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All TSOs' of the Nordic Capacity Calculation Region  
proposal for capacity calculation methodology in accordance  
with Article 20(2) of Commission Regulation (EU) 2015/1222  
of 24 July 2015 establishing a guideline on capacity allocation  
and congestion management

11 September 2017

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All TSOs of the Nordic Capacity Calculation Region, taking into account the following:

### Whereas

- (1) This document is a common proposal developed by all Transmission System Operators (hereafter referred to as “TSOs”) of the Nordic Capacity Calculation Region (hereafter referred to as “CCR Nordic”) as defined in accordance with Article 15 of Commission Regulation (EU) 2015/1222 establishing a guideline on Capacity Allocation and Congestion Management (hereafter referred to as the “CACM Regulation”) regarding a methodology for Capacity Calculation (hereafter referred to as “CCM”) in accordance with Article 20 and Article 21 of the CACM Regulation. This proposal for a CCM is hereafter referred to as the “Proposal”.
- (2) This CCM Proposal takes into account the general principles, goals and other methodologies set in the CACM Regulation, Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation, and Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity (hereafter referred to as “Regulation (EC) No 714/2009”). The goal of the CACM Regulation is the coordination and harmonisation of capacity calculation and capacity allocation in the day-ahead and intraday cross-border markets, and it sets requirements for the TSOs to cooperate on the level of capacity calculation regions (hereinafter referred to as “CCRs”), on a pan-European level and across bidding zone borders. The CACM Regulation also sets rules for establishing capacity calculation methodologies based either on the Flow-Based Approach (“FB Approach”) or the Coordinated Net Transmission Capacity Approach (“CNTC Approach”).
- (3) This CCM Proposal takes into account the Common Grid Model (hereafter referred to as “CGM”) methodology and assumes that the CGM developed accordingly, is available in order to execute capacity calculation for the day-ahead and intraday timeframes. Thus the frequency of the reassessment of intraday capacity depends on the availability of the CGM for the intraday timeframe.
- (4) This CCM Proposal also takes into account specific situations in the Nordic power system, incorporating active and reactive power flow and voltage analyses in steady state and, where appropriate, voltage and dynamic stability analyses. This entails that, in the long term, a CGM with dynamic data is to be developed in accordance with Article 19(6) of the CACM Regulation.
- (5) Article 9(9) of the CACM Regulation requires that the expected impact of the Proposal on the objectives of the CACM Regulation is described. The impact is presented below (points (6) to (14) of this Whereas Section).
- (6) The CCM Proposal contributes to and does not in any way hamper the achievement of the objectives of Article 3 of the CACM Regulation. In particular, the proposal serves the objectives of promoting effective competition in the generation, trading and supply of electricity (Article 3(a) of the CACM Regulation), ensuring optimal use of the transmission infrastructure (Article 3(b) of the CACM Regulation), ensuring operational security (Article 3(c) of the CACM Regulation), optimising the calculation and allocation of cross-zonal capacity (Article 3(d) of the CACM Regulation), ensuring and enhancing the transparency and reliability of information (Article 3(f) of the CACM Regulation), contributing to the efficient long-term operation and development of the electricity transmission system and electricity sector in the Union (Article 3(g) of the CACM Regulation), respecting the need for a fair and orderly market and fair and orderly price formation (Article 3(h) of the CACM

Regulation) and providing non-discriminatory access to cross-zonal capacity (Article 3(j) of the CACM Regulation).

- (7) The CCM for the CCR Nordic promotes effective competition in the generation, trading and supply of electricity (Article 3(a) of the CACM Regulation), since the CCM supports fair and equal access to the transmission system as it applies to all market participants on all bidding zone borders in CCR Nordic. Market participants will have access to the same reliable information on cross-zonal capacities and allocation constraints for day-ahead allocation, in a transparent way. The flow based approach does not implicitly pre-select or exclude bids from market players and, hence the competitiveness of bidding is the only criteria on which bids of market players are selected during the matching, yet taking the significant grid constraints into consideration.
- (8) The CCM for the CCR Nordic secures optimal use of the transmission capacity (Article 3(b) of the CACM Regulation) as it takes advantage of the flow-based approach, representing the limitations in the alternating current (hereafter referred to as “AC”) grids. There is no predefined and static split of the capacities on critical network elements, and the flows within CCR Nordic and between CCR Nordic and adjacent CCRs are decided based on economic efficiency during the capacity allocation phase. The CCM for the CCR Nordic treats all bidding zone borders within the CCR Nordic and adjacent CCRs equally, and provides non-discriminatory access to cross-zonal capacity. The CCM for CCR Nordic fully applies Advanced Hybrid Coupling (hereafter referred to as “AHC”) for the efficient integration of DC interconnectors into the flow-based CCM of CCR Nordic. Proposed approaches aim at providing the maximum available capacity to market participants within the operational security limits. For the intraday timeframe, a CNTC Approach ensures better use of transmission capacity compared to the currently-applied method until the FB Approach is implemented.
- (9) The CCM for CCR Nordic secures operational security (Article 3(c) of the CACM Regulation) as the most important grid constraints are taken into account in the Day Ahead and Intraday timeframe providing the maximum available capacity to market participants within the operational security limits. This supports operational security in a short time perspective, where bidding zone re-configuration will be used in a mid-term perspective and grid investments in the long-term perspective.
- (10) The CCM for CCR Nordic serves the objective of optimising the calculation and allocation of cross-zonal capacity in accordance with Article 3(d) of the CACM Regulation since the common capacity calculation methodology is using the FB Approach for the day-ahead timeframe and also for the intraday timeframe - when conditions for implementation have been fulfilled - providing optimal cross-zonal capacities to market participants. Better optimisation in the intraday timeframe, compared to current methods, can be achieved with a CNTC Approach until a FB Approach is implemented.
- (11) The CCM for CCR Nordic serves the objective of transparency and reliability of information (Article 3(f) of the CACM Regulation) as the CCM determines the main principles and main processes for the day-ahead and intraday timeframes. The CCM enables TSOs to provide market participants with the same reliable information on cross-zonal capacities and allocation constraints for day-ahead and intraday allocation in a transparent way.
- (12) The CCM for CCR Nordic does not hinder an efficient long-term operation in CCR Nordic and adjacent CCRs, and the development of the transmission system in the European Union (Article 3(g) of the CACM Regulation). The CCM, by taking most important grid constraints into consideration, will support efficient pricing in the market, providing the right signals from a long-term perspective.

- (13) The CCM for CCR Nordic contributes to the objective of respecting the need for a fair and orderly market and price formation (Article 3(h) of the CACM Regulation) by making available in due time the cross-zonal capacity to be released in the day-ahead and intraday market.
- (14) The CCM for CCR Nordic provides non-discriminatory access to cross-zonal capacity (Article 3(j) of the CACM Regulation) without compromising operational security, as proposed approaches support secure operation of the power system. The CCM also ensures a transparent and non-discriminatory approach to facilitate cross-zonal capacity allocation.
- (15) In conclusion, the capacity calculation methodology contributes to the general objectives of the CACM Regulation to the benefit of all market participants and electricity end consumers.

**SUBMIT THE FOLLOWING CAPACITY CALCULATION METHODOLOGY PROPOSAL TO ALL REGULATORY AUTHORITIES OF THE NORDIC CAPACITY CALCULATION REGION:**

## **TITLE I GENERAL**

### **Article 1 Subject matter and scope**

The CCM as determined in this Proposal is the common proposal of TSOs in accordance with Article 20(2) and Article 21 of the CACM Regulation.

The Proposal applies solely to the CCR Nordic as defined in accordance with Article 15 of the CACM Regulation.

The Proposal covers the capacity calculation methodologies for the day-ahead and intraday timeframes.

### **Article 2 Definitions and interpretation**

1. For the purposes of the Proposal, the terms used shall have the meaning given to them in Article 2 of Regulation (EC) 714/2009, Article 2 of the CACM Regulation, Article 2 of Commission Regulation (EU) 2016/1719 of 26 September 2016 establishing a guideline on forward capacity allocation and Commission Regulation (EU) No 543/2013 of 14 June 2013 on submission and publication of data in electricity markets and amending Annex I to Regulation (EC) No 714/2009 of the European Parliament and of the Council (hereafter referred to as "Regulation 543/2013").
2. In addition, in this Proposal, the following terms shall have the meaning below:
  - a) "Advanced Hybrid Coupling (AHC)" is an enhancement of the flow-based capacity calculation methodology, representing a more detailed modelling of the influence of the HVDC link on the AC network flows and allowing NTC bidding zone borders to compete for the scarce capacity within the flow-based area and vice versa, thereby enabling the capacity allocation algorithm to make an economic optimisation of the flows on NTC bidding zone borders on equal terms with the flows within the flow-based area;
  - b) "base case" means the best available forecast for the state of the power system in a specific hour of a specific day. The base case combines the expected grid topology, load and generation forecast on a nodal basis;

- c) “cut” means a flow limit spanning several lines or other grid components which is not possible to manage in a critical branch/critical outage setup;
  - d) “grid constraint” means any grid component, or set of grid components, that limits the flow that can be carried by the grid due to thermal, voltage or stability requirements;
  - e) “remaining available margin (RAM)” means the free margin that is allowed to be used by the allocation mechanism on a CNE or a cut;
  - f) “snapshot” means like a photo of a TSO’s transmission state, showing the voltage, currents, and power flows in the grid at the time of taking the photo; and
  - g) “virtual bidding zone” means an bidding zone without any buy and sell bids from market participants.
3. In this Proposal, unless the context requires otherwise:
- a) the singular indicates the plural and vice versa;
  - b) headings are inserted for convenience only and do not affect the interpretation of this proposal; and
  - c) any reference to legislation, regulations, directives, orders, instruments, codes or any other enactment shall include any modification, extension or re-enactment of it when in force.
4. For the sake of clarity it is stated, that this Proposal does not affect TSOs' right to delegate their task in accordance with the Article 81 of the CACM Regulation. In this Proposal "TSO" shall refer to Transmission System Operator or to a third party whom the TSO has delegated tasks to in accordance with the CACM Regulation, where applicable.

## **TITLE 2**

### **Calculation of the inputs to capacity calculation for DA and ID timeframe**

#### **Article 3**

#### **Methodology for determining reliability margin**

1. The TSOs shall determine the reliability margin as follows:
  - a) A probability distribution of the deviation between the forecasted and realized (observed) power flows is determined annually for each grid constraint or cross-zonal border, based on historical snapshots of the CGM for different hours. The flows for each grid constraint are calculated with a power flow simulation with the contingency for the grid constraint tripped. Observed differences (in MW) form the prediction error distribution for each grid constraint or cross-zonal border. The prediction errors shall be fitted to a statistical distribution that minimizes the modelling error; and
  - b) The reliability margin (hereafter referred to as “RM”) value shall be calculated by deriving a value from the probability distribution based on the TSOs risk level value as defined in Article 3(5) of the Proposal.
2. The principles for calculating the probability distribution of the deviations between the expected power flows at the time of the capacity calculation and realised power flows in real time are as follows:
  - a) The forecasted flow in the base case is compared with the realized flow observed in a snapshot modelled in the CGM; and
  - b) To compare the observed flows from the snapshot with the predicted flows the forecasted grid constraint and cross-zonal border flows are adjusted with the realized schedules corresponding to the instant of time, that the snapshot was created to ensure, that the realized net positions are taken into account when comparing the forecasted flows with the observed ones.

3. The margin caused by the activation of the frequency control reserve (hereafter referred to as “FCR”) shall be modelled separately and merged with the RM. The following approach shall be applied:
  - a) The FCR power flow impact is deduced for each grid constraint and cross-zonal border for historical hours annually, forming a FCR distribution;
  - b) This distribution shall be combined with the prediction error distribution, from which the RM then is selected as described in Article 3(6) of this Proposal;
  - c) Alternatively the maximum FCR impact may be assessed, giving an absolute FCR margin for the grid constraint or cross-zonal border; and
  - d) The final RM margin shall be set by the largest of the two; the RM or the FCR margin.
4. The uncertainties covered by the RM values are:
  - a) Uncertainty in load forecast;
  - b) Uncertainty in generation forecasts (generation dispatch, wind prognosis, etc.);
  - c) Assumptions inherent in the generation shift key (hereafter referred to as “GSK”) strategy;
  - d) External trades to adjacent synchronous areas;
  - e) Application of a linear grid model (with the power transfer distribution factors (hereafter referred to as the “PTDFs”)), constant voltage profile and reactive power;
  - f) Unintentional flow deviations due to activation of frequency reserves (FCR and aFRR);
  - g) Topology changes due to e.g. unplanned line outages;
  - h) Internal trade in each bidding zone (i.e. working point of the linear model);
  - i) mFRR activation; and
  - j) Grid model errors, assumptions and simplifications.
5. The TSOs shall take into account the operational security limits, the power system uncertainties and the available remedial actions when determining the risk level for their grid constraints and cross-zonal borders to ensure the system security and efficient system operation. This risk level shall determine how the RM value shall be derived from the probability distribution. The risk level is defined as the area (cumulative probability) right of the RM value in the prediction error probability distribution. The TSOs shall use the predefined risk level of 95%.
6. The TSOs shall store the differences between the observations and predictions in a database that allows the TSOs to make statistical analyses. Based on the predefined risk level, the RM value shall be computed from the prediction error distribution.
7. The probability distribution and RM value shall be stored in a standardized data format for each grid constraints and cross-zonal border. The RM value shall be defined and stored as an absolute value (in MW). It may be converted for comparison purposes to a percentage of the grid constraints  $F_{max}$  in the FB approach or cross-zonal capacity in the CNTC approach. The TSO shall send RM values as input data to the Coordinated Capacity Calculator (hereafter referred to as “CCC”).
8. The TSOs shall perform the calculation of the RM regularly and at least once a year applying the latest information on the probability distribution of the deviations between expected power flows at the time of capacity calculation and realised power flows in real time.

#### **Article 4**

##### **Methodology for determining operational security limits**

1. The TSOs shall apply the same operational security limits as in the operational security analysis. Each TSO shall provide these operational security limits to the CCC to be used in the capacity calculation.

2. All operational security limits shall be respected both during the normal operation and in application of the N-1 criterion when defining allowed power flows across the power system.

### **Article 5**

#### **Methodology for determining contingencies relevant to capacity calculation**

The TSOs shall apply the same contingencies as in the operational security analysis. Each TSO shall provide these contingencies to the CCC to be used in the capacity calculation.

### **Article 6**

#### **Methodology for determining allocation constraints**

1. TSOs may apply allocation constraints that are needed to fulfil the requirements set in Article 23(3) of the CACM:
  - a) The combined import or export from one bidding zone to other neighbouring bidding zones shall be limited to a threshold value;
  - b) The maximum flow change on DC-links between market time units (MTUs) (ramping restrictions); and
  - c) The implicit loss factors on DC-interconnectors.
2. Each TSO applying the allocation constraints of Article 6(1) of this Proposal shall define the allocation constraint with the applied limits and communicate these transparently to the market participants together with a justification.
3. The relevant TSOs shall provide the allocation constraints to the CCC.

### **Article 7**

#### **Methodology for determining generation shift keys**

1. GSKs shall define how a net position change in a given bidding zone should be distributed to each production and load unit on that bidding zone in the CGM. These GSKs shall represent the best forecast of the relation of a change in the net position of a bidding zone to a specific change of generation or load in the CGM for each scenario. The forecast shall take into account the information received in accordance to Article 10 and Article 12 of the generation and load data provision methodology.
2. Each TSO shall select a GSK strategy from Table 1 for each bidding zone, aiming at an optimal GSK based on the following aspects:
  - a) Production and load units that are, based on historical data and experience, sensitive to changes in market situation and flexible in changing their electrical output and intake and likely to be shifted shall receive a participation factor;
  - b) Non-flexible production units shall be ignored in shifting and shall receive a zero participation factor;
  - c) The TSO shall aim to find a GSK that minimizes the prediction error between the forecasted and observed flows for all production and load units in each bidding zone for a certain time span in order to find a GSK set that minimises the overall RM for the studied period;
  - d) Each of the strategies may be applicable for a bidding zone, either during all hours for a year or for a single hour; and
  - e) Different GSK strategies may be optimal (meeting the requirement under c) for different bidding zones, countries or hours as the generation technology mixture varies between bidding zones or as the geographical distribution of generation and generation technologies varies significantly between zones.

Table 1. GSK strategies including both generation (GSK) and load (LSK) components.

Strategy number	GSK	LSK	Description/comment
0	$k_g$	$k_l$	Custom TSO GSK strategy with individual set of participating factors for each generator unit and load for the MTU
1	$\max\{P_g - P_{\min}, 0\}$	0	Generators participate relative to their margin to the generation minimum (MW) for the unit
2	$\max\{P_{\max} - P_g, 0\}$	0	Generators participate relative to their margin to the installed capacity (MW) for the unit
3	$P_{\max}$	0	Generators participate relative to their maximum (installed) capacity (MW)
4	1.0	0	Flat participation of all generators, independently of the size of the generator unit
5	$P_g$	0	Generators participate relative to their current power generation (MW)
6	$P_g$	$P_l$	Generators and loads participate relative to their current power generation or load (MW)
7	0	$P_l$	Loads participate relative to their power loading (MW)
8	0	1.0	Flat participation of all loads, independently of size of load

where

$k_g$  : Participation factor [pu] for generator  $g$   
 $k_l$  : Participation factor [pu] for load  $l$   
 $P_g$  : Current active generation [MW] for generator  $g$   
 $P_{\min}$  : Minimum active power generator output [MW] for generator  $g$   
 $P_{\max}$  : Maximum active power generator output [MW] for generator  $g$   
 $P_{\text{load}}$  : Current active power load for load  $l$

3. Each TSO shall define the GSK strategy for each bidding zone from Table 1, and communicate these transparently to the market participants.
4. The TSOs shall provide the GSK for the CCC to be used in the capacity calculation for each bidding zone and the MTUs for which the GSK shall be valid.
5. The TSOs shall make ex-post analysis of the capacity calculation and allocation regularly and, using the latest available information, at least once a year review and update the application of the methodology for determining the GSK.

## Article 8

### Methodology for determining remedial actions to be considered in capacity calculation

1. Each TSO shall individually define the remedial actions (hereafter referred to as “RA”) to be applied in capacity calculation. The applied remedial actions shall be clearly described, communicated to other TSOs and, where appropriate, coordinated between all TSOs.
2. Each TSO shall take into account RA in capacity calculation to allow for an increase in remaining available margin (hereafter referred to as “RAM”) on grid constraints or cross-zonal borders. This is reflected in the equation in Article 15(1) of this Proposal. Costly RAs may only be applied in the case that they are available, more efficient, and do not compromise operational security, in accordance with Article 21(1)(b)(iv) of the CACM Regulation.

3. TSOs shall apply the following RAs to fulfil the requirements set in Article 8(2) of this Proposal:
  - a) Redispatching;
  - b) Automatic tripping of generation, consumption or grid components in case of fault (System protection schemes);
  - c) Changes in grid topology to minimise the effect of faults; and
  - d) Emergency power and runback on HVDC interconnections
4. The TSOs shall provide RAs for the CCC to be used in the capacity calculation to avoid undue discrimination in accordance with Article 11 of this Proposal.
5. The TSOs shall regularly and at least once a year review and update the remedial actions taken into account in the capacity calculation in accordance with Article 27(4) (d) of the CACM Regulation.

### **TITLE 3**

#### **Detailed description of the capacity calculation approach for DA timeframe**

#### **Article 9**

#### **Mathematical description of the applied capacity calculation approach with different capacity calculation inputs**

1. Capacity calculation approach for the DA timeframe shall be the FB approach.
2. The FB approach shall include
  - a) Simplified representation of the grid constraints as PTDFs applied for critical network elements (hereafter referred to as “CNE”) and Cuts in accordance with Article 14 of this Proposal;
  - b) Remaining available margin (RAM) for each grid constraint, which shall be the amount of transmission capacity available for the capacity allocation in the market coupling process, and determined in accordance with Article 15 of this Proposal.
3. For each grid constraint provided by the TSOs, the capacity allocation in the market coupling process shall apply the following constraint during the capacity allocation, i.e. the product of the NP vector and the PTDF matrix shall be less than or equal to the RAM vector:

$$NP \cdot PTDF \leq RAM$$

where NP refers to the vector of bidding zone market net positions within the FB region, PTDF refers to the matrix of PTDFs for the bidding zones in the FB region calculated for the specific constraint, and RAM refers to the available margin on the constraint.

4. The PTDF and RAM shall form FB parameters describing the available transmission capacity between relevant bidding zones.
5. DC interconnections and radial AC connections shall be embedded by the AHC, i.e. PTDFs and margins will be applied to the Nordic access points of the connections, in which the Nordic access points are forming a virtual bidding zone.

#### **Article 10** **CNE selection**

1. For each grid constraint, the TSO shall calculate the maximum influence on cross-zonal power exchange, by applying the following equation:

$$\text{Max } PTDF_n^{ij} = PTDF_{n,\text{Max}} - PTDF_{n,\text{Min}}$$

where PTDF is the power transfer distribution factor,  $i$  and  $j$  are the bidding zones and  $n$  is the grid constraint. If this maximum influence is below the threshold defined by each TSO, the contingency will be removed from the PTDF matrix defined under Article 9 of this Proposal.

2. Each TSO shall define a minimum level of significant influence from any cross-zonal power exchange. Initially each TSO shall apply a threshold value of 15% and above for significant influence.
3. The TSOs shall develop criteria to be applied for deciding on the threshold value. These criteria shall be based on the concepts of economic efficiency and secure operation of the power system.
4. Each TSO shall evaluate and update the maximum level of significant influence to be used in the capacity calculation at least once a year.

### **Article 11**

#### **Rules for avoiding undue discrimination between internal and cross-zonal exchanges**

1. Internal and cross-zonal flows induced by trading actions of market participants shall be given access to the market (grid capacity) on an equal and fair basis and no undue discrimination shall take place. Only selection criteria for access to the market (grid capacity) to be applied are the competitiveness of the bids submitted by the market participants, still ensuring operational security. Undue discrimination is defined as a situation where some flows are given priority on grounds which cannot be justified based on economic efficiency and operational security.
2. The TSOs shall review the grid constraints applied for capacity allocation, that are found to be limiting the cross-zonal power exchange, every six months to determine if inclusion of the grid constraints in the capacity allocation fulfils the requirements set in Article 21(1)(b)(ii) of the CACM Regulation.
3. The TSOs shall make the review of existing bidding zone configuration regularly if the same internal grid constraint is limiting cross-zonal exchanges recurrently. In this review, the TSOs shall study whether dividing the bidding zone where the grid constraint is located into several bidding zones would bring benefits to the market in accordance with Article 33 of the CACM Regulation.
4. To avoid undue discrimination between internal and cross-zonal flows, only those internal grid constraints (critical network elements or cuts within the bidding zones) that can be justified based on the criteria of operational security and economic efficiency will be included in the capacity calculation and allocation in the day ahead and intraday market.

### **Article 12**

#### **Rules for taking into account previously allocated cross-zonal capacity**

1. TSOs shall take into account the previously-allocated capacity as follows:
  - a) Capacity allocated for nominated Physical Transmission Rights (PTRs); and
  - b) Capacity allocated for cross-zonal exchange of ancillary services, except those ancillary services in accordance with Article 22(2) of the CACM Regulation.
2. Previously allocated cross-zonal capacity shall be translated into resulting flows on each CNE by applying PTDFs. The resulting flow for each CNE shall be subtracted from the RAM of that CNE to define the RAM including the previously allocated cross-zonal capacity.

### Article 13

#### Rules on the adjustment of power flows on critical network elements or of cross-zonal capacity due to remedial actions

1. TSOs shall take into account in the capacity calculation RAs as defined in Article 8 of this Proposal to increase the cross-zonal capacity for the day-ahead timeframe.
2. RAs shall be translated into resulting flows on each CNE by applying power system analyses for several relevant scenarios in the CGM. The resulting flow for each available RA on each CNE shall be added in the opposite direction to the RAM of that CNE to define the RAM including the RAs, as illustrated in Figure 1.

### Article 14

#### A mathematical description of the calculation of power transfer distribution factors for the FB approach

1. The PTDFs describe how the net position in each bidding zone impacts the flow on the grid constraints. PTDFs shall be calculated by applying an AC load flow analysis software tool to the CGM with the simplifications necessary to create a linear approximation as described in this Article.
2. PTDFs shall be calculated to represent the power system state after the contingency or disconnections, taking into account RAs, implying that PTDFs will represent the power system state after disconnection of the power system elements.
3. PTDFs shall be calculated with the following assumptions:
  - a) The magnitude of voltage in each node is 1 pu;
  - b) The resistance of the power system series elements are neglected (zero); and
  - c) The difference between the voltage angles of adjoining nodes is small
4. Taking into account these simplification in AC load flow analysis, the PTDFs can be calculated for all nodes and transmission elements as

$$PTDF_{ik,n} = B_{ik}(Zbus_{in} - Zbus_{kn})$$

where the  $PTDF_{ik,n}$  is the sensitivity for the transmission element  $ik$  for the power injection in the bidding zone  $n$  that is taken out at the defined slack node,  $B_{ik}$  is susceptance between nodes  $i$  and  $k$ ,  $Zbus$  refers to elements in the bus impedance matrix.

5. For the capacity allocation the nodal PTDFs as calculated under Article 14(4) shall be aggregated to a PTDF value for the bidding zone applying GSK weighting for each node as follows

$$PTDF_{i,j}^A = \sum_{\forall \alpha} GSK^{\alpha} PTDF_{i,j}^{\alpha}, \text{ and } \sum_{\forall \alpha} GSK^{\alpha} = 1$$

where

$PTDF_{i,j}^A$  is sensitivity of transmission element  $i,j$  to injection in bidding zone A;

$PTDF_{i,j}^{\alpha}$  is sensitivity of transmission element  $i,j$  of injection in node  $\alpha$ ; and

$GSK^{\alpha}$  is weight of node  $\alpha$  on the PTDF of zone A.

### Article 15

#### A mathematical description of available margins on critical network elements for the FB approach

1. The *RAM* shall provide the capacity available for allocation. The *RAM* shall be calculated as follows:

$$RAM = F_{max} - FRM + RA - F'_{ref} \pm FAV$$

where  $F_{max}$  is the maximum allowed physical flow on a grid constraint,  $FRM$  is the flow reliability margin,  $RA$  is the impact of remedial actions,  $F'_{ref}$  is the reference flow at zero net position applying computed PTDFs, and  $FAV$  is the final adjustment value that may receive a non-zero value in the validation stage cf. Article 17 of the Proposal.

2.  $F_{max}$  shall be calculated by an AC load flow analysis and, where appropriate, a dynamic analysis using the CGM or regional model to ensure the secure grid operation.
3.  $FRM$  shall be the flow reliability margin covering the uncertainty between the expected power flow at the time of the capacity calculation and the realised power flow in real time to be calculated in accordance with Article 3 of this Proposal.
4.  $RA$  shall be the remedial actions to increase *RAM* and defined in accordance with Article 8 of this Proposal.
5.  $F'_{ref}$  shall be the reference flow at zero net position applying the computed PTDFs and shall be defined as follows (Figure 1):

$$F_{ref}' = F_{ref} - PTDF \cdot NP^{BC}$$

where  $F_{ref}$  is the forecasted flow on the grid constraint,  $NP^{BC}$  is a vector of the forecasted zone net positions in the base case and  $PTDF$  is the vector of *PTDF* values for this grid constraint.  $F'_{ref}$  may be positive and shall be subtracted from the *RAM* or negative and shall be added to the *RAM*.

6. The *FB* approach shall allow for negative *RAMs* to the extent that the capacity allocation process within single day-ahead coupling will allow such negative values.

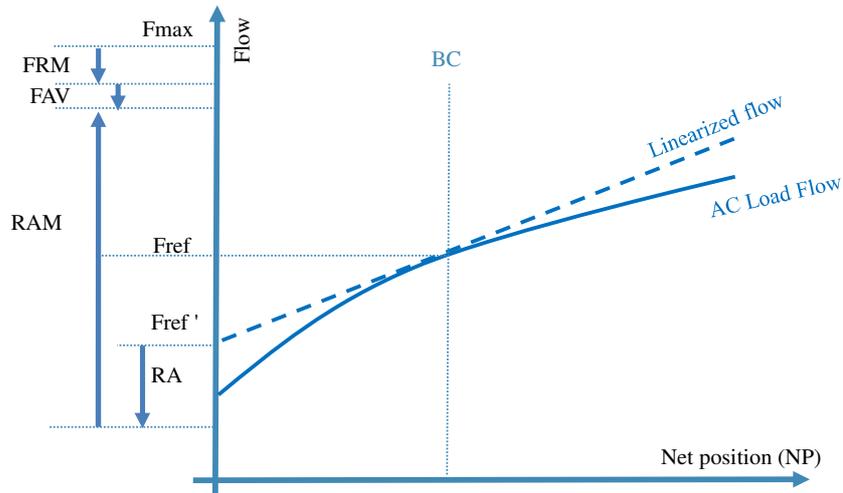


Figure 1. Relation between flow, net position and *RAM*.

## Article 16

### Rules for sharing the power flow capabilities of critical network elements among

**different capacity calculation regions in order to accommodate these flows, where power flows on critical network elements are influenced by cross-zonal power exchanges in different capacity calculation regions**

AHC is applied for the interconnectors to the neighbouring CCRs.

**TITLE 4**

**Methodology for the validation of cross-zonal capacity for DA timeframe**

**Article 17**

**Methodology for the validation of cross-zonal capacity**

1. Each TSO shall perform the validation of cross-zonal capacities on its bidding zone border(s) to ensure that the results of regional calculation of cross-zonal capacity will ensure operational security. When performing validation, TSOs shall consider the operational security limits, but may also consider additional grid constraints, grid models, and other relevant information known at the time of validation.
2. Each TSO may alter cross-zonal capacity during the validation of cross-zonal capacity for reasons of operational security.
3. *RAM* defined in accordance with Article 15(1) of this Proposal may be adjusted during the validation by applying *FAV* to take into account relevant information known at the time of validation in accordance with Article 17(1) of this Proposal. TSOs applying *FAV* shall be transparent towards the CCC and other TSOs about the value and information applied in *FAV* and report the reductions made during the validation in accordance with Article 26 of the CACM Regulation.

**TITLE 5**

**Detailed description of the capacity calculation approach for ID timeframe**

**Article 18**

The FB Approach shall be the target capacity calculation approach for the ID timeframe. The CNTC Approach shall be applied in the ID timeframe until conditions to implement FB Approach described in Article 31 of this Proposal have been fulfilled.

**Article 19**

**Mathematical description of the applied capacity calculation approach with different capacity calculation inputs**

1. Inputs to the CNTC approach shall be
  - a) CGM, which presents the forecasted state of the power system for the ID timeframe;
  - b) GSKs in accordance with Article 7 of this Proposal;
  - c) Contingencies in accordance with Article 5 of this Proposal; and
  - d) Operational security limits in accordance with Article 4 of this Proposal.
2. AC load flow analysis shall reveal the voltage (magnitude and angle) on each node of the CGM, power flows (active and reactive power) and losses on each serial component of the CGM. Voltages and power flows can be calculated when load (outtake) and generation (injection) in each node of the CGM is known. The active and reactive power flows in steady state shall be calculated as follows

$$\underline{S}_i = P_i + jQ_i = (P_{Gi} - P_{Li} - P_{Ti}) + j(Q_{Gi} - Q_{Li} - Q_{Ti})$$

where  $\underline{S}_i$  is the net apparent power coming to node  $i$ ,  $P_i$  is the net active power coming to node  $i$ ,  $Q_i$  is the net reactive power coming to node  $i$ ,  $P_{Gi}$  is the active power coming to node  $i$  from the connected generators,  $P_{Li}$  is the active power from node  $i$  to the connected load,  $P_{Ti}$  is the active power going from node  $i$  to the connected transmission lines,  $Q_{Gi}$  is the reactive power coming to node  $i$  from the connected generators,  $Q_{Li}$  is the reactive power from node  $i$  to the connected load and  $Q_{Ti}$  is the reactive power going from node  $i$  to the connected transmission lines.

3. Cross-zonal capacity shall be calculated as follows:

$CZC = TTC$  (maximum power exchange adjusted by applying remedial actions, rules for undue discrimination and rules for sharing power flow capabilities among different bidding zone borders) -  $AAC$  -  $RM$ ,

where  $TTC$  refers to total transmission capacity,  $AAC$  refers to previously allocated capacity and  $RM$  refers to reliability margin.  $TTC$  is the maximum allowed power exchange of active power between adjoining bidding zones respecting  $N-1$  criteria and operational security limits taking into account remedial actions, rules for undue discrimination and rules for efficiently sharing the power flow capabilities of critical network elements among different bidding zone borders.

## **Article 20**

### **Rules for avoiding undue discrimination between internal and cross-zonal exchanges**

1. Grid constraints within a bidding zone shall be monitored during the capacity calculation process. If these grid constraints limit the cross-zonal power exchanges, analysis shall be performed to determine if inclusion of these grid constraints fulfils the requirements in Article 21(1)(b)(ii) of the CACM Regulation, where the loss of socio-economic welfare due to limitation in the cross-zonal capacity caused by these grid constraints shall be compared to the costs of remedial actions to relieve these grid constraints.
2. If the same grid constraint within a bidding zone is limiting cross-zonal power exchanges recurrently, the relevant TSO(s) shall study whether the change in bidding zone configuration would bring benefits to the market taking into account in this study costs related to this change.

## **Article 21**

### **Rules for taking into account previously allocated cross-zonal capacity**

Cross-zonal capacities shall be reduced, where appropriate, by the amount of previously allocated capacities in the DA timeframe and in accordance with Article 12 of this Proposal. In case previously allocated capacity is bigger than  $CZC$  on a bidding zone border, defined in accordance with Article 19(3), the relevant TSO(s) shall provide zero cross-zonal capacity for the capacity allocation and use RAs to ensure operational security.

## **Article 22**

### **Rules on the adjustment of power flows on critical network elements or of cross-zonal capacity due to remedial actions**

TSOs shall take into account in the capacity calculation RAs as defined in Article 8 of this Proposal to increase the cross-zonal capacity for the ID timeframe. After calculating the maximum power exchanges between bidding zones without RAs, necessary adjustments taking into account RAs are

executed in the CGM and maximum power exchanges between bidding zones taking into account RAs shall be calculated.

### **Article 23**

#### **A mathematical description of the calculation of power transfer distribution factors for the FB approach**

The content of Article 14 of this Proposal shall apply.

### **Article 24**

#### **A mathematical description of available margins on critical network elements for the FB approach**

The content of Article 15 of this Proposal shall apply.

### **Article 25**

#### **Rules for calculating cross-zonal capacity, including the rules for efficiently sharing the power flow capabilities of critical network elements among different bidding zone borders for the CNTC approach**

1. The capacity calculation approach shall, in accordance with Article 29(8) of the CACM Regulation:
  - a) use common grid model, generation shift keys and contingences to calculate maximum power exchange on bidding zone borders, which shall equal the maximum calculated exchange between two bidding zones on either side of the bidding zone border respecting operational security limits;
  - b) adjust maximum power exchange using remedial actions taken into account in capacity calculation;
  - c) adjust maximum power exchange, applying rules for avoiding undue discrimination between internal and cross-zonal exchanges;
  - d) apply the rules for efficiently sharing the power flow capabilities of different critical network elements among different bidding zone borders; and
  - e) calculate cross-zonal capacity, which shall equal the maximum power exchange, adjusted according to b), c), and d), and taking into account the reliability margin and previously allocated cross-zonal capacity.
2. According to Article 29(8)(a) of the CACM Regulation, the following shall apply:
  - a) The calculation of the maximum power exchange on a bidding zone border consists of contingency analysis taking into account relevant operational security limits as defined in Article 4 and 5 of this Proposal.
  - b) The calculation of maximum power exchanges in accordance with Article 25(1)(a) of this Proposal shall apply the scenario of the CGM created for the studied MTU. The contingency analyses shall investigate probable scenarios, where applicable, finding the maximum power exchanges not violating operational security limits, as defined in line with Article 4 and 5 of this Proposal. In the contingency analyses, GSKs will be applied scaling the net positions of the bidding zones, in order to adjust the power exchange over the studied bidding zone border(s).
3. According to b) and c) of Article 29(8) of the CACM Regulation, the following shall apply:
  - a) The maximum power exchange from Article 25(2) of this Proposal shall be adjusted by using remedial actions as defined in accordance with Article 8 of this Proposal; and

- b) The maximum power exchanges from Article 25(2) of this Proposal shall be adjusted by applying rules for undue discrimination between internal and cross-zonal exchanges as defined in accordance with Article 11 of this Proposal.
4. According to d) of Article 29(8) of the CACM Regulation, the following shall apply:
    - a) Based on the assumption that CNTC should be applied in CCRs where cross-zonal capacity is less interdependent, sharing rules may be applied for interdependent bidding zone borders to share capacities efficiently among the different bidding zone borders. Zone-to-zone PTDF matrices may be used to evaluate on which bidding zone borders sharing rules may be applied; and
    - b) Initially the current sharing rules, to define these interdependencies, shall be applied as defined in Chapter 5 entitled “Practical Implementation of NTC Calculations” of the document “Principles for Determining the Transfer Capacities in the Nordic Power Market” of which, the latest dated version will be made available by the CCC.
    - c) Re-evaluation of the interdependencies between bidding zones borders shall be carried out regularly in accordance with the timeframe set in Article 31 of the CACM Regulation, and shall be made available by the CCC.
  5. According to e) of Article 29(8) of the CACM Regulation the following shall apply:

Cross-zonal capacity shall equal the maximum power exchange calculated in accordance with Article 25(2), Article 25(3) and Article 25(4) of this Proposal adjusting exchanges with reliability margin in accordance with Article 3 of this Proposal and previously allocated cross-zonal capacity in accordance with Article 12 of this Proposal taking into account also cross-zonal capacity allocated in day-ahead timeframe.

## **Article 26**

### **Rules for sharing the power flow capabilities of critical network elements among different capacity calculation regions in order to accommodate these flows, where power flows on critical network elements are influenced by cross-zonal power exchanges in different capacity calculation regions**

1. Adjoining bidding zones in neighbouring CCR(s) shall be taken into account in the capacity calculation in CCR Nordic. Cross-zonal capacities on bidding zone borders between CCR Nordic and neighbouring CCRs shall be calculated using CGMs and relevant information from these adjoining bidding zones in coordination with the neighbouring CCC(s).
2. If there is difference in the cross-zonal capacity on the bidding zone border to the neighbouring CCR, the lower value of the cross-zonal capacity shall be used for the capacity allocation.

## **TITLE 6**

### **Methodology for the validation of cross-zonal capacity for ID timeframe**

## **Article 27**

### **Methodology for the validation of cross-zonal capacity**

1. Each TSO shall perform the validation of cross-zonal capacities on its bidding zone border(s) in accordance with Article 17 of this Proposal.
2. For the CNTC approach, the rules for splitting the corrections of cross-zonal capacity shall follow the same sharing rules as described in Article 25(4) of this Proposal. The TSOs shall reduce the cross-zonal capacity in a manner that minimizes the negative impact on the market by applying the same rules for splitting the cross-zonal capacity as is described in Article 25(4) of this Proposal.

## **TITLE 7**

### **Miscellaneous**

#### **Article 28**

##### **Reassessment frequency of capacity for the intraday capacity calculation timeframe**

The frequency of the reassessment of intraday capacity shall be dependent on the availability of input data relevant for capacity calculation, as well as any events impacting the capacity on the cross-zonal lines. Reassessment of intraday capacity shall be done at the frequency the CGM for the intraday timeframe is made available in accordance with the CGM methodology developed in linewith Article 17 of the CACM Regulation and in case of a fault in the power system. The latest available CGM is applied in the reassessment of cross-zonal capacities.

#### **Article 29**

##### **Fallback procedure for the case where the initial capacity calculation does not lead to any results**

The TSOs will develop fallback procedures, for different parts of the capacity calculation process, in such a way that in any case capacities shall be provided to the allocation mechanism.

#### **Article 30**

##### **Information provided for national regulatory authorities**

All technical and statistical information related to the Proposal shall be made available upon request to the national regulatory authorities in the CCR Nordic.

## **TITLE 8**

### **FINAL PROVISIONS**

#### **Article 31**

##### **Publication and Implementation of the Proposal**

1. The TSOs shall publish the Proposal without undue delay after all national regulatory authorities in the CCR Nordic have approved the Proposal or a decision has been taken by the Agency for the Cooperation of Energy Regulators in accordance with Article 9 (10), Article 9(11) and 9(12) of the CACM Regulation regarding the Proposal.
2. The TSOs shall implement the Proposal on all bidding zone borders within the CCR Nordic after the CGM methodology developed in accordance with Article 17 of the CACM Regulation, the market coupling operator function developed in accordance with Article 7(3)) of the CACM Regulation, the relevant requirements set in algorithm submitted in accordance with Article 37(5), and the coordinated capacity calculator in CCR Nordic has been set up in accordance with Article 27 of the CACM Regulation, are implemented in the CCR Nordic. The milestones and the criteria for implementing the CCM are presented in Table 2 and 3.

Table 2. Implementation milestones and criteria for implementation of FB Approach for day-ahead timeframe.

#	Milestone	Criteria to be met before moving to the next milestone
1	Market simulations in Simulation Facility using prototype FB tool (overlapping with milestone #2)	<ul style="list-style-type: none"> <li>• Requirements/specifications for the industrialized tool are finished and are based on the methodology and the experience gained by using the prototype tool</li> <li>• In order to increase transparency, stakeholders are involved in the development of stakeholder information tool</li> <li>• NRAs have approved this proposal</li> </ul>
2	Investment decision - FB industrialized tool	<ul style="list-style-type: none"> <li>• Minimum of one year of FB market simulations (as described under milestone #1), where: <ul style="list-style-type: none"> <li>○ FB is not proven to be less efficient compared to NTC, at the same level of operational security</li> <li>○ FB is not proven to decrease system security, at the same level of efficiency</li> <li>○ FB is reliable in producing capacity calculation parameters and results</li> </ul> </li> <li>• Market simulation results are published to the stakeholders</li> <li>• GSK and FRM methodologies are fully developed and ready for implementation</li> <li>• CGMs are available and can be applied in the capacity calculation</li> </ul>
3	Parallel runs including FB and NTC	<ul style="list-style-type: none"> <li>• Parallel runs are performed in real NEMO systems and capacity calculation parameters are submitted to NEMOs daily as with current NTC <ul style="list-style-type: none"> <li>○ Precondition is that Euphemia is able to handle FB parameters for a larger area including CCR Nordic when performing calculations for the geographical scope of SDAC</li> </ul> </li> <li>• At the minimum 6 months of continuous parallel runs, where: <ul style="list-style-type: none"> <li>○ FB is not proven to be less efficient compared to NTC, at the same level of operational security</li> <li>○ FB is not proven to decrease system security, at the same level of efficiency</li> <li>○ FB is reliable in producing capacity calculation parameters and results</li> </ul> </li> <li>• Results from the parallel runs are published daily</li> </ul>
4	FB go-live	

Table 3. Implementation milestones and criteria for implementation of CNTC Approach and FB Approach for intraday timeframe.

#	Milestone	Criteria to be met before moving to the next milestone
1	CGMs applied in capacity calculation using current NTC approach	<ul style="list-style-type: none"> <li>• GSK and RM methodologies are fully developed and ready for implementation</li> <li>• Coordination in capacity calculation implemented</li> </ul>
2	CNTC go-live	<ul style="list-style-type: none"> <li>• FB fully developed, tested in DA and ID, and                             <ul style="list-style-type: none"> <li>○ not proven to be less efficient compared to NTC, at the same level of operational security</li> <li>○ not proven to decrease system security, at the same level of efficiency</li> <li>○ reliable in producing capacity calculation parameters and results</li> </ul> </li> <li>• XBID ready to support FB approach</li> </ul>
3	FB go-live	

### **Article 32 Language**

The reference language for this Proposal shall be English. For the avoidance of doubt, where TSOs need to translate this Proposal into their national language(s), in the event of inconsistencies between the English version published by TSOs in accordance with Article 9(14) of the CACM Regulation and any version in another language, the relevant TSOs shall be obliged to dispel any inconsistencies by providing a revised translation of this Proposal to their relevant national regulatory authorities.