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1 Nomenclature

1.1 Abbreviations

Abbreviation	Description
AAC	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
F_O	Flow on CNE in case all bidding zones operate at zero net-position
F_RA	Impact of remedial actions
F_ref	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

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.

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://test-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.

JAO Publication Tool

DATE (i)
◀ 2021-06-26 ▶

HOUR (ii)
00:00 - 01:00 ▼

HUB
None available ▼ (iii)

BORDER
None available ▼ (iv)

🏠 Nordic

- Market View
- Market Graphs
- Market Map
- Flowbased Domain
- Max Net Pos
- Max Exchanges (MaxBex)
- Validation Reductions
- Reference Net Position

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
- 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)

Max Exchanges (MaxBex)																	Download
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	FI>SE1	FI>SE
2022-03-30 00:00:00	2500	1000	1400	600	2500	590	700	481	715	985	590	3216	1016	1016	1205	3356	1200
2022-03-30 01:00:00	2500	1000	1400	600	2500	590	700	481	715	985	590	3161	1016	1016	1204	3356	1200
2022-03-30 02:00:00	2500	1000	1400	600	2500	590	700	481	715	985	590	3159	1016	1016	1204	3356	1200
2022-03-30 03:00:00	2500	1000	1400	600	2500	590	700	481	715	985	590	3144	1016	1016	1205	3356	1200
2022-03-30 04:00:00	2500	1000	1400	600					715	985	590	3212	1016	1016	1209	3356	1200
2022-03-30 05:00:00	2500	1000	1400	600					715	985	590	3230	1016	1016	1196	3356	1200
2022-03-30 06:00:00	2500	1000	1400	600					715	985	590	3237	1016	1016	1168	3356	1200
2022-03-30 07:00:00	2500	1000	1400	600					715	985	590	3237	1016	1016	1162	3356	1200
2022-03-30 08:00:00	2500	1000	1400	600					715	985	590	3235	1016	1016	1157	3356	1200
2022-03-30 09:00:00	2500	1000	1400	600	2500	590	700	481	715	985	590	3217	1016	1016	1154	3356	1200
2022-03-30 10:00:00	2500	1000	1400	600	2500	590	700	481	715	985	590	3145	1016	1016	1161	3356	1200

5 Filter functionality: Domain pages

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

- CNE_Name
- EIC_Code

Enter the text to filter in the search field, to execute the filtering either click outside of the search-field text box or by pressing enter, either of the two actions will result in returning your filtered results. The filter selection will not influence the downloading of data, here all the results are downloaded depending on the selected time period.

JAO
JAO Publication Tool
Nordic

Flowbased Domain
Test data Full Disclaimer

Download

2022-04-26

00:00 - 01:00

None available

None available

isokangas

FLOWLIMITFILTER: 100
 FLOWLIMITFILTER: 0
 DISPLAYEDROWS: 5

CNEC or Combined Dynamic Constraint					Information on the CNE					Information on the				
Date	Name	Type	TSO	Name	EIC	Status	Bidding Zone From	Bidding Zone To	Substation From	Substation To	elementType	Name	EIC	Status
2022-04-26 00:00:00	FI_P0_ISOKANGAS-PYHANSELKA_PIRTTIKOSKI-PIKKARALA	BRANCH	10X1001A1001A264	ISOKANGAS - PYHANSELKA - Terminal: IK: IK4-PS4 1 4		OK	FI	FI	Pyhanseika	Isokangas	CNE	FI_PIRTTIKOSKI - PIKKARALA		N-K
2022-04-26 00:00:00	FI_P0_PYHANSELKA-ISOKANGAS_PIRTTIKOSKI-PIKKARALA	BRANCH	10X1001A1001A264	ISOKANGAS - PYHANSELKA - Terminal: PS: IK4-PS4 1 4		OK	FI	FI	Isokangas	Pyhanseika	CNE	FI_PIRTTIKOSKI - PIKKARALA		N-K
2022-04-26 00:00:00	FI_P0_KEMINMAA-PIKKARALA_ISOKANGAS-PYHANSELKA	BRANCH	10X1001A1001A264	KEMINMAA - PIKKARALA - Terminal: KI: KI4-PR4 1 40		OK	FI	FI	Pikkarala	Keminmaa	CNE	FI_ISOKANGAS - PYHANSELKA		N-K
2022-04-26 00:00:00	FI_P0_ISOKANGAS-PYHANSELKA_OLG2	BRANCH	10X1001A1001A264	ISOKANGAS - PYHANSELKA - Terminal: IK: IK4-PS4 1 4		OK	FI	FI	Pyhanseika	Isokangas	CNE	FI_OL2		N-K
2022-04-26 00:00:00	FI_P0_ISOKANGAS-PYHANSELKA_KEMINMAA-PIKKARALA	BRANCH	10X1001A1001A264	ISOKANGAS - PYHANSELKA - Terminal: IK: IK4-PS4 1 4		OK	FI	FI	Pyhanseika	Isokangas	CNE	FI_KEMINMAA - PIKKARALA		N-K
2022-04-26	FI_P0_PIKKARALA-			ASMUNTI - PIKKARALA -								FI_ISOKANGAS		

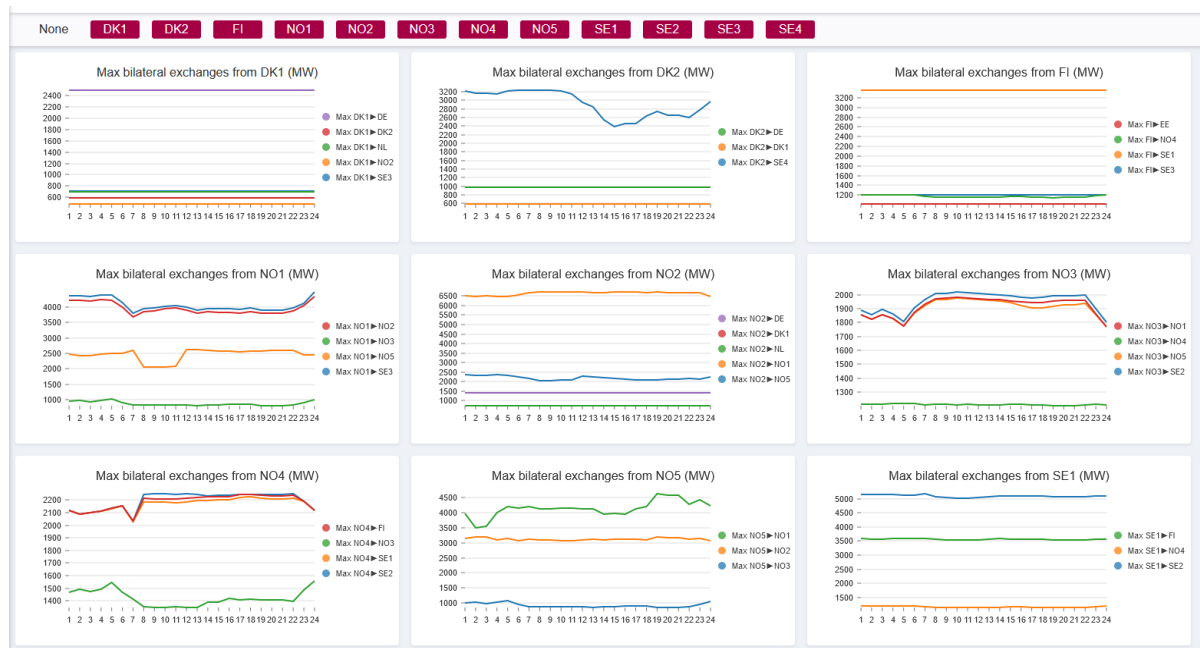
6 Publication Overview

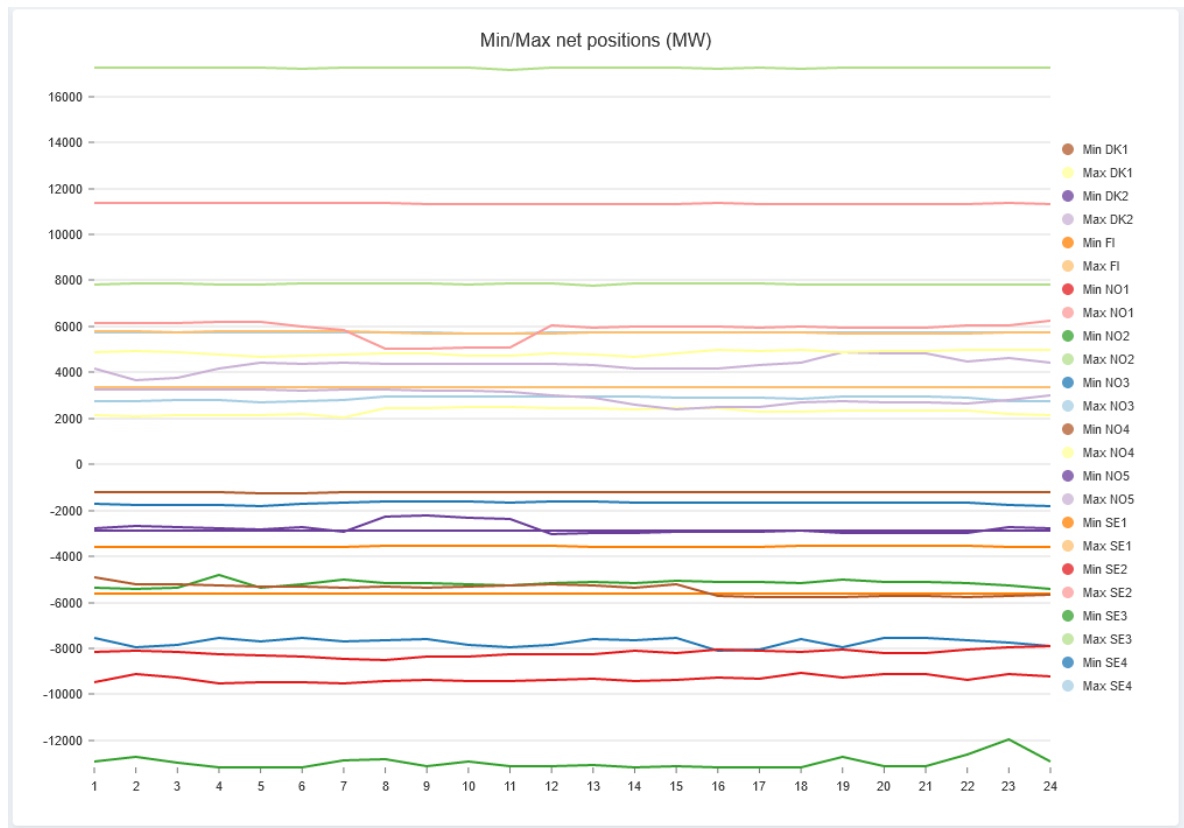
6.1 Nordic Market View

[To be developed]

6.2 Nordic Market Graphs

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



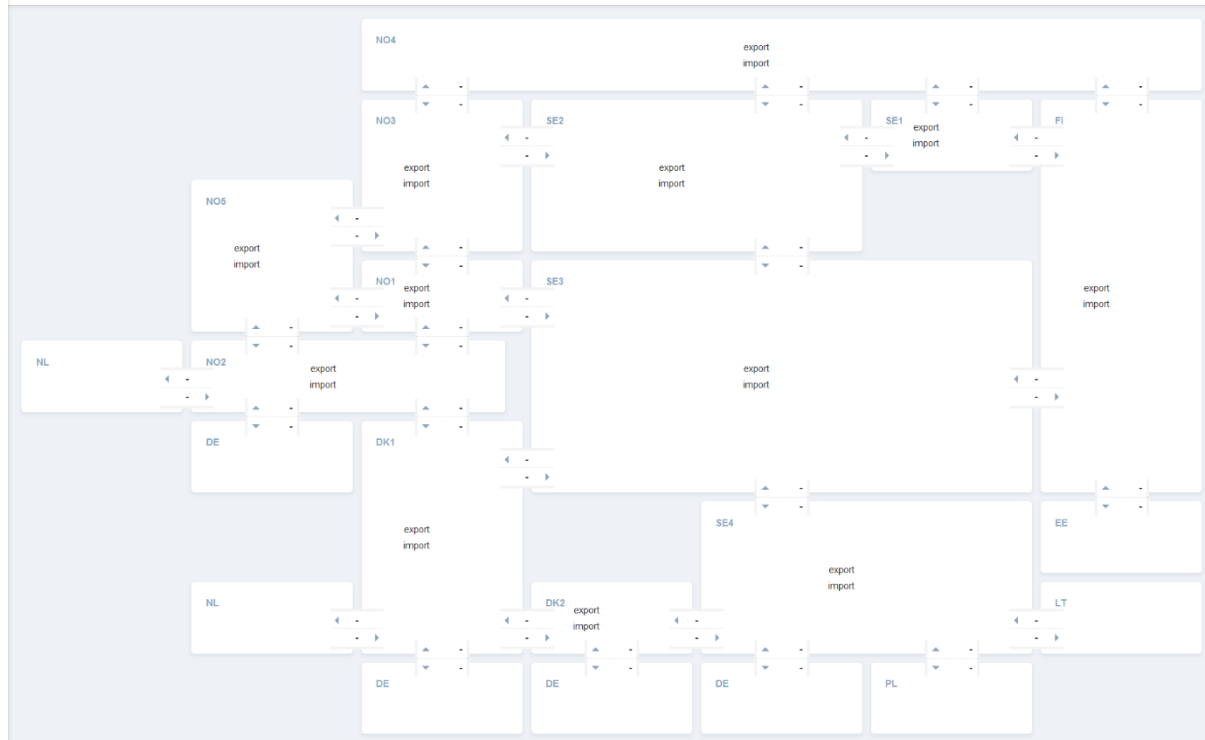


6.3 Market Map

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.

Nordic max net positions and max border flow

Test data: Full Disclaimer



6.4 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(*)
 - **Type** – Critical branch type; Branch or Allocation constraint
 - **TSO** – The TSO which has defined the CNEC and submitted it for flow-based parameters calculation.
- **Information on the CNE:**
 - **CNE_Name** – Human readable identifier of the network element(*)
 - **EIC_Code** – 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** – Hub associated with sending 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**
 - **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 largest zone-

slack PTFD for the CNEC in question. CNECs for which the difference is smaller than the PTFD 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:

$$RAM = F_{\max} - F_{RM} - F_0 + F_{RA} + AMR - F_{AAC} - IVA$$
- **Min Flow** – The minimum flow possible for the CNEC (see section 6.4.4)
- **Max Flow** – The maximum flow possible for the CNEC (see section 6.4.4)
- **U** – The voltage used in Fmax calculation
- **I_{max}** – 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.
- **F_{max}** – 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).
- **F_{ref}** – 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.

Flowbased Domain Test data Full Disclaimer

Information on the Contingency															
CNEC or Combined Dynamic Constraint				Information on the CNE								Information on the Contingency			
Date	Name	Type	TSO	Name	EIC	Status	Bidding Zone From	Bidding Zone To	Substation From	Substation To	elementType	Name	EIC	Status	Substation From
2022-04-26 00:00:00	13427_10 50% 420 Rad-Hasle + 420 Sylling-Tegneby	BRANCH	10X1001A1001A3BY	S 420 Sylling-Tegneby		OUT					PTC	Contingency S 420 Rad-Hasle		N	
2022-04-26 00:00:00	DK2_VE_EXP	BRANCH	10X1001A1001A24B	AREA EAST_VET TIES EXP MW		OK	DK2	DK2_KO			PTC	BASECASE		N	
2022-04-26 00:00:00	42F360F8A8BF3FEC9B62FF60A107E3C5	BRANCH	TSO_ORIGN	306FD9F35F11742EEB1373A6398329E4		OK					PTC	09F751668C14A59DF31D48BC08416606		N	
2022-04-26 00:00:00	6EEA3CFECB594C33F1970DA2FEAD0819	BRANCH	TSO_ORIGN	7C8378153B39360AFF22DE8866F9800B		OK	SE2	SE2			CNE	09F751668C14A59DF31D48BC08416606		N	

6.4.1 Filter functionality for flow-based domain

In the Flow-based Domain page, users may filter within two specific columns:

- Name of the CNEC (or a substring of CNEC name)
- EIC code of sending TSO

Enter the text to filter in the search field, to execute the filtering either click outside of the search-field text box or by pressing enter, either of the two actions will result in returning your filtered results. The filter selection will not have an effect on the downloading of data, here all the results are downloaded depending on the selected time period only.

JAO Publication Tool
Nordic

DATE: 2022-04-26
HOUR: 00:00 - 01:00
HUB: None available
BORDER: None available

Flowbased Domain
Test data Full Disclaimer

SEARCH: isokangas

FORUMTOPFILTER: 100
CONSUMPTIONFILTER: 0
DISPLAYEDROWS: 0

CNEC or Combined Dynamic Constraint				Information on the CNE								Information on the		
Date	Name	Type	TSD	Name	EIC	Status	Bidding Zone From	Bidding Zone To	Substation From	Substation To	elementType	Name	EIC	Status
2022-04-26 00:00:00	FI_P0_ISOKANGAS-PYHANSELKA_PIRTTIKOSKI-PIKKARALA	BRANCH	10X1001A1001A264	ISOKANGAS - PYHANSELKA - Terminal IK IK4-PS4 1 4		OK	FI	FI	Pyhanseika	Isokangas	CNE	FI_PIRTTIKOSKI-PIKKARALA		N-K
2022-04-26 00:00:00	FI_P0_PYHANSELKA-ISOKANGAS_PIRTTIKOSKI-PIKKARALA	BRANCH	10X1001A1001A264	ISOKANGAS - PYHANSELKA - Terminal PS IK4-PS4 1 4		OK	FI	FI	Isokangas	Pyhanseika	CNE	FI_PIRTTIKOSKI-PIKKARALA		N-K
2022-04-26 00:00:00	FI_P0_KEMINMAA-PIKKARALA_ISOKANGAS-PYHANSELKA	BRANCH	10X1001A1001A264	KEMINMAA - PIKKARALA - Terminal KI KI4-PR4 1 4D		OK	FI	FI	Pikkarala	Keminmaa	CNE	FI_ISOKANGAS-PYHANSELKA		N-K
2022-04-26 00:00:00	FI_P0_ISOKANGAS-PYHANSELKA_OLG2	BRANCH	10X1001A1001A264	ISOKANGAS - PYHANSELKA - Terminal IK IK4-PS4 1 4		OK	FI	FI	Pyhanseika	Isokangas	CNE	FI_OL2		N-K
2022-04-26 00:00:00	FI_P0_ISOKANGAS-PYHANSELKA_KEMINMAA-PIKKARALA	BRANCH	10X1001A1001A264	ISOKANGAS - PYHANSELKA - Terminal IK IK4-PS4 1 4		OK	FI	FI	Pyhanseika	Isokangas	CNE	FI_KEMINMAA-PIKKARALA		N-K
2022-04-26	FI_P0_PIKKARALA-			ASMUNTI - PIKKARALA -								FI_ISOKANGAS		

6.4.2 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.

6.4.3 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.

6.4.4 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:

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

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

Subject to

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

And

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

Where

- $f_0(c)$ is the flow on CNEC c in case all net positions are zero
- $\text{PTDF}(c, n)$ 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

6.5 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.

The minimum and maximum net positions are not guaranteed to be global extremes. This is because a simplified calculation method is used (see section 6.5.1).

An updated method for minimum and maximum net position calculations is under preparation for deployment in the autumn of 2023. The updated method will yield global extrema.

Min and Max Net Positions

Test data [Full Disclaimer](#)

Date	Min DK1	Min DK1_CO	Min DK1_DE	Min DK1_KS	Min DK1_SK	Min DK1_SB	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	Min NO2_SK	Min NO3	Min NO4	Min NO5
2022-04-26 00:00:00	-3413	-700	-2500	-715	-1632	-590	-2872	-985	-590	-3626	-1016	-1200	-9480	-6148	-700	-1400	-1110	-2130	-1245	-3530
2022-04-26 01:00:00	-3373	-700	-2500	-715	-1632	-590	-2872	-985	-590	-3626	-1016	-1200	-9505	-6142	-700	-1400	-1110	-2113	-1247	-3540
2022-04-26 02:00:00	-3532	-700	-2500	-715	-1632	-590	-2872	-985	-590	-3625	-1016	-1200	-9659	-7114	-700	-1400	-1110	-2105	-1247	-3540
2022-04-26 03:00:00	-3652	-700	-2499	-715	-1632	-590	-2872	-985	-590	-3617	-1016	-1200	-9648	-7006	-700	-1400	-1110	-2122	-1245	-3503
2022-04-26 04:00:00	-3536	-700	-2499	-715	-1632	-590	-2872	-985	-590	-3622	-1016	-1200	-9668	-6956	-700	-1400	-1110	-2142	-1244	-3452
2022-04-26 05:00:00	-3572	-700	-2499	-715	-1632	-590	-2872	-985	-590	-3636	-1016	-1200	-9667	-6879	-700	-1400	-1110	-2047	-1232	-3452

6.5.1 Simplified calculation of min/max net position

With the current version of NorCap (Q4 2022) the calculation of minimum and maximum net positions follows a simplified approach which is not guaranteed to yield the global minimum and maximum net positions of bidding zones.

The simplified approach takes for each bidding zone the minimum and maximum net position among the set of net positions which have been found to yield a minimum or maximum flow on any CNEC according to the calculation described in section 6.4.4.

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	FI>SE1	FI>SE3	LT>SE4	NL>DK1	NL>NO2	NO1>NO2	NO1>NO3
2022-04-26 00:00:00	2500	1000	1444	600	2500	590	700	1632	715	985	590	3166	1016	1016	1222	3356	1200	700	700	723	4926	1511
2022-04-26 01:00:00	2500	1000	1444	600	2500	590	700	1632	715	985	590	3182	1016	1016	1223	3356	1200	700	700	723	4932	1494
2022-04-26 02:00:00	2500	1000	1444	600	2500	590	700	1632	715	985	590	3190	1016	1016	1223	3356	1200	700	700	723	4911	1493
2022-04-26 03:00:00	2500	1000	1444	600	2499	590	700	1632	715	985	590	3217	1016	1016	1222	3356	1200	700	700	723	4794	1498
2022-04-26 04:00:00	2500	1000	1444	600	2499	590	700	1632	715	985	590	3217	1016	1016	1221	3356	1200	700	700	723	4729	1506
2022-04-26 05:00:00	2500	1000	1444	600	2499	590	700	1632	715	985	590	3237	1016	1016	1210	3356	1200	700	700	723	4618	1285
2022-04-26 06:00:00	2500	1000	1444	600	2499	590	700	1632	715	985	590	3023	1016	1016	1214	3356	1200	700	700	723	4497	1317
2022-04-26 07:00:00	2500	1000	1444	600	2499	479	700	1632	0	985	590	3052	1016	1016	1212	3356	1200	700	700	723	4350	1251

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:

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

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

The current implementation of maximum bilateral exchange calculation includes contribution from HVDC. A revision is planned for deployment by autumn 2023 which excludes HVDC contributions from the calculations.

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 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.

Validation Reductions			
Test data Full Disclaimer			
CORE_SEARCH		CORE_TOTAL ROWS: 48 CORE_SEARCH ROWS: 48 CORE_SHOWN ROWS: 48	
<input type="text"/>			
Date	CNEC Name	IVA	Justification
2022-04-23 00:00:00	DK2_SV_EXP	0	Wrong Fmax value - Wrong Fref'
2022-04-23 00:00:00	DK2_SV_IMP	0	Wrong Fmax value - Wrong FrefA'
2022-04-23 01:00:00	DK2_SV_IMP	0	Wrong Fmax value - Wrong FrefA'
2022-04-23 01:00:00	DK2_SV_EXP	0	Wrong Fmax value - Wrong Fref'
2022-04-23 02:00:00	DK2_SV_EXP	0	Wrong Fmax value - Wrong Fref'
2022-04-23 02:00:00	DK2_SV_IMP	0	Wrong Fmax value - Wrong FrefA'
2022-04-23 02:00:00	DK2_SV_IMP	0	Wrong Fmax value - Wrong FrefA'

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 DK1_KS (DK1 side of KontiSkan HVDC) is -259MW for hour 00:00. This means that KontiSkan is receiving 259MW from DK1, i.e. DK1 is exporting to SE3.

Reference Net Position and Reference HVDC Exchange

Test data [Full Disclaimer](#)

Date	DK1	DK1_CO	DK1_DE	DK1_KS	DK1_SK	DK1_SB	DK2	DK2_KO	DK2_SB
2022-04-23 00:00:00	-566	37	2008	-259	-1143	-76	-686	248	76
2022-04-23 01:00:00	-634	-294	1896	-31	-1143	207	-593	-249	-207
2022-04-23 02:00:00	-665	-589	1812	296	-1143	291	-463	-528	-291
2022-04-23 03:00:00	4	-371	747	296	-1111	435	-312	-535	-435

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

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

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 following url: <https://test-publicationtool.jao.eu/nordic/api>

Following databases may be queried through the web API:

Data base	URL
Flow-based domain	https://test-publicationtool.jao.eu/nordic/api/nordic/finalComputation/index
Max Exchange (MaxBex)	https://test-publicationtool.jao.eu/nordic/api/nordic/maxExchanges/index
Min and Max Net Positions	https://test-publicationtool.jao.eu/nordic/api/nordic/maxNetPos/index
Ref Net Pos. and HVDC exch.	https://test-publicationtool.jao.eu/nordic/api/nordic/referenceNet position/index
Validation reductions	https://test-publicationtool.jao.eu/nordic/api/nordic/validationReductions/index

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.
Extracting from the flow-based domain for EDD 2022.09.27T22:00Z the first 10 entries where cneName contains the
phrase "Border_"
'''
import requests

url = "https://test-publicationtool.jao.eu/nordic/api/nordic/finalComputation/index"
header = {"Authorization": "Bearer ***token*** (will be implemented in future release)"}
query = {"date": "{:04}-{:02}-{:02}T{:02}:{00}:{00}.000Z".format(mtu.year, mtu.month, mtu.day, mtu.hour),
        "search": "Border_",
        "skip": 0,
        "take": 10}

r = requests.get(url, headers=header, data=query)

if r.status_code >= 200 and r.status_code < 300:
    print(r.json())
else:
    HTMLResponseError = "HTML query returned an unexpected response. Status_code: " + str(r.status_code)
    raise Exception(HTMLResponseError)
```

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?!)
- 'tso': Sending TSO (if any)
- 'cneName': name of CNEC
- 'cneType': 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)
- 'direction': N/A
- 'hubFrom': sending end bidding zone
- 'hubTo': receiving end bidding zone
- 'substationFrom': sending end substation
- 'substationTo': receiving end substation
- 'elementType': N/A
- 'fmaxType': N/A
- 'contTso': N/A
- 'contName': name of contingency
- 'contStatus': status of contingency (N or N-k)
- 'contSubstationFrom': contingency element sending end substation
- 'contSubstationTo': contingency element receiving end substation
- 'imaxMethod': PATL – permanent limit or TATL – temporary limit
- 'contingencies': N/A
 - 'number': N/A
 - 'branchName': N/A
 - 'branchEic': N/A
 - 'hubFrom': N/A
 - 'hubTo': N/A
 - 'substationFrom': N/A
 - 'substationTo': N/A
 - 'elementType': N/A
- 'presolved': 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
- 'frefInit': N/A
- 'fnrao': Remedial action contribution to RAM
- 'fref': flow on CNEC at base case net position
- 'fcore': N/A
- 'fall': FO – flow on CNEC in case of zero net positions in all bidding zones
- 'fuaf': N/A
- 'amr': Adjustment for negative RAM (zero if RAM is positive)
- 'aac': Already allocated capacity
- 'ItaMargin': N/A
- 'cva': N/A
- 'iva': individual value adjustment
- 'ftotalLtn': N/A
- 'fltn': N/A
- '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_ST': zone-slack PTDF towards DK1_ST
- 'ptdf_DK2': zone-slack PTDF towards DK2
- 'ptdf_DK2_KO': zone-slack PTDF towards DK2_KO
- 'ptdf_DK2_ST': zone-slack PTDF towards DK2_ST
- '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 PTFD towards NO1
- 'ptdf_NO2': zone-slack PTFD towards NO2
- 'ptdf_NO2_ND': zone-slack PTFD towards NO2_ND
- 'ptdf_NO2_SK': zone-slack PTFD towards NO2_SK
- 'ptdf_NO2_NK': zone-slack PTFD towards NO2_NK
- 'ptdf_NO3': zone-slack PTFD towards NO3
- 'ptdf_NO4': zone-slack PTFD towards NO4
- 'ptdf_NO5': zone-slack PTFD towards NO5
- 'ptdf_SE1': zone-slack PTFD towards SE1
- 'ptdf_SE2': zone-slack PTFD towards SE2
- 'ptdf_SE3': zone-slack PTFD towards SE3
- 'ptdf_SE3_FS': zone-slack PTFD towards SE3_FS
- 'ptdf_SE3_KS': zone-slack PTFD towards SE3_KS
- 'ptdf_SE3_SWL': zone-slack PTFD towards SE3_SWL
- 'ptdf_SE4': zone-slack PTFD towards SE4
- 'ptdf_SE4_BC': zone-slack PTFD towards SE4_BC
- 'ptdf_SE4_NB': zone-slack PTFD towards SE4_NB
- 'ptdf_SE4_SP': zone-slack PTFD towards SE4_SP
- 'ptdf_SE4_SWL': zone-slack PTFD 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 at start of flow-based External Parallel Run

This section conveys information about the TSOs modeling approaches and input parameters to flow-based calculations as they are at the start of external parallel run.

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 HVDC, although redundant PTCs are defined for monitoring, and these include the default 5% RM	Not yet implemented
Statnett	5 % of Fmax on all AC-lines 0 % of Fmax on all DC-lines	Not yet implemented
Svenska kraftnät	5 % of Fmax on all 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

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

TSO	Strategy number with description / comments
Energinet	Custom GSK strategy (0) 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 areas NO1-NO4: GSK strategy 6 – “Generators and loads participate relative to their current power injection”. Wind power excluded from participation (participation factor set to 0) For NO5: GSK strategy 5 – “Generators 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	RA is currently not used
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 for system protection schemes, and maybe for planned counter trade and for bypassing of series capacitors.

9.2 Naming Convention for CNECs

[To be developed]

9.3 Naming Convention for RAs

[To be developed]