Explanatory document to the second amendment of the Day-Ahead Capacity Calculation Methodology of the Core Capacity Calculation Region

in accordance with article 20ff. of the Commission Regulation (EU) 2015/1222 of 24th July 2015 establishing a guideline on capacity allocation and congestion management

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Table of Content

1. Introduction

The Commission Regulation (EU) 2015/1222 establishing a guideline on Capacity Calculation and Congestion Management ('CACM') requires the development and implementation of a common Day-Ahead Capacity Calculation Methodology ('DA CCM') per Capacity Calculation Region ('CCR').

Based on Article 13 (3) of the currently effective DA CCM for the CCR Core ('Core DA CCM'), the Core TSOs must no later than six months after the implementation of this methodology and in accordance with Article 28 (3) develop a proposal for the implementation of Advanced Hybrid Coupling ('AHC') and submit it by the same deadline to all Core regulatory authorities as a proposal for amendment of said methodology in accordance with Article 9 (13) of the CACM Regulation.

With the Capacity Calculation Methodology (CCM) of the Nordic Capacity Calculation Region (CCR) as a reference, Core TSOs originally did not foresee a detailed methodological description of the AHC and respective far-reaching changes to the Core DA CCM. However, a discussion with Core NRAs led to the conclusion that the implementation of the AHC should be prioritized, the Core DA CCM should be amended in a single step and include all changes to the methodology triggered by the implementation of the AHC. Within the course of the discussion, Core TSOs also see the benefit and have agreed upon drafting such detailed proposal for amendment.

Furthermore, the second amendment of the Core DA CCM brings about an update to ensure correct handling of core internal HVDC interconnectors.

In this explanatory document Core TSOs explain the background to the changes included in the proposal for amendment of the Core DA CCM. A track-change version of the Core DA CCM reflecting the proposed changes is shared for informative purpose.

In section 2.3, two specific questions to stakeholders regarding the prioritisation of the implementation of AHC and the selection of borders where AHC should be introduced can be found. Feedback on these two aspects is particularly welcome. The two questions on page 7 are marked accordingly.

2. Advanced Hybrid Coupling

2.1. General Aspects of Advanced Hybrid Coupling

The term hybrid coupling refers to the combined use of Flow-Based ('FB') and Available Transmission Capacity constraints in one single capacity allocation mechanism. There are two forms of the hybrid coupling: Standard Hybrid Coupling ('SHC') and Advanced Hybrid Coupling ('AHC').

The difference between SHC and AHC is how power exchanges over interconnectors between bidding zones ('BZ') within the Core CCR and BZs outside of the Core CCR, where both BZ are part of the Single Day Ahead Coupling ('SDAC'), are mapped onto Core CNECs. SHC grants access to the scarce CNEC capacity by reserving a capacity on the Core CNECs before capacity calculation, based on the forecasted power exchanges over the respective interconnectors and including a security margin for deviations from this forecast. By contrast, in AHC, the power exchanges over the respective interconnectors are subject to competition for CNEC capacity with all other cross-zonal power exchanges within the Core CCR during market coupling, e.g., in SDAC. The expectation is that by ensuring a non-discriminatory competition for the scarce CNEC capacity, AHC will lead to an increase in socio-economic welfare and improved operational gird security at the same time.

Only SHC is in use in the Core CCR today; however, there is an obligation to introduce AHC although an implementation timeline has not yet been set. Furthermore, a detailed specification of the AHC method was still to be defined as well as an assessment of the influence of AHC on existing processes and tools.

Core TSOs do not intend to conduct a Cost Benefit Analysis ('CBA') regarding the introduction of AHC, as the obligation resulting from the CCM to introduce AHC is independent of economic viability. Therefore, no market analysis is planned for the introduction of the AHC, but only an implementation assessment and impact analysis.

The method explained in the following paragraphs is intended to be as general and flexible as possible and shall not be bound to specific configurations, borders, or today's grid topology. For example, the merging of two separate CCRs or cross-CCR-border grid expansion could make new or less borders applicable for AHC.

2.2. Explanation of Changes to Article 2, Article 13 (3) (b) and Article 13 (3) (c) of the DA CCM

AHC can be applied on any border to a bidding zone ('BZ') outside the Core CCR which is part of the SDAC.[1] To avoid confusion with the methodology to include virtual hubs of core internal HVDC lines (often referred to as evolved flow-based), the virtual hubs for AHC are referred to as 'AHC virtual hubs.' Whilst the concept of AHC is similar to this concept used to integrate HVDC interconnectors on bidding zone borders inside the Core CCR, a distinction shall be possible in the Core CCM.

> *1a. 'AHC border' means a border between a bidding zone within and outside of Core CCR where both bidding zones are part of Single-Day-Ahead Coupling and the AHC is applied;*
>
> *1b 'AHC virtual hub' means a virtual bidding zone without any buy and sell orders, used to represent the imports and exports on an AHC border;*

[1] This means that the AHC can be implemented for the borders with Norway but not for borders with Switzerland, for example.

The underlying idea of the AHC concept is to treat such AHC borders analogously to internal borders whenever possible. The methodology for the AHC itself is subsequently described in Article 13 (b):

In the AHC, the CNECs of the Core Day-ahead capacity calculation region shall not only limit the net positions of Core bidding zones due to exchanges on bidding zone borders of the Core CCR but also the exchanges on bidding zone borders between the Core CCR and adjacent BZs. Core TSOs applying AHC shall apply the following rules:

For each border where the AHC shall be applied, one virtual hub must be defined. The requirement to introduce only one single AHC virtual hub per border arises as a simplification to limit the expected challenges with respect to performance that are already foreseeable. The Net Position ('NP') of such AHC virtual hub thus represents the imports and exports from a bidding zone ('BZ') outside of the Core CCR.

For each AHC border, the Core TSOs shall introduce one single AHC virtual hub.

The restriction to one single AHC virtual hub results in the challenge of having to define exactly one GSK per AHC border that maps all paths (different DC lines, parallel AC lines, etc.) with a fixed ratio as well. While the PTDFs of the converter station can simply be used for HVDC interconnectors, a detailed GSK must be defined for AC or mixed AC/DC borders:

The CCC shall define GSKs for the AHC virtual hubs according to Article 9 (1) as follows:

In case an AHC border contains only HVDC interconnectors, the GSK shall be defined by all converter stations of the HVDC interconnectors, weighted based on the respective transmission capacity.

In case an AHC border contains only AC interconnectors, the CCC shall use the GSK of the adjacent bidding zone provided by the TSOs of that bidding zone. When this GSK is not available, the CCC shall define a GSK based on all positive injections in the IGM of the adjacent bidding zone.

In case an AHC border contains both HVDC interconnectors and AC interconnectors, the respective Core TSO shall define a single combined GSK based on the GSK for the HVDC interconnectors and the GSK for the AC interconnectors.

Subsequently, PTDFs are required for the AHC virtual hubs. The existing rules for the computation of PTDFs should be applied:

The CCC shall compute zone-to-slack PTDFs and zone-to-zone PTDFs for the AHC virtual hubs in accordance with Article 11.

The Core TSOs shall send to the CCC adjustment values for each AHC border according to Article 4 (4) (b).

Since the effects of flow-changes on the CNEs resulting from deviations in imports and exports on the AHC borders are now implicitly considered during the market coupling, there is no longer a need to maintain additional safety margins for these borders in the FRM:

> *The FRMs shall not cover forecast uncertainties according to Article 8 (1) (a) induced by AHC borders.*

The introduction of new PTDFs automatically leads to an adjusted selection of CNECs. Cross-zonal lines become CNEs per legal requirement, internal lines may be defined by the TSO. It seems reasonable that possible congestions in the grid shall not be considered twice and that the capacity is not limited unnecessarily. Therefore, in the case of AHC, TSOs may exceptionally decide not to define a cross-border grid element as a CNE (for example, because the respective CNEs have already been considered in the calculation of the NTC of the neighbouring CCR). However, it should also be possible to introduce new CNEs if the ATC of the neighbouring CCR can potentially be increased as a result. Thus, the respective TSO at the border takes over a coordinating role between the two CCRs. For HVDC interconnectors, analogous to the consideration of internal HVDC interconnectors, there shall be the possibility to limit the NP of the Virtual Hubs to the installed transmission capacity. Subsequently, this limitation shall only cover the limitations on the Core side of the connection.

> *The maximum zone-to-zone PTDF of a CNEC ($PTDF_{z2zmax,l}$) according to Article 11 (5) shall additionally consider the PTDFs of the AHC virtual hubs.*
>
> *Cross-zonal network elements pursuant to Article 5 (1) shall additionally include those on AHC borders. In case the capacity constraints of resulting from cross-zonal network elements on an AHC border are already considered in another CCR, a Core TSO may decide not to define such network elements as CNE or CNEC in Core. Such a CNE or CNEC on an AHC border shall be regularly monitored only in a single CCR. Any deviation from this rule shall be subject to a sound justification.*
>
> *Core TSOs may impose a limit to the net position of the AHC virtual hubs for AHC borders consisting of at least one cross-border HVDC interconnector to account for the limitations of the HVDC cables on that border and the converter stations on the Core side.*

To keep the computation in the Remedial Actions Optimisation (‘RAO’) consistent with the updated computations, the following adjustment is necessary:

> *The* zone-to-zone PTDFs used to compute RAM_{rel} *for the non-costly remedial actions optimisation pursuant to Article 16 (3) (d) shall additionally consider the PTDFs of the AHC virtual hubs.*

The objective of equal treatment of flows resulting from exchanges within Core and from exchanges on AHC borders implicitly results in a change in the computation of $\vec{F}_{0,Core}$.[2] Both share the same capacity on the CNECs.

[2] The name of the figure is maintained for the sake of simplicity.

The situation for the computation of $\vec{F}_{0,Core}$ according to Article 17 shall exclude the commercial exchange on the AHC borders. The computation of $PTDF_f$ shall include the AHC virtual hubs. The $\overrightarrow{NP}_{ref,Core}$ shall include the net positions of the AHC virtual hubs. $\vec{F}_{uaf}$ shall not include flows resulting from commercial exchanges on the AHC borders.

The RAM as referred to in Article 17 (5) shall be the capacity offered within the Core CCR and to the AHC borders. $\vec{F}_{uaf}$ shall be the flow per CNEC assumed to result from commercial exchanges outside the Core CCR except the AHC borders.

Regarding the inclusion for Long Term Allocations ('LTA'), the same rules shall apply as for borders within the Core FB Region:

When applying the rules for LTA inclusion according to Article 18, Core TSOs shall addtionally take into account the previously allocated cross-zonal capacity of AHC borders. $\overrightarrow{NP}_{LTAi}$ and $\overrightarrow{NP}_{ref}$ shall include the net position of the AHC virtual hubs.

Regarding fallbacks, the same rules shall apply as for borders within the Core FB Region:

The PTDFs of the AHC virtual hubs shall be included in the flow-based parameters according to Article 21. The CCC shall include the exchanges on the AHC borders resulting from LTN as net position of the AHC virtual hubs when computing the $\overrightarrow{NP}_{LTN}$.

The computations performed according to Article 22 shall also be performed for the AHC virtual hubs. In case of application of default flow-based parameters, the bilateral capacities on the AHC borders shall be defined based on the LTA capacity increased by the adjustment provided pursuant to Article 13 (3) (b) (iv).

The ATCs for the SDAC fallback procedure according to Article 23 shall be based on the LTA capacity increased by the adjustment provided pursuant to Article 13 (3) (b) (iv).

In Article 13 (3) (c) Core TSOs aim to propose a reasonable timeline for their methodological and technical readiness to introduce the AHC. Since the implementation in SDAC is still subject to feedback from tool vendors and NEMOs on the time required to make the necessary adaptations to the respective tools (e.g., Core Capacity Calculation tool, Backup tool and Euphemia) and based on the estimated time to configure the local validation tools to handle the changes introduced by AHC to the Core DA CC process. This timeline is based on considerable uncertainty that must be pointed out as effects on the performance of the tools cannot be estimated at present. It is also worth noting that the implementation of AHC for Core is a complex undertaking due to the size of the CCR and the number of borders to other areas:

Core TSOs shall introduce the AHC until 2025 for borders to bidding zones adjacent to the Core CCR insofar as these bidding zones are part of the Single Day Ahead Coupling ('SDAC'), subject to the prioritisation of its implementation in SDAC. Until the AHC is implemented, the Core TSOs shall monitor the accuracy of non-Core exchanges in the CGM. The Core TSOs shall report in the annual report to all Core regulatory authorities the accuracy of such forecasts.

A detailed explanation regarding the next steps and a reasoning for the implementation milestone can be found in the following chapter.

2.3. Next steps towards the implementation of the AHC

Since one AHC Virtual Hub needs to be introduced for each border where AHC is applied and Core TSOs aim for simultaneous introduction of the AHC for all relevant borders, significant challenges for the capacity calculation and the market coupling could be faced and hence performance issues may arise. Since, the introduction of AHC can influence the performance of internal (e.g., the tools used for the Capacity Calculation and the TSOs tools for individual validation), and external processes (e.g., market coupling algorithm EUPHEMIA), an appropriate assessment of all tools and process steps is necessary. Subsequently, modifications of tools and processes might become necessary before finally committing to an implementation timeline. The corresponding studies and surveys are currently being planned for the calendar year 2023. Tools and process steps that need to be assessed compromise inter alia the Core CC Tool ('CCCt'), the Core Backup Tool, the Remedial Action Optimization ('RAO'), the tools used for the validation (this covers both the Individual Validation and Coordinated Validation which is currently under development) and the reporting tools and processes. Furthermore, an analysis is pending for the interference with the Core Intraday Capacity Calculation ('Core IDCC'), the extraction of Intraday ATC, the Publication Tool ('PuTo') and the IGM creation.

While the aforementioned aspects are within the sole sphere of influence of the Core TSOs, this is not the case with EUPHEMIA, the SDAC market coupling algorithm. Significantly increased computational efforts are to be expected and hence performance challenges arise due to the "stronger" coupling and the newly introduced AHC Virtual Hubs. Core TSOs will submit the corresponding change request ('RfC') to SDAC OPSCOM immediately after the AHC method has been finally described in Core. Investigations into the performance of EUPHEMIA – especially in the context of 15 min Market time unit ('MTU') – are currently being planned.

While the Core TSOs generally plan to introduce the AHC for all borders to bidding zones that are adjacent to the Core CCR and in the SDAC at the same time, it may turn out that a simultaneous introduction is not reasonably feasible during the concretisation of the implementation planning. Explanations for this could be performance problems of the tools or (expected) changes to the CCR layout. Core TSOs intend to develop a concrete implementation plan in 2023 which takes algorithm performance and changes of CCR boundaries into account. The implementation plan also includes an alignment with Core NRAs and ACER on the applicable borders and setting out a detailed scheduling in terms of milestones. Any reasoned feedback on borders to be prioritized for the implementation of the AHC by the stakeholders is highly appreciated.

Stakeholder question

The Core TSOs intend to complete all the necessary steps on Core CCR's side by the end of 2025. However, implementation is also subject to prioritisation in SDAC since a conflict with 15 min MTU introduction, which has a higher priority at the moment, must already be anticipated. Hence, stakeholders are kindly requested to provide feedback if this prioritisation should be changed.

Stakeholder question

3. Updates to ensure a correct handling of core internal HVDC interconnectors

The updates to Article 11 have already been publicly consulted for to the Core ID CCM and are required for standardization. It is a change that is necessary for the mathematically correct description of the calculation in the context of Core internal HVDC interconnectors (e.g., ALEGrO) and must not be confused with the AHC despite the concept is similar and the term virtual hub is used. More details regarding the modelling of Core internal HVDC interconnectors in capacity calculation has been added. Therefore, equation 5 of article 11 has been extended with additional terms to reflect the impact of an HVDC link to CNECs.

<u>New equation:</u>

$$\begin{aligned} PTDF_{z2zmax,l} = max \Bigg(& \max_{A \in BZ}\left(PTDF_{A,l}\right) \\ & - \min_{A \in BZ}\left(PTDF_{A,l}\right), \max_{H \in HVDC} \Bigg(\left|\left(PTDF_{A,l} - PTDF_{VH\_1\ ,l}\right)\right. \\ & \left. - \left(PTDF_{B,l} - PTDF_{VH\_2\_,l}\right)\right|, \left|PTDF_{VH\_1\ ,l} - PTDF_{VH\_2\ ,l}\right| \Bigg) \Bigg) \end{aligned}$$

The new formula is based on the concept of Evolved Flow Based, meaning that the market is given the freedom to freely select the virtual hub net positions for system optimality (not only for BE-DE exchanges) and that the sensitivity regarding this optimization variable should also be part of the CNEC selection.

To complete the description of the HVDC interconnector integration of Core bidding zones, additional constraints that model the maximum possible exchange of the HVDC interconnector itself have been added to Article 12. These constraints ensure that HVDC links are operated within its technical limits, this is in addition to modelling their impact on CNECs in capacity calculation and allocation.