTDF towards DK2
- 'ptdf_DK2_KO': zone-slack PTDF towards DK2_KO
- 'ptdf_DK2_SB': zone-slack PTDF towards DK2_SB
- 'ptdf_FI': zone-slack PTDF towards FI
- 'ptdf_FI_EL': zone-slack PTDF towards FI_EL
- 'ptdf_FI_FS': zone-slack PTDF towards FI_FS
- 'ptdf_NO1': zone-slack PTDF towards NO1
- 'ptdf_NO2': zone-slack PTDF towards NO2
- 'ptdf_NO2_ND': zone-slack PTDF towards NO2_ND
- 'ptdf_NO2_SK': zone-slack PTDF towards NO2_SK
- 'ptdf_NO2_NK': zone-slack PTDF towards NO2_NK
- 'ptdf_NO3': zone-slack PTDF towards NO3
- 'ptdf_NO4': zone-slack PTDF towards NO4
- 'ptdf_NO5': zone-slack PTDF towards NO5
- 'ptdf_SE1': zone-slack PTDF towards SE1
- 'ptdf_SE2': zone-slack PTDF towards SE2
- 'ptdf_SE3': zone-slack PTDF towards SE3
- 'ptdf_SE3_FS': zone-slack PTDF towards SE3_FS
- 'ptdf_SE3_KS': zone-slack PTDF towards SE3_KS
- 'ptdf_SE3_SWL': zone-slack PTDF towards SE3_SWL
- 'ptdf_SE4': zone-slack PTDF towards SE4
- 'ptdf_SE4_BC': zone-slack PTDF towards SE4_BC
- 'ptdf_SE4_NB': zone-slack PTDF towards SE4_NB
- 'ptdf_SE4_SP': zone-slack PTDF towards SE4_SP
- 'ptdf_SE4_SWL': zone-slack PTDF towards SE4_SWL

8 Publication tool (underlying architecture)

The publication tool website is developed with a .netCore backend and a react frontend, communicating via rest-api.
A .netCore service runs on a separate server saving all data retrieved via ECP/EDX into an SQL-database.

9 Appendix

9.1 TSO input parameters for Nordic FB domain calculation

This section conveys information about the TSOs modeling approaches and input parameters to flow-based calculations.

9.1.1 Reliability Margin (RM) (Article 3 of CCM)

TSO	RM component	FCR component
Energinet	5 % of Fmax on all AC-lines 5% of Fmax on DK2 – SE4 PTC 0 % of Fmax on all DC-lines and DK1 – DE PTC	Not yet implemented
Fingrid	5 % of Fmax on all AC-lines 0 % of Fmax on all DC PTCs 5 % of Fmax on all AC PTCs, except for (0 % of Fmax) : FI_PTC_RAC_FI-SE1, FI_PTC_RAC_SE1-FI, FI_PTC_FI-SE1_FI-NO4, FI_PTC_SE1-FI_NO4-FI, where 100MW FRM is given as a reduction of the Fmax value due to a software constraint.	Not yet implemented
Statnett	5-15 % of Fmax on all AC CNECs, where high value indicates high expected modelling error 10% on all AC PTCs. 0 % of Fmax on all DC-lines.	Not yet implemented
Svenska Kraftnät	10 % of Fmax on certain AC-lines 5 % of Fmax on remaining AC-lines 0 % of Fmax on all DC-lines	Not yet implemented

9.1.2 Operational Security Limits (OSL) (Article 4 of CCM)

TSO	Type of OSL applied	Comments on application
Energinet	TATL for N-1 CNECs PATL for N-0 CNECs	For some N-1 CNECs it might be changed to PATL
Fingrid	TATL for N-1 CNECs PATL for N-0 CNECs (PTCs)	
Statnett	Thermal limits Dynamic stability limits Voltage limits	Limits in MW-values
Svenska Kraftnät	TATL for N-1 CNECs PATL for N-0 CNECs	

9.1.3 Critical Network Elements (CNE) and contingencies (Article 5 of CCM)

TSO	Short description how CNEs and contingencies are selected and how contingencies are associated with CNEs
Energinet	CNECs are copied from the limitation known in the NTC world.
Fingrid	CNEs and Contingencies are selected based on experiences from historical and continuous operational security analysis done with PSSE and operational experience.

Statnett	For CNEs with dynamic stability limits, corridors from/to or close to bidding zones are used for 300kV and 420kV corridors. For CNEs with a defined contingency, CNECs on 300kV and 420kV are used, which are considered to be effectively relieved by a change in relevant net position.
Svenska Kraftnät	CNECs are selected by a qualitative assessment and operational experience. Most the CNECs are permanent, and some are temporary based on outages.

9.1.4 Allocation Constraints (AC) (Article 6 of CCM)

TSO	Type of AC	BZ border(s) applied
Energinet	Used to define min and max flows for HVDCs by setting min/max net positions on the HVDC virtual bidding zones.	DK1_SK, DK1_KS, DK1_CO, DK1_SB, DK2_SB, DK2_KO
Fingrid	Used to define min and max flows for HVDCs by setting min/max net positions on the HVDC virtual bidding zones.	FI-FI_EL (FI-EE) FI-FI_FS (FI-SE3)
Statnett	Used to define min and max flows for HVDCs by setting min/max net positions on the HVDC virtual bidding zones.	NO2_NL, NO2_ND, NO2_SK
Svenska Kraftnät	Used to define min and max flows for HVDCs by setting min/max net positions on the HVDC virtual bidding zones.	SE3_SWL, SE4_SWL, SE3_KS, SE3_FS, SE4_SP, SE4_BC, SE4_NB
	Ramping Rate (RR) and Implicit Loss Factors (ILF)	FennoSkan: RR=600 KontiSkan: RR=600 Skagerrak: RR=450, ILF=0.029 Storebelt: RR=600 NO2-NO2A: RR=900

9.1.5 Generation Shift Keys (GSKs) (Article 7 of CCM)

TSO	Strategy number with description / comments
Energinet	GSK strategy 0 – “Custom GSK strategy with individual set of GSK factors for each generator unit and load for each market time unit for a TSO”- with equal participation factors assigned to thermal powerplants and offshore windfarms.
Fingrid	GSK strategy 6 – “Generators and loads participate relative to their current power injection”. Nuclear, wind power and non-conform loads are excluded from participation (participation factor set to 0).
Statnett	For NO1: GSK strategy 7 – “Loads participate relative to their power loading (MW)”. For NO2-NO5: GSK strategy 6 – “Generators and loads participate relative to their current power injection”. Wind power excluded from participation (participation factor set to 0).
Svenska Kraftnät	GSK strategy 6 – “Generators and loads participate relative to their current power injection”. Nuclear and wind power excluded from participation (participation factor set to 0).

9.1.6 Remedial Actions (RAs) (Article 9 of CCM)

TSO	Short description how RAs will be applied in capacity calculation timeframe
Energinet	Predefined RAs is applied to increase the capacity on certain limiting CNECs.
Fingrid	Might be added for planned counter trade.
Statnett	Predefined RAs is applied to increase capacity on CNECs. Available RAs may be trip of hydropower, wind power, large consumption unit or HVDC runback.
Svenska Kraftnät	RA-values will be added on certain CNECs to take into account system protection schemes and other predefines RAs, such as bypassing of series capacitors.

9.2 Bidding Zones Codes and EIC Codes

Short Code (name)	Description	EIC code
NO1	Norwegian Area Elspot Area 1	10YNO-1--------2
NO2	Norwegian Area Elspot Area 2	10YNO-2--------T
NO3	Norwegian Area Elspot Area 3	10YNO-3--------J
NO4	Norwegian Area Elspot Area 4	10YNO-4--------9
NO5	Norwegian Area Elspot Area 5	10Y1001A1001A48H
SE1	Swedish Elspot Area 1	10Y1001A1001A44P
SE2	Swedish Elspot Area 2	10Y1001A1001A45N
SE3	Swedish Elspot Area 3	10Y1001A1001A46L
SE4	Swedish Elspot Area 4	10Y1001A1001A47J
FI	Finland	10YFI-1--------U
DK1	Denmark DK1	10YDK-1--------W
DK2	Denmark DK2	10YDK-2--------M
NO2_SK	Skagerrak (NO2-DKW) in NO2	50YCUY85S1HH29EK
DK1_SK	Skagerrak (NO2-DKW) in DK1	45Y000000000001C
DK1_SB	Storebelt (DKW-DKE) in DK1	45Y0000000000038
DK2_SB	Storebelt (DKW-DKE) in DK2	45Y0000000000062
FI_FS	Fenno-Skan (FI-SE3) in FI	44Y-00000000160K
SE3_FS	Fenno-Skan (FI-SE3) in SE3	46Y000000000001Y
DK1_KS	Konti-Skan (SE3-DKW) in DK1	45Y000000000002A
SE3_KS	Konti-Skan (SE3-DKW) in SE3	46Y000000000002W
SE4_SP	SVE-POL in SE4	46Y000000000003U
SE4_NB	Nord-Balt SE4	46Y000000000004S
SE4_BC	Baltic Cable SE4	46Y000000000005Q
FI_EL	Est-Link in FI	44Y-00000000161I
DK1_DE	DK1 to DE	45Y0000000000054
DK2_KO	Kontek in DK2 (DKE-DE)	45Y0000000000070
DK1_CO	COBRA (DK1-NL) in DK1	45Y0000000000046
NO2_NK	NordLink (NO-DE) in NO2	50YNBFFTWZRAHA3P
NO2_ND	NorNed (NO-NL) in NO2	50Y73EMZ34CQL9AJ
NO2_NSL	NothSeaLink (NO2-GB) in NO2	50Y0JVU59B4JWQCU
SE3_SWL	Sydvästlänken (SE3-SE4) in SE3	46Y000000000017J
SE4_SWL	Sydvästlänken (SE3-SE4) in SE4	46Y000000000018H