Core CCR TSOs' proposal for the regional design of the intraday common capacity calculation methodology in accordance with Article 20ff. of Commission Regulation (EU) 2015/1222 of 24 July 2015

15 September 2017

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TSOs OF THE CORE CCR, TAKING INTO ACCOUNT THE FOLLOWING,

WHEREAS

1. This document is the proposal developed by the transmission system operators of the Core CCR (hereafter referred to as “Core TSOs”) regarding the development of the common capacity calculation methodology in accordance with Article 20ff. of Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on Capacity Allocation and Congestion Management (hereafter referred to as the “CACM Regulation”). This proposal is hereafter referred to as “intraday common capacity calculation methodology Proposal”.
2. The intraday common capacity calculation methodology Proposal takes into account the general principles and goals set in the CACM Regulation as well as 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 allocation in the intraday cross-border markets. It sets for this purpose requirements to develop a proposal for an intraday common capacity calculation methodology to ensure efficient, transparent and non-discriminatory capacity allocation.
3. Article 20(2) of the CACM Regulation stipulates ”all TSOs in each capacity calculation region shall submit a proposal for a common coordinated capacity calculation methodology within the respective region.”
4. According to Article 9(9) of the CACM Regulation, the expected impact of the intraday common capacity calculation methodology Proposal on the objectives of the CACM Regulation has to be described and is presented below. The proposed intraday common capacity calculation methodology generally contributes to the achievement of the objectives of Article 3 of the CACM Regulation.
5. The intraday common capacity calculation methodology Proposal serves the objective of promoting effective competition in the generation, trading and supply of electricity (Article 3(a) of the CACM Regulation) since the same intraday common capacity calculation methodology will apply to all market participants on all respective bidding zone borders in the Core CCR, thereby ensuring a level playing field amongst respective market participants. Market participants will have access to the same reliable information on cross-zonal capacities and allocation constraints for intraday allocation, at the same time and in a transparent way.
6. The intraday common capacity calculation methodology Proposal contributes to the optimal use of transmission infrastructure and operational security (Article 3(b) and (c) of the CACM Regulation) since the flow-based mechanism aims at providing the maximum available capacity to market participants on intraday timeframe within the operational security limits.
7. The intraday common capacity calculation methodology Proposal serves the objective of optimising the allocation of cross-zonal capacity in accordance with Article 3(d) of the CACM Regulation since the common capacity calculation methodology is using the flow-based approach which provides optimal cross-zonal capacities to market participants.
8. The intraday common capacity calculation methodology Proposal is designed to ensure a fair and non-discriminatory treatment of TSOs, NEMOs, the Agency, regulatory authorities and market participants (Article 3(e) of the CACM Regulation) since the intraday common capacity calculation methodology is performed with transparent rules that are approved by the relevant national regulatory authorities after the consultation period where applicable.
9. Regarding the objective of transparency and reliability of information (Article 3(f) of the CACM Regulation), the intraday common capacity calculation methodology Proposal determines the main

principles and main processes for the intraday timeframe. The proposed intraday common capacity calculation methodology Proposal enables TSOs to provide market participants with the same reliable information on cross-zonal capacities and allocation constraints for intraday allocation in a transparent way and at the same time.

10. The intraday common capacity calculation methodology Proposal also 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 market.
11. When preparing the intraday common capacity calculation methodology Proposal, TSOs took careful consideration of the objective of creating a level playing field for NEMOs (Article 3(i) of the CACM Regulation) since all NEMOs and all their market participants will have the same rules and non-discriminatory treatment (including timings, data exchanges, results formats etc.) within the Core CCR.
12. Finally, the intraday common capacity calculation methodology Proposal contributes to the objective of providing non-discriminatory access to cross-zonal capacity (Article 3(j) of the CACM Regulation) by ensuring a transparent and non-discriminatory approach towards facilitating cross-zonal capacity allocation.
13. In conclusion, the intraday common capacity calculation methodology Proposal contributes to the general objectives of the CACM Regulation to the benefit of all market participants and electricity end consumers.
14. The foreseen timeframe of 10 months in the CACM Regulation to come up with a day-ahead and intraday common capacity calculation methodology Proposal covering 16 TSOs from 13 countries is highly challenging. The Core TSOs need more time to further develop and perform experimentations on the day-ahead and intraday common capacity calculation methodologies. This intraday common capacity calculation methodology Proposal is submitted as an initial deliverable since further work is required in accordance with Article 20 of the CACM Regulation. The Core TSOs also would like to highlight that experimentation results from the parallel run with market participants are required to ensure both the well-functioning and acceptability of the intraday common capacity calculation methodology. After finalizing the methodology and analyzing the experimentation results, the Core TSOs will submit an improved intraday common capacity calculation methodology Proposal to the Core regulatory authorities after having consulted market participants.

SUBMIT THE FOLLOWING INTRADAY COMMON CAPACITY CALCULATION METHODOLOGY PROPOSAL TO REGULATORY AUTHORITIES OF THE CORE CCR:

GENERAL PROVISION

Article 1 Subject matter and scope

The intraday common capacity calculation methodology Proposal shall be considered as a proposal of Core TSOs in accordance with Article 20 ff. of the CACM Regulation and shall cover the intraday common capacity calculation methodology for the Core CCR bidding zone borders.

Article 2 Definitions and interpretation

1. For the purposes of the intraday common capacity calculation methodology Proposal, terms used in this document shall have the meaning of the definitions included in Article 2 of the CACM Regulation, of Regulation (EC) 714/2009, Directive 2009/72/EC and Commission Regulation (EU) 543/2013. In addition, the following definitions and abbreviations shall apply:
    d. ‘advanced hybrid coupling’ (hereinafter ‘AHC’) means a solution to fully take into account the influences of the adjacent capacity calculation regions during the capacity allocation;
    e. ‘available transmission capacity’ (hereinafter ‘ATC’) means the transmission capacity that remains available after allocation procedure and which respects the physical conditions of the transmission system;
    f. ‘balance responsible party’ (hereinafter ‘BRP’) means a market participant or its chosen representative responsible for its imbalances;
    g. ‘CCC’ is coordinated capacity calculator, as defined in Article 2(11) of the CACM Regulation;
    h. ‘CCR’ is the capacity calculation region as defined in Article 2(3) of the CACM Regulation;
    i. ‘central dispatch model’ means a scheduling and dispatching model where the generation schedules and consumption schedules as well as dispatching of power generating facilities and demand facilities, in reference to dispatchable facilities, are determined by a TSO within the integrated scheduling process;
    j. ‘CGM’ is the common grid model as defined in Article 2(2) of the CACM Regulation;
    k. ‘CGMM’ is the common grid model methodology as submitted to all regulatory authorities by all TSOs on the 27 of May 2016 as amended;
    l. ‘CNE’ is a critical network element;
    m. ‘CNEC’ is a critical network element with a contingency;
    n. ‘Core CCR’ is the Core capacity calculation region as given by the Agency for the cooperation of energy regulators No. 06/2016 on 17 November 2016;
    o. Core TSOs are 50Hertz Transmission GmbH (“50Hertz”), Amprion GmbH (“Amprion”), Austrian Power Grid AG (“APG”), CREOS Luxembourg S.A. (“CREOS”), ČEPS, a.s. (“ČEPS”), Eles, d.o.o., sistemski operater prenosnega elektroenergetskega omrežja (“ELES”), Elia System Operator S.A. (“ELIA”), Croatian Transmission System Operator Ltd. (HOPS d.o.o.) (“HOPS”), MAVIR Hungarian Independent Transmission Operator Company Ltd. (“MAVIR”), Polskie Sieci Elektroenergetyczne S.A. (“PSE”), RTE Réseau de transport d’électricité (“RTE”), Slovenská elektrizačná prenosová sústava, a.s. (“SEPS”), TenneT TSO GmbH (“TenneT GmbH”), TenneT TSO B.V. (“TenneT B.V.”), National Power Grid Company Transelectrica S.A. (“Transelectrica”), TransnetBW GmbH (“TransnetBW”);
    p. ‘cross-zonal network element’ means in general only those transmission lines which cross a bidding zone border. However, the term ‘cross-zonal network elements’ is enhanced to

also include the network elements between the interconnector and the first substation to which at least two internal transmission lines are connected;

q. 'D-1' means day-ahead;

r. 'D-2' means two-days ahead;

s. 'default flow-based parameters' means the precoupling backup values computed in situations when inputs for flow-based parameters are missing for more than two consecutive hours. This computation is done based on existing long term bilateral capacities;

t. 'external constraint' (hereinafter 'EC') means the maximum import and/or export constraints of given bidding zone;

u. 'evolved flow-based' (hereinafter 'EFB') means a solution that takes into account exchanges over all cross border HVDC interconnectors within a single CCR applying the flow-based method of that CCR;

v. 'FAV' is the final adjustment value;

w. 'flow-based domain' means the set of constraints that limits the cross-zonal capacity calculated with a flow-based approach;

x. 'F_{max}' is the maximum admissible power flow;

y. 'F_i' is the expected flow in commercial situation i;

z. 'F_{ref}' is the reference flow;

aa. 'F_{LTN}' is the expected flow after Long Term Nominations;

bb. 'flow reliability margin' (hereinafter 'FRM') means the reliability margin as defined in Article 2(14) of the CACM Regulation applied to a critical network element in a flow-based approach;

cc. 'GSK' is the generation shift key as defined in Article 2(12) of the CACM Regulation;

dd. 'HVDC' is a high voltage direct current transmission system;

ee. 'IGM' is the individual grid model as defined in Article 2(1) of the CACM Regulation;

ff. 'I_{max}' is the maximum admissible current;

gg. 'LTA' are the long term allocated capacities;

hh. 'LTN' are the long term nominations submitted by market participants based on LTA;

ii. 'merging agent' as defined in Article 20 of the CGMM;

jj. 'neighbouring bidding zone pairs' means the bidding zones which have a common commercial border;

kk. 'MTU' is the market time unit;

ll. 'MP' is the market participant;

mm. 'NP' is the net position;

nn. 'presolved domain' means the final set of binding constraints for capacity allocation after pre-solving process ;

oo. 'presolving process' means that the redundant constraints are identified and removed from flow-based domain by CCC;

pp. 'previously allocated capacities' means the long term capacities which have already been allocated in previous (yearly and/or monthly) time frames;

qq. 'PST' is a phase shifting transformer;

rr. '$PTDF$' is the power transfer distribution factor;

ss. 'PTR' is the physical transmission right;

tt. 'RA' means a remedial action as defined in Article 2(13) of the CACM Regulation;

uu. 'RAM' is the remaining available margin;

vv. 'RAO' is the remedial action optimization;

ww. 'SA' is a shadow auction as defined in the Core CCR TSOs' fallback procedures proposal in accordance with Article 44 of the Commission Regulation (EU) 2015/1222;

xx. 'slack node' means the reference node used for determination of the $\boldsymbol{PTDF}$ matrix, i.e. shifting the power infeed of generators up results in absorption of the power shift in the slack node;

yy. 'spanning' means the precoupling backup solution in situation when inputs for flow-based parameters are missing for less than three consecutive hours. This computation is based on the intersection of previous and sub-sequent available Flow-Based domains;

zz. 'SO GL' is the System Operation Guideline (Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation);

aaa. 'standard hybrid coupling' means a solution to capture the influence of exchanges with non-Core bidding zones on CNECs that is not explicitly taken into account during the capacity allocation phase;

bbb. 'static grid model' is a list of relevant grid elements of the transmission system, including their electrical parameters;

ccc. 'U' is the reference voltage;

ddd. 'vertical load' means the total amount of electricity which exits the national transmission system to connected distributions systems, end consumers connected to transmission system and to electricity producers for consumption in the generation of electricity;

eee. 'zone-to-slack $PTDF$' means the power transfer distribution factor of a commercial exchange between a bidding zone and slack node;

fff. 'zone-to-zone $PTDF$' means the power transfer distribution factor of a commercial exchange between two bidding zones;

ggg. 'preventive' remedial action means a remedial action which is applied before a contingency occurs;

hhh. 'PX' is the power exchange for spot markets;

iii. 'curative' remedial action means a remedial action which is applied after a contingency occurs;

jjj. the notation x denotes a scalar;

kkk. the notation $\vec{x}$ denotes a vector;

lll. the notation $\boldsymbol{x}$ denotes a matrix.

2. In this intraday common capacity calculation methodology Proposal, unless the context requires otherwise:

   d. the singular indicates the plural and vice versa;

   e. the table of contents and headings are inserted for convenience only and do not affect the interpretation of this intraday common capacity calculation methodology Proposal; and

   f. any reference to legislation, regulations, directive, order, instrument, code or any other enactment shall include any modification, extension or re-enactment of it then in force.

Article 3 Application of this proposal

This intraday common capacity methodology Proposal solely applies to the intraday capacity calculation within the Core CCR. Common capacity calculation methodologies within other capacity calculation regions or other time frames are outside the scope of this proposal.

Article 4 Cross-zonal capacities for the intraday market

For the intraday market time-frame, individual values for cross-zonal capacity for each remaining intraday market time unit shall be calculated using the common capacity calculation methodology performed in the end of D-1 and/or during the day of delivery based respectively on day-ahead congestion forecast and intraday congestion forecast and other updated inputs.

Article 5 Intraday capacity calculation

1. In accordance with Article 14 of the CACM Regulation, the Core TSOs shall calculate cross-zonal capacities for each bidding-zone border of the Core CCR.
2. The Core TSOs shall provide the coordinated capacity calculator with the last updated information on the transmission systems in a timely manner for the first intraday capacity calculation that is performed in the end of D-1 and for the second intraday capacity calculation performed during the day.
    a. in case it turns out feasible and of added value during the project implementation, additional computations will be performed during day D.
    b. target for the intraday common capacity methodology is to have multiple recomputation throughout the day. The amount of recomputations needs to be assessed in terms of feasibility and effectiveness.
    c. Core TSOs shall further detail the approach on how to determine additional intraday capacity calculations performed during the day applying the following procedure:
        i. Core TSOs shall submit a 'Core TSOs deliverable report' to regulatory authorities in Q1 2018;
        ii. the following steps shall be included and specified in the deliverable report:
            1. assessment and definition of options;
            2. time line and possible method(s) for conducting experimentation and studies;
    d. Core TSOs shall conclude on finalization of the methodology, consult it with market participants and propose the updated methodology to regulatory authorities;
    e. regulatory authorities shall approve the proposed update.
3. The intraday common capacity calculation process includes a remedial action optimization methodology which aims to find optimal secure capacity based on the inputs provided by the TSOs.
4. The CCC shall define the flow-based parameters for each market time unit up to the first unsecured situation. These values shall be provided to Core TSOs for validation.
5. The CCC of the Core CCR or the Core TSOs shall provide the NEMOs with the validated flow-based parameters of the Core CCR. In case the allocation mechanism expects ATCs for each bidding-zone border, the CCC or the Core TSOs shall derive these from the coordinated flow-based parameters and provide it to the NEMOs.
6. The Core TSOs shall review the frequency of recalculation two years after the implementation of the capacity calculation for the intraday market timeframe by performing a cost-benefit analysis on the Core CCR.

METHODOLOGIES FOR CALCULATION OF THE INPUTS

Article 6 Methodology for critical network elements and contingencies selection

1. Each Core TSO shall provide a list of critical network elements (CNEs) of its own control area based on operational experience.

   A CNE can be:

   - a cross-zonal network element;
   - an internal line; or
   - a transformer.

2. In accordance with Article 23(1) of CACM Regulation, Core TSOs shall provide a list of contingencies used in operational security analysis in line with Article 33 of the SO GL, limited to their relevance for the set of CNEs as defined in Article 6(1) and pursuant to Article 23(2) of the CACM Regulation. A contingency can be a trip of:

   - a line, a cable or a transformer;
   - a busbar;
   - a generating unit;
   - a load; or
   - a set of the aforementioned contingencies.

3. The association of contingencies to critical network elements shall be done from the list of CNEs defined in Article 6(1) and from the list of contingencies as defined in Article 6(2). Besides, it shall follow the rules established in Article 75 of SO GL, which means that the contingencies of one TSO can be associated to another TSO. The outcome of this association is the initial pool of CNECs.

4. Core TSOs shall distinguish between:

   d. the CNECs of the initial pool that are significantly influenced by the changes in bidding zone net positions. A cross-zonal network element is always considered as significantly influenced. The other CNECs shall have a maximum zone-to-zone $PTDF$ as described in Article 14 higher than a common threshold to be considered as significantly influenced by the changes in bidding zone net positions, in accordance with Article 29(3) of the CACM Regulation. The CNECs of this category will be taken into account in all the steps of the common capacity calculation and will determine the cross-zonal capacity;

   e. the CNECs of the initial pool that are significantly influenced by the RAs defined in Article 12, but are not significantly influenced by the changes in bidding zone net positions. The CNECs of this category may only be monitored during the RAO and will not limit the cross-zonal capacity;

   f. the CNECs of the initial pool that are neither described in Article 6(4)(a) nor Article 6(4)(b). The CNECs of this category will not be taken into account in the intraday common capacity calculation.

5. In case a TSO decides to keep a CNEC within the list described in Article 6(4)(a) which is not significantly influenced by the changes in bidding zone net positions, the respective TSO shall provide Core regulatory authorities with a clear description of the specific situation that led to this decision in the monitoring report defined in Article 23.

6. In case a TSO decides to exclude a CNEC within the list described in Article 6(4)(a) which is significantly influenced by the changes in bidding zone net positions, the respective TSO shall provide to Core regulatory authorities in the monitoring report defined in Article 23 a clear description of the specific situation that lead to this decision.

7. In response to Article 21(1)(b)(ii) of the CACM Regulation, Core TSOs shall aim to ensure a minimum RAM for the CNECs determining the cross-zonal capacity before allocating commercial exchanges, in addition to applying the common threshold set in Article 6(4)(a).

Article 7 Methodology for operational security limits

1. In accordance with Article 23 of the CACM Regulation, Core TSOs shall determine the operational security limits at the level used in operational security analysis carried out in line with Article 72 of the SO GL which also means that 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:
    d. Core TSOs shall respect the maximum admissible current (I_{max}) which is the physical limit of a CNE according to the operational security policy in line with Article 25 of the SO GL. The maximum admissible current can be defined with:
        i. fixed limits for all market time units;
        ii. fixed limits for all market time units of a specific season;
        iii. a value per market time unit depending on the weather forecast.
    e. when applicable, I_{max} shall be defined as a temporary current limit of the CNE in accordance with Article 25 of the SO GL. A temporary current limit means that an overload is only allowed for a certain finite duration.
    f. I_{max} is not reduced by any security margin, as all uncertainties in the common capacity calculation are covered on each CNEC by the flow reliability margin (FRM) in accordance with Article 10 and final adjustment value (FAV) in accordance with Article 8.
    g. the value F_{max} describes the maximum admissible power flow on a CNE. F_{max} is calculated from I_{max} by the given formula:

$$F_{max} = \sqrt{3} \times I_{max} \times U$$

Equation 1

where I_{max} is the maximum admissible current in kA of a critical network element (CNE). The values for the reference voltage U (in kV) are fixed values for each CNE.

Article 8 Final Adjustment Value

1. The maximum admissible power flow on a CNE may be increased or decreased by FAV, where
    d. positive values of FAV (given in MW) reduce the available margin on a CNE while negative values increase it;
    e. FAV can be set by the responsible TSO during the validation process in accordance with Article 20;
    f. in case a TSO decides to use FAV during the common capacity calculation, the respective TSO shall provide to Core regulatory authorities with a clear description of the specific situation that lead to this decision in the monitoring report defined in Article 23.

Article 9 Methodology for allocation constraints

1. In accordance with Article 23(3)(a) of the CACM Regulation, besides active power flow limits on CNEs, other specific limitations may be necessary to maintain the secure grid operation. Since such specific limitations cannot be efficiently transformed into operational security limits of individual CNEs, they are expressed as maximum import and export constraints of bidding zones. These

allocation constraints are called external constraints. External constraints are determined by Core TSOs and taken into account during the intraday capacity calculation.

2. A TSO may use external constraints in order to avoid situations which lead to stability problems in the network, detected by at least yearly reviewed system dynamics studies.
3. A TSO may use external constraints in order to avoid situations which are too far away from the reference flows going through the network in the D-1 and ID ICGMs, and which in exceptional cases would induce extreme additional flows on grid elements resulting from the use of a linearized GSK, leading to a situation which could not be validated as safe by the concerned TSO.
4. A TSO may use external constraints in case of a central dispatch model that needs a minimum level of operational reserve for balancing. In central dispatch systems, BRPs do not need to submit balanced schedules. Instead, the TSO acts as the BRP responsible for the power system balance. In order to execute this task, the TSO in a central dispatch system needs to ensure the availability of sufficient upward or downward regulation reserves for maintaining secure power system operation. The external constraint introduced varies depending on the foreseen balancing situation.
5. A TSO may discontinue the usage of an external constraint as described in Article 9(2), 9(3) and 9(4). The concerned TSO shall communicate this change to the Core regulatory authorities and to the market participants at least one month before its implementation.

Article 10 Reliability margin methodology

1. The intraday common capacity calculation methodology Proposal is based on forecast models of the transmission system. Therefore, the outcomes are subject to inaccuracies and uncertainties. The aim of the reliability margin is to cover a level of risk induced by these forecast errors.
2. In accordance with Article 22(1) of the CACM Regulation, the FRMs are calculated in a two-step approach:
    d. in a first step, for each market time unit of the observatory period, the CGMs used in the intraday common capacity calculation are updated in order to take into account the real-time situation of at least the remedial actions that are considered in the common capacity calculation and defined in Article 12. These remedial actions are controlled by Core TSOs and thus not considered as an uncertainty. This step is undertaken by copying the real-time configuration of these remedial actions and applying them into the historical CGM. The power flows of the latter modified CGM are computed (F_{ref}) and then adjusted to realised commercial exchanges inside the Core CCR with the $PTDF$s calculated during the intraday common capacity calculation as described in Article 14. Consequently, the same commercial exchanges in the Core CCR are taken into account when comparing the power flows based on the intraday common capacity calculation with flows in the real-time situation. These flows are called expected flows (F_{exp}), see Equation 2.

$$\vec{F}_{exp} = \vec{F}_{ref} + \boldsymbol{PTDF} \times \left(\overrightarrow{NP}_{real} - \overrightarrow{NP}_{ref}\right)$$

Equation 2

with

$\vec{F}_{exp}$	expected flow per CNEC in the realised commercial situation
$\vec{F}_{ref}$	flow per CNEC in the CGM (reference flow)
$\boldsymbol{PTDF}$	power transfer distribution factor matrix
$\overrightarrow{NP}_{real}$	Core net position per bidding zone in the realised commercial situation

$\overrightarrow{NP_{ref}}$ Core net position per bidding zone in the CGM

The power flows on each CNEC of the Core CCR, as expected with the intraday common capacity calculation methodology are then compared with the real time flows observed on the same CNEC. All differences for all market time units of a one-year observation period are statistically assessed and a probability distribution is obtained;

e. in a second step and in accordance with Article 22(3) of the CACM Regulation, the 90th percentiles of the probability distributions of all CNECs are calculated. This means that the Core TSOs apply a common risk level of 10% i.e. the FRM values cover 90% of the historical errors. Core TSOs can then either:
    i. directly take the 90th percentile of the probability distributions to determine the FRM of each CNEC. This means that a CNE can have different FRM values depending on the associated contingency;
    ii. only take the 90th percentile of the probability distributions calculated on CNEs without contingency. This means that a CNE will have the same FRM for all associated contingencies;
    iii. or undertake an operational adjustment on the values derived from Article 10(2)(b)(i) or 10(2)(b)(ii), which can set the FRM values between 5% and 20% of the F_{max} calculated under normal weather conditions.

3. The FRM values will be updated every year based upon an observatory period of one year so that seasonality effects can be reflected in the values. The FRM values are then fixed until the next update.
4. Before the first operational calculation of the FRM values, Core TSOs will either use the FRM values already in operation in existing flow-based market coupling initiatives or determine the FRM values as 10% of the F_{max} calculated under normal weather conditions.
5. In accordance with Article 22(2) and (4) of the CACM Regulation, the FRMs cover the following forecast uncertainties:
    d. Core external transactions (out of Core CCR control: both between Core CCR and other CCRs as well as among TSOs outside the Core CCR);
    e. generation pattern including specific wind and solar generation forecast;
    f. generation shift key;
    g. load forecast;
    h. topology forecast;
    i. unintentional flow deviation due to the operation of load frequency controls; and
    j. flow-based capacity calculation assumptions including linearity and modelling of external (non-Core) TSOs' areas.
6. Core TSOs shall assess the possible improvements of the inputs of the intraday common capacity calculation in the annual review as defined in Article 21.

Article 11 Generation shift keys methodology

1. In accordance with Article 24 of the CACM Regulation, Core TSOs developed the following methodology to determine the common GSK:
    d. Core TSOs shall take into account the available information on generation or load available in the common grid model for each scenario developed in accordance with Article 18 of the CACM Regulation in order to select the nodes that will contribute to the GSK;

e. each Core TSO shall aim to find a GSK that minimizes the error of dispatch forecast;
f. Core TSOs shall define a constant generation shift key per market time unit;
g. Core TSOs belonging to the same bidding zone shall determine a common methodology that translates a change in the net position to a specific change of generation or load in the common grid model.

2. For the application of the methodology, Core TSOs may define:
    d. generation shift keys proportional to the actual generation and potentially consumption in the CGM used in the intraday common capacity calculation for each market time unit;
    e. generation shift keys for each market time unit with fixed values based on the CGM used in the intraday common capacity calculation and based on the maximum and minimum net positions of their respective bidding zones; or
    f. generation shift keys with fixed values based on the CGM used in the intraday common capacity calculation for each market time unit.
3. During the different implementation phases the application of the current GSK methodology shall be continuously tested and improved with the future target of harmonization as far as possible.

Article 12 Methodology for remedial actions in capacity calculation

1. In accordance with Article 25(1) of the CACM Regulation, Core TSOs shall individually define Remedial Actions (RAs) to be taken into account in the intraday common capacity calculation.
2. In accordance with Article 25(2) and (3) of the CACM Regulation, these RAs will be used for coordinated optimization of cross-zonal capacities while ensuring secure power system operation in real time.
3. In accordance with Article 25(4) of the CACM Regulation, a TSO may refrain from considering a particular remedial action in capacity calculation in order to ensure that the remaining remedial actions are sufficient to ensure operational security.
4. In accordance with Article 25(5) of the CACM Regulation, the common capacity calculation takes non-costly RAs into account. These RAs can be:
    d. changing the tap position of a phase shifting transformer (PST);
    e. topological measure: opening or closing of one or more line(s), cable(s), transformer(s), bus bar coupler(s), or switching of one or more network element(s) from one bus bar to another.
5. In accordance with Article 25(6) of the CACM Regulation, the RAs taken into account are the same for day-ahead and intra-day common capacity calculation, depending on their technical availability.
6. The RAs can be preventive or curative, i.e. affecting all CNECs or only pre-defined contingency cases, respectively.
7. The optimized application of RAs is performed in accordance with Article 15.

Article 13 Provision of the inputs

1. The TSOs of the Core CCR shall provide to the CCC before a certain deadline commonly agreed between the TSOs and the CCC the following inputs:
    d. D-1 and ID IGMs respecting the methodology developed in accordance with Article 19 of the CACM Regulation;
    e. critical network elements (CNEs) and contingencies in accordance with Article 6;
    f. operational security limits in accordance with Article 7;
    g. allocation constraints in accordance with Article 9;
    h. flow reliability margin (FRM) in accordance with Article 10;
    i. generation shift key (GSK) in accordance with Article 11; and

j. remedial actions in accordance with Article 12.

2. When providing the inputs, the TSOs of the Core CCR shall respect the formats commonly agreed between the TSOs and the coordinated capacity calculators of the Core CCR, while respecting the requirements and guidance defined in the CGMM.
3. When applicable, the merging agent shall merge the D-1 and ID IGMs to create the CGMs respecting the methodology developed in accordance with Article 17 of the CACM Regulation.
4. The TSOs shall send for each time unit of the day the already allocated capacities (AAC) to the CCC.

DETAILED DESCRIPTION OF THE CAPACITY CALCULATION APPROACH

Article 14 Mathematical description of the capacity calculation approach

1. In accordance with Article 21(b)(i) of the CACM Regulation, for each CNEC defined in Article 6(3), Core TSOs shall calculate the influence of the bidding zone net position changes on its power flow. This influence is called zone-to-slack power transfer distribution factor ($PTDF$). This calculation is performed from the CGM used in the intraday common capacity calculation and the GSK defined in accordance with Article 11.
2. The nodal $PTDFs$ can be first calculated by subsequently varying the injection of each node defined in the GSK in CGM used in the intraday common capacity calculation. For every single nodal variation, the effect on every CNE's or CNEC's loading is monitored and calculated as a percentage. The GSK shall translate these node-to-slack $PTDFs$ into zone-to-slack $PTDFs$ as it converts the bidding zone net position variation into an increase of generation in specific nodes as follows:

$$\boldsymbol{PTDF}_{zone-to-slack} = \boldsymbol{PTDF}_{node-to-slack} \cdot \boldsymbol{GSK}_{node-to-zone}$$

Equation 3

with

$\boldsymbol{PTDF}_{zone-to-slack}$	matrix of zone-to-slack $PTDFs$ (columns: bidding zones, rows: CNECs)
$\boldsymbol{PTDF}_{node-to-slack}$	matrix of node-to-slack $PTDFs$ (columns: nodes, rows: CNECs)
$\boldsymbol{GSK}_{node-to-zone}$	matrix containing the $GSKs$ of all bidding zones (columns: bidding zones, rows: nodes, sum of each column equal to one)

3. $PTDFs$ may also be defined as zone-to-slack $PTDFs$ or zone-to-zone $PTDFs$. A zone-to-slack $PTDF_{A,l}$ represents the influence of a variation of a net position of bidding zone A on a CNE or CNEC l. A zone-to-zone $PTDF_{A\rightarrow B,l}$ represents the influence of a variation of a commercial exchange from A to B on a CNE or CNEC l. The zone-to-zone $PTDF_{A\rightarrow B,l}$ can be linked to zone-to-slack $PTDFs$ as follows:

$$PTDF_{A\rightarrow B,l} = PTDF_{A,l} - PTDF_{B,l}$$

Equation 4

4. The maximum zone-to-zone $PTDF$ of a CNE or a CNEC is the maximum influence that a Core exchange can have on the respective CNE or CNEC:

$$\text{maximum zone-to-zone } PTDF = \max_{\text{A}\in\text{BZ}}(PTDF_{\text{A,l}}) - \min_{\text{A}\in\text{BZ}}(PTDF_{\text{A,l}})$$

Equation 5

with

$PTDF_{A,l}$	zone-to-slack $PTDF$ of bidding zone A on a CNE or CNEC l
BZ	list of Core bidding zones

5. The reference flow (F_{ref}) is the active power flow on a CNE or a CNEC based on the CGM. In case of a CNE, F_{ref} is directly simulated from the CGM whereas in case of a CNEC, F_{ref} is simulated with the specified contingency.
6. The expected flow F_i in the commercial situation i is the active power flow of a CNE or CNEC based on the flow F_{ref} and the deviation of commercial exchanges between the CGM (reference commercial situation) and the commercial situation i:

$$\vec{F}_i = \vec{F}_{ref} + \boldsymbol{PTDF}\times\left(\overrightarrow{NP_i} - \overrightarrow{NP_{ref}}\right)$$

Equation 6

with

$\vec{F}_i$	expected flow per CNEC in the commercial situation i
$\vec{F}_{ref}$	flow per CNEC in the CGM (reference flow)
$\boldsymbol{PTDF}$	power transfer distribution factor matrix
$\overrightarrow{NP_i}$	Core net position per bidding zone in the commercial situation i
$\overrightarrow{NP_{ref}}$	Core net position per bidding zone in the CGM

7. The remaining available margin (RAM) of a CNE or a CNEC in a commercial situation i is the remaining capacity that can be given to the market taking into account the already allocated capacity in the situation i. This RAM_i is then calculated from the maximum admissible power flow (F_{max}), the reliability margin (FRM), the final adjustment value (FAV) and the expected flow (F_i) with the following equation:

$$\boldsymbol{RAM_i = F_{max} - FRM - FAV - F_i}$$

Equation 7

Article 15 Rules on adjustment of power flows on critical network elements due to remedial actions

1. In accordance with Article 21(1)(b)(iv) of the CACM Regulation, this intraday common capacity calculation methodology Proposal shall describe the rules on the adjustment of power flows on critical network elements due to remedial actions:
    d. the coordinated application of RAs shall aim at optimizing cross-zonal capacity in the Core CCR. The remedial action optimization (RAO) itself consists of a coordinated optimization of cross-zonal capacity within the Core CCR by means of enlarging the flow-based domain ;
    e. the optimization shall be an automated, coordinated and reproducible process that applies RAs defined in accordance with Article 12; and
    f. the applied RAs should be transparent to all TSOs, also of adjacent CCRs.

Article 16 Integration of HVDC interconnectors located within the Core

1. Core TSOs shall apply the evolved flow-based (EFB) methodology when including cross border HVDC interconnectors within the flow-based Core CCR.
2. Core TSOs shall take into account the impact of an exchange over a cross border HVDC interconnector on all CNEs within the process of capacity allocation. The flow-based properties and constraints of the Core CCR (in contrast to an NTC approach) and at the same time optimal allocation of capacity on the interconnector in terms of market welfare shall be taken into account.
3. Core TSOs shall distinguish between AHC and EFB. AHC considers the impact of exchanges between two capacity calculation regions (as the case may be belonging to two different synchronous areas) e.g. an ATC area and a flow-based area, implying that the influence of exchanges in one CCR (ATC or flow-based area) is taken into account in the flow-based calculation of another CCR. EFB takes into account commercial exchanges over the cross border HVDC interconnector within a single CCR applying the flow-based method of that CCR.
4. The main adaptations to the intraday common capacity calculation process introduced by the concept of EFB are twofold:
    d. the impact of an exchange over the cross border HVDC interconnector is considered for all relevant CNECs;
    e. the outage of the HVDC interconnector is considered as a contingency for all relevant CNEs in order to simulate no flow over the interconnector, since this is becoming the N-1 state.
5. In order to achieve the integration of the cross border HVDC interconnector into the flow-based process, two virtual hubs at the converter stations of the cross border HVDC will be added. These hubs represent the impact of an exchange over the cross border HVDC interconnector on the relevant CNECs. By placing a GSK value of 1 at the location of each converter station, the impact of a commercial exchange can be translated into a $PTDF$ value. This action adds two columns to the existing $PTDF$ matrix, one for each virtual hub.
6. The list of contingencies considered in the capacity calculation will be extended to include the cross border HVDC interconnector. Therefore, the outage of the interconnector has to be modelled as a N-1 state and the consideration of the outage of the HVDC interconnector creates additional CNEC combinations for all relevant CNEs during the process of capacity calculation and allocation.

Article 17 Consideration of non-Core CCR borders

1. In accordance with Article 21(1)(b)(vii) of the CACM Regulation, Core TSOs will take into account the influences of other CCRs by making assumptions on what will be the future non-Core exchanges in accordance with Article 18(3) of the CACM Regulation and Article 19 of the Common Grid Model Methodology.
2. The assumptions of non-Core exchanges are captured in the CGM used in the intraday common capacity calculation and underlying schedules, which are used as a starting point for common capacity calculation. In Core CCR, this constitutes the rule for sharing power flow capabilities of Core CNECs among different CCRs. The expected exchanges are thus captured implicitly in the RAM via the reference flow F_{ref} over all CNECs (see also Equations 6 and 7). As such, these assumptions will impact (increase or decrease) the $RAMs$ of Core CNECs. Resulting uncertainties linked to the aforementioned assumptions are implicitly integrated within each CNEC's FRM. This concept is usually referred to as standard hybrid coupling.
3. In contrast, advanced hybrid coupling (AHC) would enable Core TSOs to explicitly model the exchange situations of adjacent CCRs within the flow-based domain and thus in the single day-ahead coupling. This would reduce uncertainties in the CGM used in the intraday common capacity

calculation regarding forecast of non-Core exchanges and increase the degree of freedom for the market coupling in terms of allocation of capacities. The feasibility of AHC will be studied in accordance with Article 24(5).

4. In accordance with Article 20(5) of the CACM Regulation, future merging of adjacent CCRs that apply a flow-based capacity calculation will, in addition to advanced hybrid coupling, facilitate a more efficient sharing of power flow capabilities among different borders.

Article 18 Calculation of the final flow-based domain

1. After the determination of the optimal preventive and curative RAs, the RAs are explicitly associated to the respective Core CNECs (thus altering their Reference flow F_{ref} and $PTDF$ values) and the final FB parameters computed in the following sequential steps:
    d. execution of the rules for previously allocated capacity;
    e. only the constraints that are most limiting the net positions need to be respected in the market coupling: the non-redundant constraints (or the "presolved" domain). As a matter of fact, by respecting this "presolved" domain, the commercial exchanges also respect all the other constraints. The redundant constraints are identified and removed by the CCC by means of the so-called "presolve" process.

Article 19 Backup procedures

For the capacity calculation performed in the end of D-1 and during the day, where an incident occurs in the capacity calculation process and the CCC is unable to produce results, the CCC or TSOs of Core CCR where applicable, shall provide the NEMOs of the Core CCR with the last cross-zonal capacities calculated within Core CCR for the market time unit considered.

Article 20 Capacity validation methodology

1. Each TSO will, in accordance with Article 26(1) and 26(3) of the CACM Regulation, validate and have the right to correct cross-zonal capacity relevant to the TSO's bidding zone borders for reasons of operational security during the validation process. In exceptional situations cross-zonal capacities can be decreased by TSOs. These situations are:
    d. an occurrence of an exceptional contingency;
    e. an exceptional situation where sufficient redispatch or countertrade potential may not be available, that is needed to ensure the minimum RAM on all CNECs and/or to ensure the inclusion of the day-ahead market results;
    f. a mistake in input data, that leads to an overestimation of cross-zonal capacity from an operational security perspective.
2. When performing the validation, Core TSOs may consider the operational security limits, but may also consider additional grid constraints, grid models, and other relevant information. Therefore Core TSOs may use, but are not limited to, the tools developed by the CCC for analysis and might also employ verification tools not available to the CCC.
3. In case of a required reduction due to situations as defined in Article 20(1)(a) and 20(1)(b), a TSO may use a positive value for FAV for its own CNECs or adapt the external constraints to reduce the cross-zonal capacity for his market area, and may request a common decision to launch a new final flow-based computation. In case of a situation as defined in Article 20(1)(c), a TSO may also request a common decision to launch the back-up procedure as defined in Article 19. In case the allocation requires ATC values, the validation could also be performed based on ATCs. In this case, a reduction of ATC in the relevant amount is applied.

4. Any reduction of cross-zonal capacities during the validation process will be communicated to market participants and justified to the Core regulatory authorities in accordance with Article 22 and Article 23, respectively.
5. The regional coordinated capacity calculator shall coordinate with neighbouring coordinated capacity calculators during the validation process. Any information on decreased cross-zonal capacity from neighbouring coordinated capacity calculators shall be provided to Core TSOs. Core TSOs may then apply the appropriate reductions of cross-zonal capacities as described in Article 20(3).

UPDATES AND DATA PROVISION

Article 21 Reviews and updates

1. In accordance with Article 27(4) of the CACM Regulation all TSOs shall regularly and at least once a year review and update the key input and output parameters listed in Article 27(4)(a) to (d) of the CACM Regulation.
2. If the operational security limits, contingencies and allocation constraints used for the common capacity calculation need to be updated based on this review, Core TSOs shall publish the changes early in advance before the implementation.
3. In case the review proves the need of an update of the reliability margins, Core TSOs shall publish the changes early in advance before the implementation.
4. The review of the remedial actions taken into account in capacity calculation shall include at least an evaluation of the efficiency of specific PSTs and the topological RAs considered during RAO.
5. In case the review proves the need for updating the application of the methodologies for determining generation shift keys, critical network elements and contingencies referred to in Articles 22 to 24 of the CACM Regulation, changes have to be published before the final implementation.

Article 22 Publication of data

Publication of data shall be in line with Article 3 of the CACM Regulation aiming at ensuring and enhancing the transparency and reliability of information and will be based on the definitions of Commission Regulation (EU) No 543/2013 on submission and publication of data in electricity markets.

Article 23 Monitoring and information to regulatory authorities

1. With reference to the Whereas and Article 26(5) of the CACM Regulation, monitoring data shall be provided towards the Core regulatory authorities as basis for supervising a non-discriminatory and efficient Core congestion management.
2. The provided monitoring data shall also be the basis for the biennial report to be provided according to Article 27(3) of the CACM Regulation.
3. Monitoring data shall be treated as confidential by the Core regulatory authorities and shall not be disclosed to the public.

IMPLEMENTATION

Article 24 Timescale for implementation of the Core flow-based intraday capacity calculation methodology

Below, in accordance with Article 9(9) of the CACM Regulation, a proposed timescale for implementation is presented:

1. The TSOs of the Core CCR shall publish the common capacity calculation methodology Proposal without undue delay after all national regulatory authorities have approved the proposed methodology or a decision has been taken by the Agency for the Cooperation of Energy Regulators in accordance with Article 9(10) to (12) of the CACM Regulation.
2. Subject to several dependencies (e.g. progress of the internal parallel run, implementation, proposed changes to the concept, regulatory authorities' approval of the methodology), the TSOs of the Core CCR shall implement the intraday capacity calculation methodology to launch the external parallel run no later than S2-2020 and S1-2021 as the go-live window for the market.
3. Until the intraday common capacity calculation is operational, the Core intraday capacities will be produced based on the left over capacity from the day-ahead common capacity calculation process.
4. After the implementation of the common capacity calculation methodology, Core TSOs are willing to work on a solution, in addition to standard hybrid coupling, that fully takes into account the influences of the adjacent CCRs during the capacity allocation i.e. the so called advanced hybrid coupling concept.
5. The deadlines defined in the above Article 24(2) can be modified on request of all TSOs of the Core CCR to their national regulatory authorities, where testing period does not meet necessary conditions for implementation.

LANGUAGE

Article 25 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 TSO shall, in accordance with national legislation, provide the relevant national regulatory authorities with an updated translation of the proposal.