Explanatory document to the proposal for the common coordinated capacity calculation methodology for Capacity Calculation Region Hansa in accordance with Article 10 of the Commission Regulation (EU) 2016/1719 of 26 September 2016 establishing a guideline on forward capacity allocation

15 April 2019

Abbreviations:

AAC	Already Allocated and nominated Capacity
AC	Alternating Current
ATC	Available Transfer Capacity
CA	Capacity Allocation
CACM	Capacity Allocation and Congestion Management
CC	Capacity Calculation
CCM	Capacity Calculation Methodology
CCR	Capacity Calculation Region
CGM	Common Grid Model
CNE	Critical Network Element
CNTC	Coordinated Net Transmission Capacity
DA	Day Ahead
DC	Direct Current
GSK	Generation Shift Key
ID	Intraday
IGM	Individual Grid Model
NTC	Net Transfer Capacity
NP	Net Position
OWF	Offshore Wind Farm
PD	Probability Distribution
PTDF	Power Transfer Distribution Factor
RA	Remedial Action
TRM	Transmission Reliability Margin
TSO	Transmission System Operator
TTC	Total Transfer Capacity

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1. Introduction

This document contains explanations for the proposal for a common coordinated capacity calculation methodology for the long-term time frame for the capacity calculation region of Hansa (CCR Hansa) in accordance with Article 10 of the Commission Regulation (EU) 2016/1719 of 26 September 2016 establishing a guideline on forward capacity allocation (FCA Regulation). CCR Hansa Transmission system operators (CCR Hansa TSOs) are obliged to consult stakeholders on proposals for terms and conditions or methodologies required by the FCA Regulation.

The CCR Hansa is placed between two larger CCRs: CCR Nordic and CCR Core. This document has been written with the aim of ensuring that the methodology developed in the CCR Hansa is as efficient as possible from a market point of view and that it is easily implementable from an operational and security of supply point of view when coordinating with adjacent regions.

The CCR Hansa proposes a capacity calculation methodology based on a coordinated NTC (CNTC) methodology with a strong link to the adjacent CCRs that have chosen CNTC capacity calculation methodologies. By utilising the CNTC methodologies of CCR Nordic and CCR Core which are to take fully into account the influences of the CCR Hansa bidding-zone borders while representing the AC meshed grids in calculation, the capacity calculation on the CCR Hansa borders is optimised to the fullest extent possible. This implicitly means that CCR Hansa assumes that, if possible, all AC grid limitations outside the CCR Hansa interconnectors are considered in the capacity calculations within CCR Nordic and CCR Core. The combination of the capacity calculation inputs from the adjacent CCR Nordic and CCR Core CNTC methodologies together with the capacity calculation results within CCR Hansa determine the cross-zonal capacity between the CCR Hansa bidding-zone borders, which shall be respected during the allocation process.

This document is structured as follows: Chapter 2 contains a description of the relevant legal references. Thereafter, Chapter 3 defines CCR Hansa and the borders that are subject to this proposal. Chapter 4 contains the explanation for the capacity calculation methodology for the long-term time frames presented in the legal proposal. The methodologies are described according to the requirements set in the FCA Regulation. A description of the proposed validation methodology is given in Chapter 5. Chapters 6 and 7 deal with the issue of sharing CNE among bidding-zone borders of CCR Hansa and among adjacent CCRs. Chapter 8 contains a description of scenarios used in security analyses. A planning for the implementation of this can subsequently be found in Chapter 9. Public consultation responses will be shown and commented on in Chapter 10.

2. Legal requirements

According to Article 10 of the FCA Regulation, each CCR is required to submit a common capacity calculation methodology for approval by the relevant national regulatory authority (NRA). This is to be done no later than six months after approval of the capacity calculation methodology for the day-ahead and intraday time frame.

According to Article 10 (2) of the FCA Regulation, one of the approaches to be used in the capacity calculation methodology (CCM) is the coordinated net transmission capacity approach (CNTC) and this is the applied approach in Hansa CCR.

Article 10(4) of the FCA Regulation further states that the FCA CCM shall consider the uncertainty associated with long-term capacity calculation time frames by applying either a security analysis based on multiple scenarios or statistical approach based on historical cross-zonal capacity calculation for day-ahead or intraday time frames.

The CCR Hansa TSOs have decided to prepare a security analysis. Scenarios to be used in a security analysis for long-term capacity calculation time frames associated with AC grid of adjacent CCRs shall be considered by applying in CCMs of adjacent CCRs Core and Nordic scenarios as defined in Article 3 of the CGM methodology developed in accordance with Article 18 of FCA regulation. When applying security analysis for long-term capacity calculation time frames associated with CCR Hansa bidding-zone borders, relevant maintenance plans shall be considered.

Article 10(4) of the FCA Regulation states that the FCA CCM shall be compatible with the capacity calculation methodology established for the day-ahead and intraday time frames pursuant to Article 21(1) of Regulation (EU) 2015/1222 (CACM). This further implies that FCA CCM shall include the following:

- methodologies for the calculation of the inputs to capacity calculation, which shall include the following parameters:
  - a methodology for determining the reliability margin;
  - the methodologies for determining operational security limits, contingencies relevant to capacity calculation and allocation constraints that may be applied;
  - the methodology for determining the generation shift keys;
  - the methodology for determining remedial actions to be considered in capacity calculation.
- a detailed description of the capacity calculation approach which shall include the following:
  - a mathematical description of the applied capacity calculation approach with different capacity calculation inputs;
  - rules for avoiding undue discrimination between internal and cross-zonal exchanges to ensure compliance with point 1.7 of Annex I to Regulation (EC) No 714/2009;
  - rules for considering, where appropriate, previously allocated cross-zonal capacity;
  - rules on the adjustment of power flows on critical network elements or of cross-zonal capacity due to remedial actions;
  - for the coordinated net transmission capacity approach, the 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;
  - where the power flows on critical network elements are influenced by cross-zonal power exchanges in different capacity calculation regions, the rules for sharing the power flow capabilities of critical network elements among different capacity calculation regions in order to accommodate these flows.
- a methodology for the validation of cross-zonal capacity
- a fallback procedure for the case where the initial capacity calculation does not lead to any results

3. Definition of bidding-zone borders in CCR Hansa

This methodology relates to the bidding-zone borders of CCR Hansa. In line with ACER's decisions on the determination of capacity calculation regions, CCR Hansa currently consists of the following bidding-zone borders:

1) Denmark 1 – Germany/Luxembourg (DK1-DE/LU)
   Energinet.dk and TenneT TSO GmbH;
   Via onshore AC-grid connection
   Additional information on the DK1-DE/LU border is given in section 3.1

2) Denmark 2 – Germany/Luxembourg (DK2-DE/LU)
   Energinet.dk and 50Hertz Transmission GmbH; and
   Via the Kontek HVDC interconnector

3) Sweden 4 – Poland (SE4 – PL)
   Svenska Kraftnät and PSE S.A.
   Via the SwePol HVDC interconnector

4) Denmark 1 – the Netherlands (DK1-NL)
   Via the COBRA cable HVDC interconnector

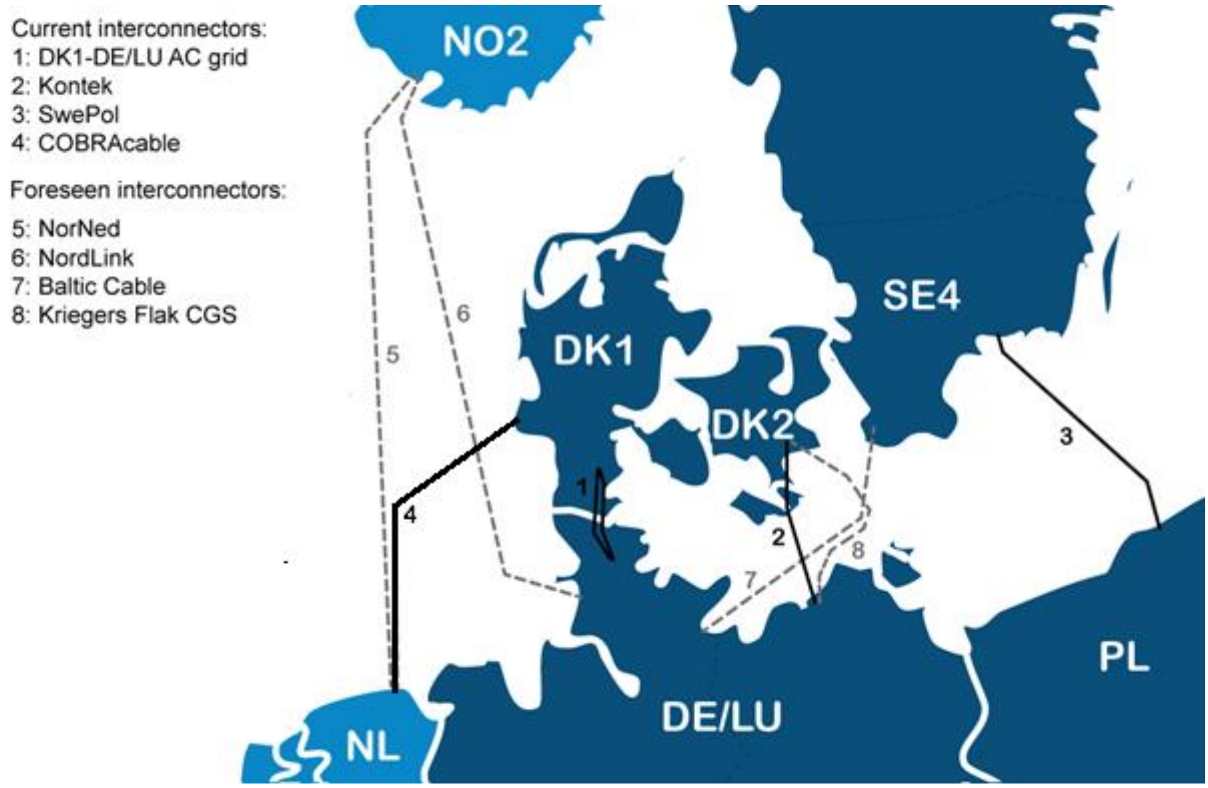

Figure 1: Geographical overview of the current and foreseen bidding-zone borders covered by CCR Hansa.

Additionally, new bidding-zone borders are expected to be added to the CCR Hansa through requests for amendment. In the upcoming years, it is foreseen that requests for amendment could be handed in for the following bidding-zone borders to be added to CCR Hansa:

5) Norway 2 – the Netherlands (NO2-NL)

Via the NorNed interconnector
Additionally, it is expected that NorNed (NO2-NL) will be added to CCR Hansa once Norway ratifies the CACM Regulation. The 3rd EU liberalisation package, EU Regulation No. 713-714/2009 was ratified in Norway in April 2018, but the Network Codes and Guidelines are not yet ratified.

6) Germany/Luxembourg – Norway 2 (DE/LU-NO2)
Via the NordLink HVDC interconnector
Similar prerequisite as NorNed that Norway ratifies the CACM Regulation. Foreseen go-live of the IC is end of 2020.

7) Germany/Luxembourg – Sweden 4 (DE/LU-SE4)
Via the BalticCable HVDC interconnector
At present, the owner of Baltic cable (SE4-DE/LU) is not a certified CCR Hansa TSO. Until the owner of Baltic Cable becomes a certified CCR Hansa TSO, BalticCable is not expected to be allowed to join CCR Hansa and is therefore not in scope of the CCR.

Lastly, an additional interconnector is foreseen to be added to an already existing bidding-zone border in CCR Hansa:

8) Denmark 2 – Germany/Luxembourg (DK2-DE/LU)
Through the development of Kriegers Flak Combined Grid Solution, a hybrid interconnector consisting of interconnected offshore wind farms in the DK2 and DE/LU bidding zone, an additional interconnector will arise parallel to the already existing Kontek interconnector.
Additional information on the Kriegers Flak CGS is given in section 3.2

As is apparent from the list and table above, CCR Hansa largely consists of fully controllable HVDC interconnectors. There are two exceptions to this, the AC-grid border DK1-DE/LU and the Kriegers Flak CGS attributed to the DK2-DE/LU border, of which an additional description will be given in the next sections.

3.1 Description of the Denmark 1 – Germany/Luxembourg AC border

CCR Hansa consists of DC-connected borders and one AC-connected border. To understand the capacity calculation methodology and the related methodologies for remedial actions, it is important to know the current topology of the AC border which is shown in Figure 2. When the 220kV lines (green lines in map) are upgraded to 400kV, the one which connects to the Danish substation “Ensted” will instead connect to “Kassø”, making the existing and new 400kV lines fully parallel.

At present, there are two phase-shifting transformers placed in Denmark at the substations where the 220kV lines connect. The aim of these is to equalize the distribution of flows between the 400kV and 220kV lines and therefore to ensure the 220kV lines are not overloaded in operation.

There is no synchronous connection from DK1 to DK2 or Scandinavia. DK1 is only connected with AC lines to the German grid. This means that all exchanges between DK1 and DE must flow from Kassø to Audorf. Only the grid between Kassø and Audorf is represented within the capacity calculation of CCR Hansa. The 150kV line from Ensted in Denmark and Flensburg in Germany is only a supply line, as there is no transfer capability between the bidding zones of DK1 and DE on this line. Due to historic reasons, significant parts of Flensburg are supplied from Denmark and are part of the market in DK1.

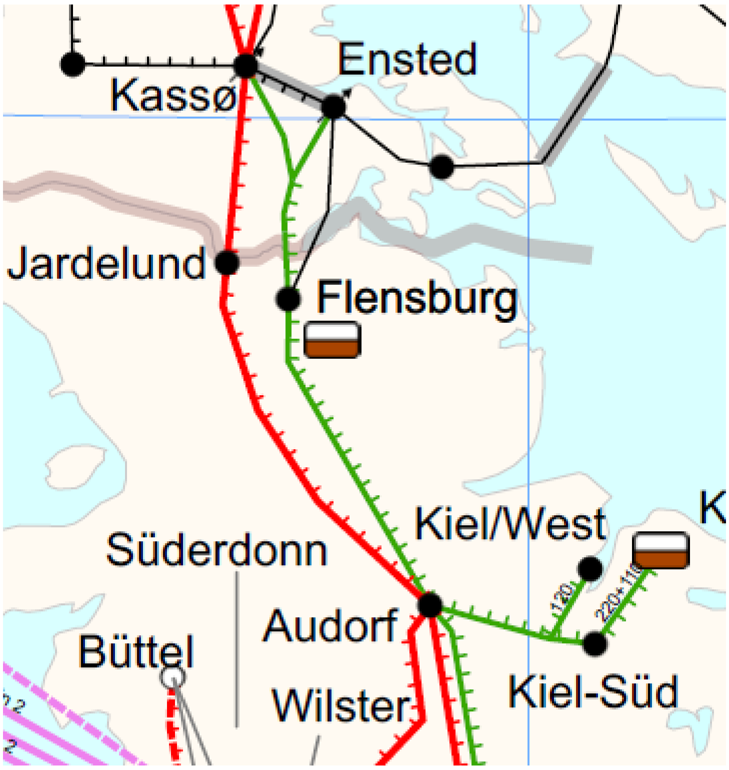

Figure 2: Topological overview of the Denmark West (DK1) – Germany (DE/LU) AC connection within CCR Hansa. The green lines are 220kV lines and the red lines are 400kV lines, and these are both double circuits across the border between Denmark (DK1) and Germany (DE/LU).

Since both cross-border connections are connected to the substations Kassø in Denmark and Audorf in Germany, the DK1-DE/LU border is considered radial and no loop flows can occur.

3.2 Description of Kriegers Flak Combined Grid Solution

From 2019, two separate connections will make up the DK2-DE bidding-zone border: the existing KONTEK DC interconnector and the Kriegers Flak Combined Grid Solution (KF CGS).

KF CGS is a novel type of CCR Hansa interconnector, being a hybrid with interconnector and offshore wind farm (OWF) grid connection.

Due to the fact that the transmission grids in Eastern Denmark and Germany, respectively, belong to different synchronous areas and are thus operated non-synchronously, KF CGS, in case it being solely a CCR Hansa interconnector between Eastern Denmark and Germany with no OWFs connected to it, would have been set up as an ordinary DC line. For both technical and economic reasons, KF CGS is set up as an AC line, however with a back-to-back converter which is located at one of its ends and converts AC into DC and back into AC and thus enables the connection of the Nordic synchronous area with the one in continental European synchronous areas.

KF CGS is comprised of

- a back-to-back converter station at the German terminal of KF CGS.
- two German OWFs that feed into the German bidding zone through an AC radial grid connection.
- an AC cable connecting the grid connection of the German OWFs with the grid connection of the Danish OWFs.
- one Danish OWF that feeds into the DK2 bidding zone through an AC radial grid connection

Despite its technical setup, in operational terms KF CGS behaves like an ordinary DC link and is therefore to be treated as such.

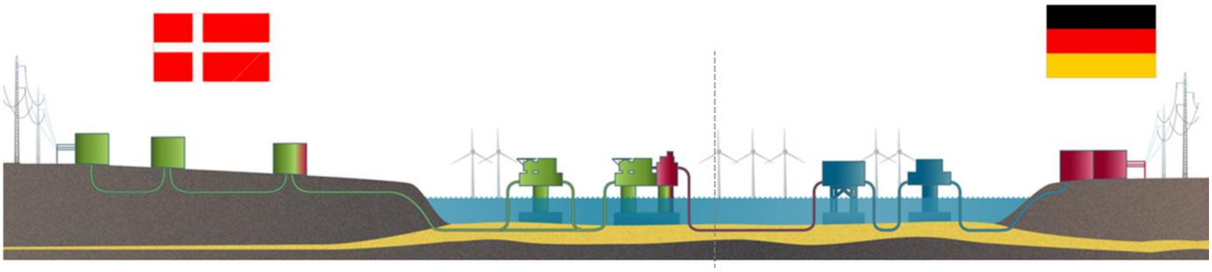

Figure 3 Conceptual sketch of KF CGS that is constituted of parts from a Danish OWF (with two offshore substations), two German OWFs, a connecting cable between the OWFs, and a back-to-back converter station. Green colours indicate parts of KF CGS stemming from the Danish OWF, blue colours show parts stemming from the German OWFs, and red colours show parts stemming from the CCR Hansa interconnector.

As such, KF CGS is not directly comparable to a traditional interconnector, regardless of it being a DC or an AC connection but is instead a hybrid. When the capacity for the DK2-DE/LU bidding-zone border is calculated, the hybrid nature of KF CGS means that special considerations must be made in the capacity calculation methodology.

1. The generation of the German OWF(s) [of the Danish OWF(s)] reduces the transmission capacity on KF CGS that can be used for imports into the German bidding zone [into the Danish bidding zone].
2. The generation of the German OWF(s) [of the Danish OWF(s)] can in some cases increase the transmission capacity on KF CGS that can be used for exports out of the German bidding zone [out of the Danish bidding zone].

Regarding point 1, the capacity that can be given to the market depends on the generation of the OWFs since the KF CGS CCR Hansa interconnector can only utilise the share in the transmission capacity on KF CGS which is not needed to transmit the electricity generation of the German and Danish OWFs to the respective national transmission grid.

It is not feasible to forecast the wind generation of the OWFs reliably and with the appropriate accuracy for a long-time period like a year or even a month. Therefore, the long-term capacity on KF CGS needs to be based on the respective installed generation capacities of the German and the Danish OWFs instead of using wind generation forecasts as it is done in the day-ahead and intraday, respectively, capacity calculation.

OWF generation has prioritised access to the transmission capacity towards its home market which directly reduces the capacity available for the electricity markets. This is reflected in the mathematical description of the capacity calculation methodology as a term related to already allocated capacity.

Regarding point 2, the fact that generation units are physically located on the CCR Hansa interconnector implies that wind generation can supplement the flow on the CCR Hansa interconnector and thus compensate for transmission losses on KF CGS.

However, as already mentioned above, reliable long-term wind generation forecasts are not feasible. Therefore, a compensation of transmission losses by the wind generation of the connected OWFs cannot be considered in the long-term capacity calculation on KF CGS.

Conceptually, KF CGS consists of three sections, as shown in Figure 4, with section 1 being the radial grid connection of the Danish OWF to DK2 (capacity of 600 MW), section 2 being the cable connection between the Danish OWFs and the German OWFs (capacity of about 400 MW), and section 3 being the radial grid connection of the Germans OWFs to Germany (capacity of about 400 MW).

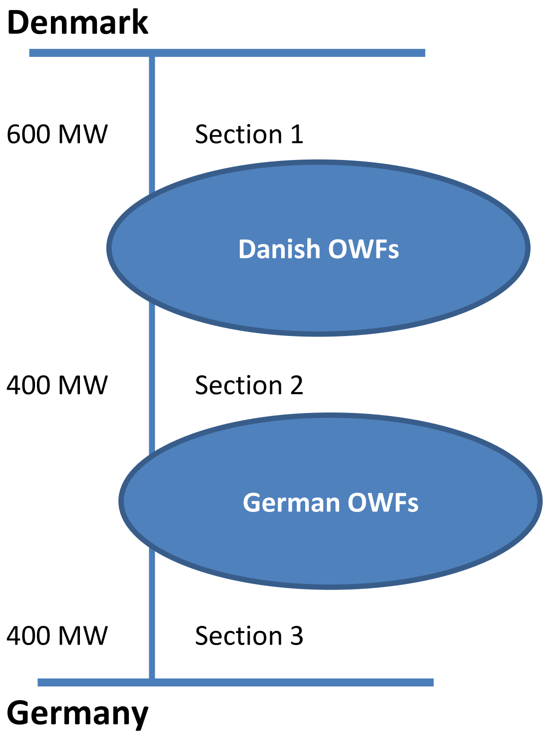

Figure 4 Conceptual illustration of transmission capacity of different sections of KF CGS.

4. Capacity calculation methodology for the long-term time frame

This chapter describes the target capacity calculation methodology which is proposed to be applied for CCR Hansa bidding-zone borders in the long-term time frame.

4.1 Rules for calculating cross-zonal capacity

Article 8 in the CCM for CCR Hansa describes the rules for calculating cross-zonal capacity in CCR Hansa.

The capacity calculation approach for CCR Hansa follows the coordinated net transmission capacity (CNTC) approach. The CCR Hansa TSOs will provide the CCC with the necessary information listed in Article 8 of the CCM.

This information is necessary for the CCC to calculate the cross-border capacity in both directions for the CCR Hansa bidding-zone borders.

The rules also specify that if the capacity calculation cannot be performed by the CCC, then the fallback proposals will apply.

The rules also state that the CCC shall submit the results of the capacity calculation to the CCR Hansa TSOs for validation and, in the end, the CCC shall make sure that the validated cross-zonal capacities and allocation constraints are provided to the single allocation platform following Article 24 of the FCA Regulation.

4.2 Description of the capacity calculation methodology in CCR Hansa

The capacity calculation methodology proposed for the long-term time frame unifies three congestion-relevant parts. It takes advantage of the CNTC methodologies developed in CCR Nordic and CCR Core in order to represent the limitations in the AC grid. Those methodologies are to take fully into account the influences of the CCR Hansa bidding zone, and the actual CCR Hansa interconnector capacities are addressed individually within CCR Hansa.

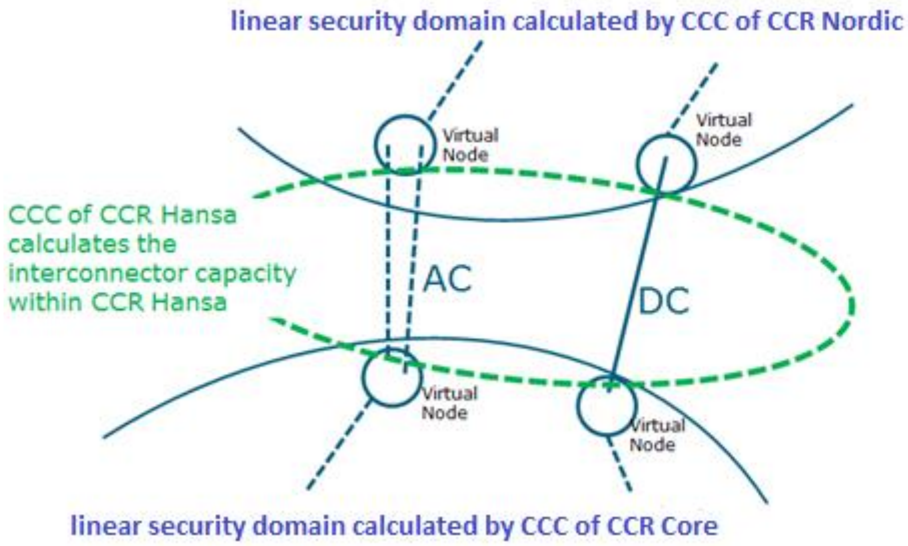

Figure 5: Capacity calculation in CCR CORE, CCR Nordic, and CCR Hansa.

Cross-border trade between bidding zones always affects at least three different parts of the grid:

1. The AC grid sensitive to the trade surrounding the CCR Hansa interconnector on the exporting side;
2. The CCR Hansa interconnector itself;
3. The AC grid sensitive to the trade surrounding the CCR Hansa interconnector on the importing side.

This holds true for all cross-border trade, irrespective of the type of CCR Hansa interconnector (AC or DC).

Years of experience with capacity calculation have shown that a congestion resulting from a cross-border trade can occur in each of these three parts of the grid. In order to maintain system security, it is therefore necessary to take all three parts into account in the capacity calculation.

Since CCR Hansa has the unique feature that all bidding zones are currently connected by means of radial lines, the assessment of cross-border capacity can be split into three separate parts. This allows the CCR Hansa TSOs to look at the impact of cross-border trade independently on each part of the grid.

The methodology is thus based on three parts:
1. The actual CCR Hansa interconnector capacity within the CCR Hansa;
2. The limitations on the CCR Hansa interconnectors from the AC grid handled by CNTC in CCR Core;
3. The limitations on the CCR Hansa interconnectors from the AC grid handled by CNTC in CCR Nordic.

These three contributions together determine available transfer capacities for the CCR Hansa interconnectors.

In a CNTC methodology, the following terminologies are used. The NTC is the maximum total exchange programme between two adjacent bidding zones compatible with security standards and considering the technical uncertainties on future network conditions: NTC = TTC - TRM. In case the TRM equals zero, the NTC equals the TTC. The ATC is a measure of the transfer capability remaining in the physical transmission network for further commercial activity over and above already committed uses: ATC = NTC – AAC. In case the AAC equals zero, the ATC equals the NTC.

4.2.1 Capacity limitations originating from the AC grid handled CCR Nordic

The capacity of a DC line (being a fully controllable active power flow) is an NTC by nature. CCR Nordic has decided to handle the power flows of DC lines including CCR Hansa interconnections into its calculation process. This means that the flows on the DC lines are competing for the scarce capacity on the AC grid, like the exchanges from any of the other Nordic bidding zones (SE1, SE2, NO1, FI, and so on).

The converter stations of the CCR Hansa DC interconnectors are modelled as 'virtual' bidding zones in the linear security domain (however, a bidding zone without production and consumption), having their own PTDF factors reflecting how exchanges on the DC lines are impacting the AC grid elements. Radial AC connections can be handled in the same way. This is illustrated in Figure 6.

CCR Nordic provides the linear security domain with the representation of the AC grid in the Nordic area, which is imposing AC grid limitations on the commercial exchanges over the Hansa lines as well.

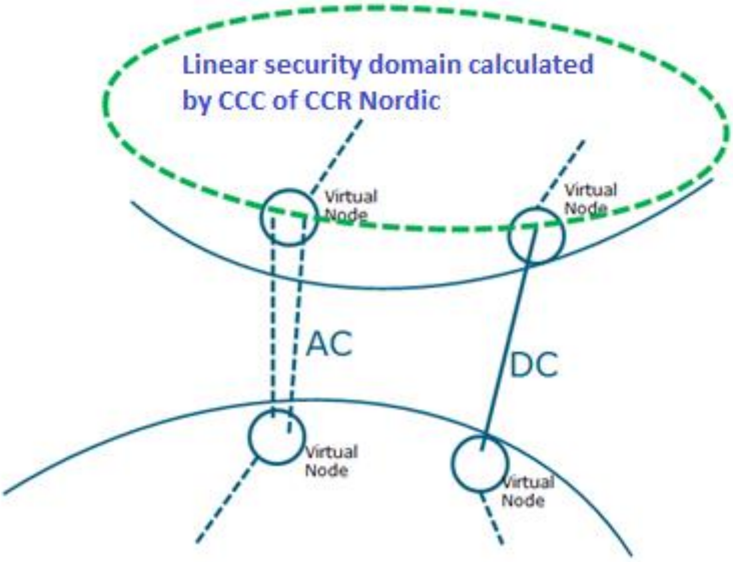

Figure 6: Linear security domain in CCR Nordic.

4.2.2 Capacity limitations originating from the AC grid handled by CCR Core

The capacity of a DC line (being a fully controllable active power flow) is an NTC by nature. CCR Core decided to handle the power flows of DC lines with including CCR Hansa interconnections into its calculation process in the target model. This means that the flows on the DC lines will compete for the scarce capacity on the AC grid, like the exchanges from any of the other Core bidding zones (NL, DE, PL, FR, and so on). The converter stations of the CCR Hansa DC interconnectors are to be modelled as 'virtual' bidding zones in the linear security domain (a bidding zone without production and consumption), having their own PTDF factors reflecting how exchanges on the DC lines are impacting the AC grid elements. Radial AC connections can be handled in the same way. This is illustrated in Figure 7.

CCR Core is to provide the linear security domain with the representation of the AC grid in the Core area, which is imposing AC grid limitations on the commercial exchanges over the Hansa lines as well.

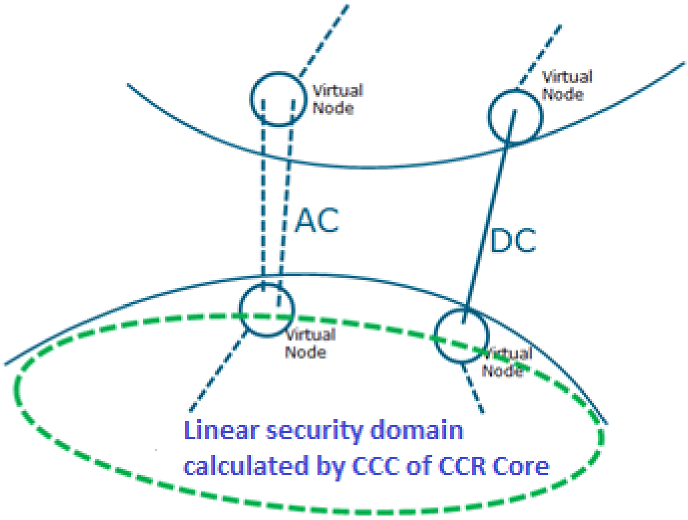

Figure 7: Linear security domain in CCR Core.

4.3 Methodology for determining the Transmission Reliability Margin

The TSOs use a transmission reliability margin (hereafter referred to as „TRM“) to reduce the probability of physical overloads to an acceptable risk level. The methodology to determine the TRM includes the principles for calculating the probability distribution (hereafter referred to as “PD”) of the deviations between the expected power flows at the time of the capacity calculation, and realised power flows in real time, and subsequently specifies the uncertainties to be taken into account in the capacity calculation. The following description sets out common harmonised principles for deriving the TRM from the probability distribution, as required in Article 11 of the FCA Regulation and, by referring to Article 22 of the CACM Regulation, as also required by Article 22(3) of the CACM Regulation.

Due to the controllability of the power flow over DC interconnections, the determination of a TRM does not need to be applied on bidding-zone borders only connected by DC interconnections. Therefore, on the borders SE4-PL and DK2-DE/LU no TRM is currently applied. The methodology described here therefore only applies to the radial-connected AC border DK1-DE/LU.

In general, the cross-zonal capacity derived for the AC border in CCR Hansa is expressed as an NTC value. During the capacity calculation, the CCR Hansa TSOs apply the TRM in order to hedge against risks inherent in the calculation. The methodology for the TRM is determined by the CCR Hansa TSOs and reflects the risks that the CCR Hansa TSOs are facing. As demanded by Article 11 of the FCA Regulation, the presented TRM methodology meets the requirements set out in Article 22(2) of the CACM Regulation, and particularly considers:
(a) Unintended deviations of physical electricity flows within a market-time unit caused by the adjustment of electricity flows within and between control areas, to maintain a constant frequency;
(b) Uncertainties which could affect capacity calculation, and which could occur between the capacity calculation time frame and real time, for the market time unit being considered.”

The TRM calculation consists of the following high-level steps:

1. Identification of sources of uncertainty for each TTC calculation process;
2. Derivation of independent time series for each uncertainty and determination of PD of each time series;
3. Convolution of individual PDs and derivation of the TRM value from the convoluted PD.

The method is illustrated in the figure below.

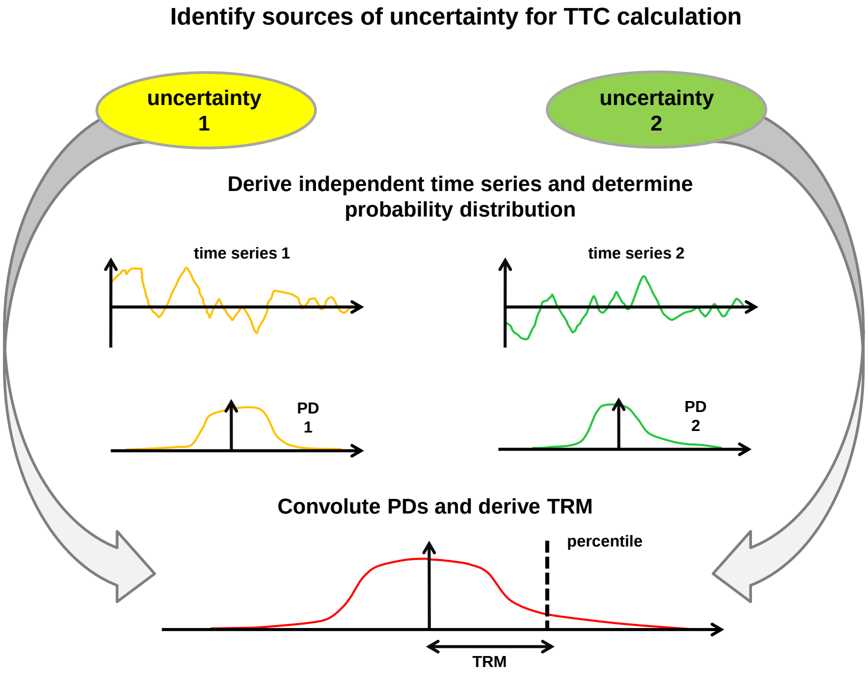

Figure 8: Illustration of the concept used to calculate the TRM.

Below, the individual steps are described in more detail.

Step 1: Identification of sources of uncertainty

In the first step, the corresponding uncertainties are identified. In general, the TTC calculation is based on the CGM, which includes assumptions and forecasts for the generation and load pattern as well as for the grid topology. This is the starting point to identify specific sources of uncertainty. For the AC border in CCR Hansa, typical sources of uncertainty at the capacity calculation stage are:

1. Inaccuracy of forecasts for wind, load and solar infeed, which impact the load and generation pattern in the network model;
2. Assumptions of cross-border exchange between third countries which are not part of the TTC profile;
3. Exchange of frequency containment reserve.

Step 2: Determination of appropriate PDs

The second step of the TRM calculation is the determination of appropriate time series that measure or estimate the effect of each uncertainty on the TTC calculation. Depending on the nature of the uncertainty, the determination of such time series can differ. In general, generic time series from an already existing data base can be used as a starting point. The time series cover an appropriate timespan from the past in order to get a significant and representative amount of data. After performing quality checks, the impact of the uncertainty on the TTC calculation is determined.

Step 3: Convolution and TRM calculation

At the beginning of this step, the individual PDs are convoluted to get the overall PD for an event. The convolution of the PDs of the relevant uncertainties merges the individual independent factors into one common PD for one TRM. Before the convolution is made, each PD is normalised. The convoluted PD is the basis for the determination of initial TRM values. From the convoluted PD, a certain percentile is taken.

4.4 Methodologies for determining operational security limits, contingencies relevant to capacity calculation and allocation constraints

In accordance with Article 12 of the FCA Regulation, which further refers to Article 23(1) of the CACM Regulation, CCR Hansa TSOs shall respect the operational security limits used in operational security analysis carried out in line with Article 72 of the COMMISSION REGULATION (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation (SO Regulation). The operational security limits used in the common capacity calculation are the same as those used in operational security analysis, therefore any additional descriptions pursuant to Article 23(2) of the CACM Regulation are not needed.

In particular, the following operational security limits and contingencies shall be used in the operational security analysis:

- steady-state thermal limits
- voltage stability
- frequency and dynamic transient stability
- short-circuit ratio (SCR)
- security of supply (interaction with distribution network)
- identified and possible or already-occurred fault of the transmission system element
- identified and possible or already-occurred fault of the significant grid users if relevant for the transmission system operational security
- identified and possible or already-occurred fault of the distribution network element if relevant for the transmission system operational security

Steady-state thermal limits of CCR Hansa interconnectors are considered in the TTC calculation process described in the capacity calculation sections. Operational security limits and contingencies of adjacent AC grid elements, reflecting interactions between CCR Hansa interconnectors and the AC grids, are handled by the long-term capacity calculation methodologies in CCR Core and CCR Nordic.

Operational security limits which cannot be evaluated in the frame of long-term calculations of adjacent CCRs (e.g. voltage stability, dynamic stability, short-circuit limits, etc.) are assessed by individual CCR Hansa TSOs who perform the simulations in their offline tools using a CGM. The results are translated into cross-zonal capacity constraints, e.g. as constraints of particular virtual bidding zones representing CCR Hansa interconnectors that are respected during capacity allocation. Additionally in accordance with Article 12 of the FCA Regulation, in combination with the Articles 23(1) and 23(2) of the CACM Regulation, the CCR Hansa TSOs may use operational security limits and contingencies for capacity calculation which are not the same as those used in operational security analysis, but take consider the needs for operational security analysis on how to deal with uncertainties of generation and load.

Such operational security limits shall be modelled as a constraint on bidding-zone import/export limits (the sum of all cross-zonal exchanges for a certain bidding zone), thus limiting the net position of the respective bidding zone considering:

- The production in a bidding zone shall be above a given minimum production level
- The combined import or export from one bidding zone to other adjacent bidding zones shall be limited in order to ensure adequate level of generation reserves required for secure system operation
- Maximum flow change on DC-lines between MTUs (ramping restrictions)
- Implicit loss factors on DC-lines.

A minimum production level may need to be applied in a bidding zone in order to guarantee a minimum number of generators running in the system that are able to supply reactive power needed for voltage support or to safeguard sufficient inertia to ensure dynamic stability.

Such constraints as import/export limits are determined for systems where a central dispatch market model is applied, i.e. where the CCR Hansa TSO acts as the balance responsible party for the whole control area and procures reserves in an integrated scheduling process. In order to execute this task, the CCR Hansa TSO in central dispatch systems needs to ensure the availability of sufficient upward or downward regulation reserves for maintaining secure power system operation.

Implicit loss factor on DC lines during capacity allocation ensures that the DC line will not flow unless the welfare gain of flowing exceeds the costs of the corresponding losses (currently not implemented).

A ramping restriction is an instrument of system operation to maintain system security (frequency management purposes). This sets the maximum change in DC flows between MTUs (max. MW/MTU per CCR Hansa interconnector) on an hour-to-hour basis.

The import/export limits are included during the capacity allocation process and can influence the interconnections belonging to the different CCRs.

4.5 Methodology for determining the generation shift keys

On the radial AC connection between DK1 and DE, the GSKs of DK1 and DE, defined in the CCR Nordic and CCR Core respectively, are applied to represent the distribution of the power flow between the different cross-border lines.

Any interaction between the CCR Hansa interconnectors and the adjacent AC grids, is modelled in the corresponding long-term methodologies of CCR Core and CCR Nordic and is therefore not a part of this methodology.

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

When considering the use of remedial actions in capacity calculation, it is important to first and foremost understand the objective. The overall objective is to increase the economic efficiency of the European allocation process. Thus, to give the market capacity as much as possible while still ensuring system security.

Remedial actions are normally split into two categories, costly remedial actions such as countertrading and redispatching and non-costly remedial actions which include topological changes, modifying duration of planned outages, voltage control and manage reactive power or use of phase shifters. The CCM requires CCR Hansa TSOs to include non-costly remedial action, while costly remedial actions are not required specifically to be used for capacity calculation.

In CCR Hansa, only the cross-border lines are represented in capacity calculation, and capacity is given to the market in accordance with the mathematical description in article 8 of the legal proposal.

It is important to highlight that the CCR Hansa LT CCM aims at giving a maximum amount of capacity on each bidding-zone border to the market. And given the scope of CCR Hansa LT CCM, there are only few possible limitations to the capacity calculated. When full capacity is given based on these conditions, then remedial actions will not be able to increase it, if capacity given to the market has to be kept within the physical possibilities. Outage management could be considered as a relevant RA if the following conditions are met; replacing is non-costly and the new timing will provide a total increase of capacity. Hansa TSO suggest available RA to the CCC to be evaluated to optimise calculated capacity taking these into account.

In CCR Hansa, there are currently phase shifters in operation on the 220kV lines between DK1 and DE/LU. These are planned to be removed when the 220kV grid is upgraded to 400kV. After this, there will be no remedial actions available within CCR Hansa which can be utilised to influence the flow distribution on the cross-border lines. The impact of remedial actions that become available in the future will be considered in the determination of the TTC value. Furthermore, it is important to note that the remedial actions found in bidding zones, in general, can be considered in the long-term methodologies of CCR Nordic and CCR Core to enlarge the overall security domains. This can, in turn, also positively impact the cross-border capabilities of CCR Hansa.

4.6.1 Remedial actions to maintain anticipated market outcome on KF CGS

On the KF CGS, the respective installed generation capacities of the German and Danish OWFs will be used when calculating the long-term capacities. The actual wind generation of an OWF will be less or at most equal to its installed capacity. In any case, the installed capacity of the respective OWF will be exceeded. Consequently, remedial actions will not increase the calculated capacity and therefore, will not be considered in the long-term capacity calculation on KF CGS.

4.7 Rules for considering previously allocated cross-zonal capacity

The previously-allocated cross-zonal capacity can be subtracted from the actual CCR Hansa interconnector capacity. The CCR Hansa TSOs shall include the following as already allocated capacity (ACC) in the capacity calculation following the mathematical descriptions:

a. Capacity allocated in previous allocation processes for respective direction
b. For KF CGS, AAC^{WIND} is the installed wind generation capacity on the OWF(s)

4.8 Fallback procedure for long-term capacity calculation

According to Article 10(7) of the FCA Regulation, which refers to Article 21(3) of the CACM Regulation, the capacity calculation methodology shall include a fallback procedure for any cases where the initial capacity calculation does not lead to any results.

Since the long-term calculation process is done in advance, there is room for introducing a postponement of the calculation process and, if possible, an allocation process as well. Therefore, in case the capacity calculation fails, the CCC will repeat that process. In case the capacity calculation cannot be performed by the CCC until the respective deadline, a way forward is to ask the single allocation platform to postpone the respective allocation process.

In case the capacity calculation cannot be performed by the CCC and the allocation process postponement is not possible, the concerned CCR Hansa TSOs will bilaterally calculate and agree on cross-zonal capacities. CCR Hansa TSOs will individually apply the CCM, and the results will be selected by CCR Hansa TSOs by using the minimum value of adjacent CCR Hansa TSOs of a bidding-zone border. The concerned CCR Hansa TSOs shall submit the capacities to the relevant CCC and to the other CCR Hansa TSOs.

5. Methodology for the validation of the cross-zonal capacity

The capacity calculation methodology shall include a methodology for validation of cross-zonal capacity. This methodology shall meet the requirements set out in Article 26 of the CACM Regulation.

In accordance with CACM Regulation Article 26(1,2,3), each CCR Hansa TSO shall validate and have the right to reduce cross-zonal capacity relevant to the TSO's bidding-zone borders provided by the CCC. Each CCR Hansa TSO may reduce cross-zonal capacity during the validation of cross-zonal capacity relevant to the CCR Hansa TSO's bidding-zone borders for reasons of operational security. Additionally, each CCR Hansa TSO has the right to propose increases in the cross-zonal capacity. Any increase in capacity following this validation process shall be coordinated by the CCC and commonly agreed upon by the affected CCR Hansa TSOs. The affected CCR Hansa TSO will normally mean the CCR Hansa TSOs directly involved on the specific bidding-zone border in question.

The CCR Hansa TSOs are legally responsible for the cross-zonal capacities. The validation of the interconnection capacity, which is calculated by the CCC, will be performed by each concerned CCR Hansa TSO. The validation of cross-zonal capacity and allocation constraints ensures that the results of the capacity allocation process will respect operational security requirements.

The CCR Hansa TSOs will consider the operational security limits when performing the validation but may also consider additional grid constraints, grid models, and other relevant information. The CCR Hansa TSOs may use, but are not limited to, the tools developed by the CCC for analysis. Thus, the CCR Hansa TSOs might also employ verification tools not available to the CCC. Validation of the results shall include a check of whether the correct data provided by CCR Hansa TSOs was used by the CCC in the capacity calculation process.

The CCC will coordinate with adjacent CCCs during the capacity calculation and validation process to ensure that the correct input data has been used and, subsequently, that the capacities are within a plausible solution space in line with the CACM Regulation Article 26(4).

Results from the validation process shall be sent from each CCR Hansa TSO to the CCC of CCR Hansa and at the same time to all CCR Hansa TSOs within a time limit to be agreed upon by all CCR Hansa TSOs. All decisions from CCR Hansa TSOs on reduction of capacity, and proposals for increase of capacity, shall include an explanation and justification.

Validated results shall be subject to Splitting Rules applied in accordance to Article 16 of FCA Regulation and submitted from the Hansa CCC to the Single Allocation Platform for the execution of forward capacity allocation pursuant to Article 29 of FCA.

If capacities on a given bidding-zone border are regularly corrected by CCR Hansa TSOs, the CCR Hansa TSOs shall jointly evaluate the capacity calculation process and the capacity calculation methodology and investigate how to reduce the need for corrections.

The CCR Hansa CCC shall every three months report all reductions made during the validation of cross-zonal capacity to all CCR Hansa NRAs. The report shall include the location and amount of any reduction in cross-zonal capacity and shall provide the reason for the reductions, following the requirements in CACM Regulation Article 26(5).

6. Rules for calculating cross-zonal capacity, including rules for efficiently sharing power-flow capabilities of CNEs among different bidding-zone borders

CCR Hansa interconnectors are either a radial DC line(s) or the combination of radial AC lines between the meshed AC grids on either side of the bidding-zone border so there is no ex-ante split of capacity on CNEs since CCR Hansa interconnectors are the only CNEs considered in the capacity calculation.

7. Rules for sharing the power flow capabilities of CNEs among different CCRs

Full consideration of the influences of the CCR Hansa bidding-zone borders in representing the AC meshed grids of CCR Core and CCR Nordic ensures that an economic optimisation determines where capacities are allocated between borders and different capacity calculation regions. The methodology only takes cross-border elements and the radial lines associated with these into account, thus there are no CNEs of which the power-flow capabilities must be shared.

8. Scenarios with long-term capacity calculation timeframes

In accordance with Article 19 of the FCA Regulation, the CCR Hansa TSOs shall jointly develop a common set of scenarios to be used in the common grid model for each long-term capacity calculation timeframe. This applies for the situation where security analysis based on multiple scenarios pursuant to Article 10 of the FCA Regulation is applied, which is the case for the Hansa region.

Article 2(4) of the CACM Regulation defines scenarios as t*he forecasted status of the power system for a given time frame* and hence reflects a specific representative predicted grid state (expected grid topology, generation and load pattern, net position, etc.) for a certain period in time.

The definition of the scenarios and the methodology to determine its so-called key values are part of the Common Grid Model Methodology ("CGMM"). The CGMM in accordance with Article 18 of the FCA Regulation has been approved by all NRAs on 04.07.2018 (*All TSOs' proposal for a common grid model methodology in accordance with Article 18 of Commission Regulation EU 2016/1719 of 26 September 2016 establishing a Guideline on forward capacity allocation*).

The scenarios for each year have the following structure:

As the figure shows, the current CGMM proposal defines the key values for the creation of four scenarios of non-overlapping time periods: WINTER, SPRING, SUMMER and AUTUMN. For each season a scenario is created for peak and valley, hence resulting in eight final scenarios for each year.

The related year-ahead seasonal scenarios used for yearly CNTC calculation may be updated for monthly CNTC calculation. TSOs should require a scenario update for any predictable change compared to the year-ahead seasonal scenarios in accordance with Article 3.2 and Article 3.3 of CGMM for FCA, which is associated with a specific measure concerning the grid topology respectively generation pattern. If this is the case, the TSOs may update:

- the generation pattern,
- the topology due to grid element

in its own IGM and may provide one updated IGM for each default seasonal scenario for the referred calculation time frame, while the net positions in the IGMs shall remain the same as given in the year-ahead CGMs. Accordingly, the CCC updates the merged CGM by replacing the initial IGM with the newly updated single TSOs' IGM in accordance with the agreed timing.

Scenarios to be used in a security analysis for long-term capacity calculation time frames associated with AC grid of adjacent CCRs shall be considered by applying in CCMs of adjacent CCRs Core and Nordic scenarios as defined in Article 3 of the CGM methodology developed in accordance with Article 18 of FCA regulation. When applying security analysis for long-term capacity calculation time frames associated with CCR Hansa bidding-zone borders, relevant maintenance plans shall be considered.

9. Timescales for implementation

Due to their location and the radial structure, the interconnectors of CCR Hansa can be considered independent from one another. This allows the CCR Hansa TSOs to initially continue to use their current processes and implement the new CCM in a stepwise manner in order to improve the capacity calculation whenever possible.

The first improvements are in terms of input and process coordination, while the second set of improvements utilises long term CCMs of CCR Nordic and CCR Core in order to reflect the limitations from the AC grids on CCR Hansa interconnectors.

The implementation of the CCM in CCR Hansa will be done in parallel with the implementation of the CCMs in CCR Nordic and CCR Core.

Current practice:
Following the approval of the capacity calculation methodology by the relevant NRAs, the CCR Hansa TSOs will start the implementation of improvements of the current processes to ensure a smooth and efficient transition towards one common capacity calculation process in coordination with the CCRs Nordic and Core. Up to the introduction of the yearly/monthly CGMs, the current capacity calculation applied in the Hansa region continues as is.

Implementation of CCM for CCR Hansa consists of the following steps:

Step 1:
As a first step the appointed CCC will coordinate the capacity calculation process in CCR Hansa. The CCC will calculate the CCR Hansa interconnector capacity while the CCR Hansa TSOs will send the results from their capacity calculations on the AC grid to the CCC. The minimum value will prevail and will be calculated by the CCC. The resulting cross-zonal capacities are subject to validation by each CCR Hansa TSO for its bidding-zone borders. The CCC provides the validated cross-zonal capacities to the allocation mechanism.

Step 2:
With the introduction of the yearly/monthly CGMs, as a first improvement, all CCR Hansa TSOs will use the same common grid model as input in their CCR Hansa related capacity calculation processes. This will ensure that the forecast of demand, generation and line availability is the same, thus increasing the coordination on the capacity calculation.

Step 3:
The third step of the CCR Hansa capacity calculation implementation comes with the go-live of the Nordic long-term capacity calculation. The power flows in the surrounding AC grid on the Nordic side stemming from the CCR Hansa lines will be considered in the capacity calculation of CCR Nordic. Possible interdependencies between trade on CCR Hansa borders and trade on CCR Nordic borders are represented in the linear security domains.

Step 4:
Step four in the CCR Hansa CC implementation is the full consideration of Hansa bidding-zone borders in capacity calculation process of CCR Core. At this point, CCR Nordic and CCR Core model the impact

of the CCR Hansa interconnectors on the AC grid in the Nordic and the Core region in the respective long-term capacity calculation processes. Operational security limits (e.g. voltage and dynamic stability) which cannot be evaluated in the frame of linear security domain are assessed by individual CCR Hansa TSOs as the constraints representing CCR Hansa interconnectors. The CCR Hansa CCC is responsible for calculating the capacity of the CCR Hansa interconnectors themselves and for cooperation with the CCCs of adjacent CCR Nordic and CCR Core.

10. Results from consultation

Comment number	Reviewer (Organisation)	Comments received	CCR Hansa TSOs' reply