European Network of
Transmission System Operators
for Electricity

CACM CIDM Amendment Explanatory note

9 July 2021

Disclaimer

This explanatory document is submitted by all TSOs to the Agency for the Cooperation of Energy Regulators for information and clarification purposes only accompanying the "All TSOs' proposal for amendment of congestion income distribution methodology in accordance with Article 73 of the Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management.

Contents

I. Introduction

Article 73 of the Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management (hereinafter referred to as the "CACM Regulation") required that within 12 months after the entry into force of CACM, all TSOs shall jointly develop a methodology for congestion income distribution (hereinafter referred to as the "CACM CIDM"). CACM CIDM was approved by Agency for the Cooperation of Energy Regulators (hereinafter referred to as the "ACER") on 14 December 2017 pursuant to Article 9(12) of the CACM Regulation. This methodology foresaw the possibility of using a single Slack hub for establishing the congestion income distribution in CCRs where Flow-based methodologies are in place.

During the Day-ahead Flow-based Market Coupling (hereinafter referred to as the "FBMC") implementation in the Capacity Calculation Region (hereinafter referred to as the "CCR") Core, the possibility of multiple Slack hubs approach was examined. From the simulations it was found that having two Slack hubs, i.e. virtual sink or source hubs for all external flows, results in a better optimization of the congestion income distribution (hereinafter referred to as the "CID") than having only one.

Taking into account that in accordance with Article 5.3 of Regulation (EU) 2019/942 of the European Parliament and of the Council of 5 June 2019 establishing a European Union Agency for the Cooperation of Energy Regulators (hereinafter referred to as "Regulation 2019/942") and the six months period provided for ACER to decide, in view of the implementation of Core FBMC foreseen in February 2022 the Core TSOs submitted to Market Integration Working Group on 3 September 2020 a request for amendment of the CACM CIDM.

The CACM CIDM neither addresses the way congestion income (hereinafter referred to as "CI") is generated (e.g. capacity calculation and allocation mechanisms) nor the use of CI (e.g. for investments, etc.) once it has been distributed. These aspects are regulated and defined by other legal provisions and methodologies. Instead, the CACM CIDM describes how the CI is allocated to the Bidding Zone borders (hereinafter referred to as the "BZB") and distributed between the relevant parties at the BZB.

During the work on the amendment additional needs for adjustments resulting from experience with regional implementations and legislative developments were identified. The final objective of the CACM CIDM amendment is:

- To ensure the possibility of Multi Slack hub approach;
- To include changes to be consistent with the methodology for sharing CI according to in Article 57 of the Commission Regulation (EU) 2016/1719 of 26 September 2016 establishing a guideline on forward capacity allocation (hereinafter referred to as the "FCA Regulation" and the "FCA CIDM");
- To include intraday timeframe into the scope of the CACM CIDM and preparing the ground for the Intraday Capacity Pricing Auctions (hereinafter referred to as "IDA") launch and subsequent transition to a Flow-based approach in some CCRs;
- To include the possible occurence of negative CI under specific circumstances.

Capitalised terms used in this document are understood as defined in the CACM Regulation, CACM CIDM, FCA Regulation, FCA CIDM, Regulation (EU) 2019/942 and Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity.

II. Main changes

1 Multi Slack hub approach

In the current methodology, the so-called Slack hub is needed, which is a virtual sink or source hub for all external flows. External flows are a natural result of FBMC remaining after the subtraction between the net position of a bidding zone and the sum of calculated flows at its internal BZB, i.e. Additional Aggregated Flow (AAF). To assign CI to an external border, there is the need to know the price spread between the given bidding zone and the Slack hub. The price of the Slack hub must therefore be calculated by optimizing for a suitable solution with the minimum CI for external borders.

If more than one Slack hub were determined as connected to one CCR, more prices would also be optimized in case of relevant CCR FBMC. From the simulations performed by Core CCR it was identified that in the case of two Slack hubs, better optimization, i.e. less CI for external borders, is achieved than in the case of only one Slack hub surrounding the entire CCR.

As the current form of the CACM CIDM allows only one Slack hub, Core TSOs suggested a slight adjustment of the calculation formulas, so that they do not limit the number of Slack hubs for the regional FBMC implementation. Thus, this change has no negative impact, but only brings more possibilities.

During this change, a definition of the term “Slack hub” was also introduced, as the originally used term “Virtual hub” was in conflict with other legal documents and process descriptions[1]. The term Slack hub is also well-established and better defines the nature of things.

The determination of the number of Slack hubs and their associated bidding zones should be unambiguous for each CCR. Either only one Slack hub surrounding the entire CCR will be selected or the following conditions must be met.

1. External flows of each bidding zone can only be assigned to a one Slack hub.
2. There shall be no direct flows between Slack hubs meaning that the sum of all external flows towards a Slack hub is zero.
3. A Slack hub is defined only in case the external flow can re-enter the relevant CCR via a different external border, but within the same Slack hub.

2 Consistency with FCA CIDM

These changes reflect the principles described in the newly approved FCA CIDM and are included mainly in the Article 6 - Sharing keys. Wording of the paragraphs and specific rules of sharing are now similar for both methodologies.

Newly added paragraph 3 is a copy of the paragraph in the FCA CIDM. In essence, in the implicit allocation there should be no auctions separately for individual interconnectors on one BZB. However, the potential necessity of this paragraph was discussed by the group and IDA experts. For example, so-called common ATC borders in IDA can potentially result in this situation. Since the content of this paragraph does not bring

[1] The term Virtual HUB is leading to confusion with the term Virtual Bidding zone which is a terminology used by the Algorithm Methodology; This Virtual bidding zone refers to a configuration of the DA algorithm which allows to model how the critical network elements of a CCR applying the flow-based approach are impacted by cross-zonal exchanges on HVDC interconnectors within a CCR or by cross-zonal exchanges on bidding zone borders outside the CRR that are applying the coordinated net transmission capacity approach.

any drawbacks, but only expands the possibilities, TSOs believe it is not harmful to include it just to secure this situation for the future.

To simplify future amendments concerning only changes to the specific sharing keys table, the table is removed as Annex 1 of CACM CIDM. The sharing keys for these specific cases shall be published in a common document by ENTSO-E on its web page for information purposes only. This principle was also introduced in the FCA CIDM, as the table is not needed as an integral part of the methodology. The only difference compared to FCA CIDM is that the common specific sharing keys document will not be published on the website of the Single Allocation Platform, as it is relevant only for long-term allocation.

3 Intraday timeframe inclusion

Current version of the CACM CIDM was created at a time when the intraday capacity pricing methodology pursuant to Article 55 of the CACM Regulation was not defined yet. Therefore, it was not possible to devise the rules for the sharing of CI generated in the intraday timeframe in the first version of the CACM CIDM. For this reason, the CACM CIDM now covers only the CID in the day-ahead timeframe, and it was mentioned, that the scope should be amended in order to extend the scope to intraday timeframe once sufficient clarity is gained on how congestion income in the intraday timeframe will be generated.

Currently, Single Intraday Coupling (hereinafter referred to as “SIDC”) is already operating steadily in most of Europe on the basis of continuous trading and the intraday capacity pricing methodology pursuant to Article 55 of the CACM Regulation was approved by ACER on 24 January 2019. From 2023, the introduction of hybrid solutions and IDAs is planned. It was therefore convenient to examine the possibility of intraday timeframe inclusion already in this amendment, as it would be inefficient to follow up with another amendment right away.

After a thorough examination of the CACM CIDM processes in the IDA context, it was concluded that no special changes and additional new articles are needed. Both within NTC and FB approach, the processes are fully adaptable to IDA, and its inclusion can be done only by a simple extension of the articles. The references are not made to the SIDC, but directly to the IDA, as the results relevant for CID are based only on the IDA and continuous trading must be discarded. Within the intraday time frame, processes specific only to the day-ahead timeframe must also be singled out, which is a consideration of the costs for the long-term transmission rights remuneration.

Due to the fact that the current scope and implementation of the CACM CIDM is linked to the implementation of the methodology according to Article 20 of the CACM Regulation, for some CCRs there will be an interim period when they do not fall under the CACM CIDM, but have CI from IDA. Therefore, this amendment proposes to extend the scope only for intraday timeframe so that it is limited only by implementation of IDA. After IDA, all CCRs will be part of the final SIDC model and will thus be included even without the final capacity calculation.

There is a known risk that with the impending launch of IDA and the subsequent transition to FB allocation, new specifics will emerge that will not be in line with the CACM CIDM. Especially for a FB approach, a high-level design is still being developed, but it is not expected that there will be fundamental differences from a FB approach in day-ahead timeframe. Therefore, there is confidence that the inclusion of the intraday timeframe is adequately general enough, and that all potential uncertainties are addressed, so that no further amendment to this CACM CIDM will be required.

4 Negative congestion income

In general, the generated gross CI for a CCR under FBMC and LTA-inclusion shall always be positive or zero in case of price convergence for each MTU.

However, caused by some very rare and specific situations, it could happen that the gross CI for CCR becomes negative, being either:

- Due to the activation of a specific patch implemented in the optimisation algorithm for FBMC (Euphemia) for curtailment mitigation & sharing, or also called the Adequacy Patch (hereafter referred to as the ”AP”), as it is included in the Algorithm Methodology, Common set of DA requirements for the price coupling algorithm;
- The handling of block orders in combination with certain FB price principles;
- Inconsistencies caused by the application of rounding.

Main root cause behind this gross CI becoming negative is that due to the mechanism of the AP, or the FB pricing principles there could occur cases where the initial prices calculated by Euphemia (so called “uncapped prices”) are above (or below) the max (or min) ranges of the DA prices (the Harmonised maximum and minimum clearing prices for single day-ahead coupling in accordance with Article 41(1) of CACM). As the prices that market parties pay or receive cannot be above these thresholds, the initial uncapped prices have to be capped.

In Annex 2 an example is shown in which the activation of the AP is used to mitigate curtailment. The slide was delivered by N-side (IT provider for Euphemia) to CWE TSOs while discussing the topic in the past, and it describes a situation within a FB context, where non-intuitive prices occur and where the AP was activated to mitigate and share the curtailment that finally took place.

Curtailment occurs when hourly orders in Euphemia with either minimum or maximum prices would be selected. If something is supplied for the minimum price, or at the maximum price, then this is seen as a “price taking order”. When the market coupling reaches such price taking orders, it means that the respective country is facing adequacy issues, which can have severe effects. It is therefore to be avoided that the outcome of the market coupling leads to conditions where bidding zones could face such situations of curtailment of price taking orders. However due to PTDF constraints, it would be possible to not have such orders accepted under regular welfare optimisation. To avoid such behaviour of the algorithm where in a FB region price taking orders are curtailed, the AP would be triggered to initially try to avoid curtailment in bidding zones and to ensure curtailment sharing only if it cannot be avoided. To avoid the curtailment, a penalty term is added to the selection of price taking orders. Meaning that avoiding the selection of this order would lead to a better optimum for the algorithm from a welfare perspective. When an optimum is found in such a situation by Euphemia and respective buy & sell volumes are fixed, it could result finally in prices above the maximum (currently +3000 €/MWh) or minimum (currently -500€/MWh) prices that are applicable (uncapped prices). However, price results of power exchanges to be paid/received by market parties are capped by such maximum prices.

So the end result of gross negative CI is finally caused by the last step where the switch is made from the situation with uncapped prices to the final situation with capped prices. Or to state otherwise, the gross CI calculated by using capped prices (compared to uncapped prices used in Euphemia for determining the market coupling result with the highest welfare in case of curtailment) could become negative. However, it is to be noted that this can only occur if it happens simultaneously with non-intuitive flows/prices, and “price taking orders” in competition with constraints in the flow-based market coupling for other orders which are possibly also reaching the price limits.

So far, such a situation did not occur within CWE FBMC from its start until today at middle of 2021. However, in principle it could happen. In such a situation TSOs would have to pay to CCPs for relevant hours.

To cover this unregulated situation in the Methodology, a proposal is made to share these negative CI amounts that can occur in a simple equal sharing manner among bidding zones of a CCR under FBMC:

- As the causes that lead to this negative CI are triggered by features that are defined in other EU methodologies for good reasons to make sure the whole market process can work well for all parties in all circumstances.
- The low likelyhood of the situation can justify a simple approach, as other complex sharing principles will be arbitrary.

III. Minor beneficial changes

With the incorporation of several different changes, the structure of the original document was disrupted. Therefore, the amendment also included a slight restructuring of the document, including the adjustment of some calculation formulas. However, no change to the processes of the original methodology has been made, but only improvement of comprehensibility and transparency.

The following changes are not the main changes due to which the methodology was reopened but were identified during the modifications. They are the result of the development of other legislation, the extension of freedom during implementation, and the improvement of wording and definitions.

5 Specifics in the regional implementation

In several cases, it is necessary to have differences between CCRs. This is mainly based on the fact that Capacity Calculation Methodologies are approved at the CCR level and thus introduce significant differences between CCRs, which are closely related to CID principles. In the pre-coupling phase there are specifications on a CCR level. Those logically have an impact on the post-coupling processes as well, hence consistency and continuity is required.

CCR	CI CCR Formula	Reasoning	Non-intuitive flows or losses
Baltic	B	Received market results are flows over the respective Baltic interconnectors. It is in line with the current approach.	YES
Core	A	Received market results are Net Positions.	YES

		Implementation of CID tools almost finished based on this principle.	
GRIT	B	Received market results are flows over the DC link between Greece and Italy- South. Not applicable to the Italian internal bidding zone borders.	NO
Hansa	B	Received market results are flows over the respective Hansa interconnectors where each of them is either a DC link or can be considered to behave like a DC link. Net positions are not applicable to CCR Hansa due to the facts that 1) the Hansa CCR does not include any BZs and 2) all BZs that are linked by the CCR Hansa interconnectors belong either to the Nordic CCR or to the Core CCR. It is in line with the current approach.	YES
Italy North	A	Received market results are Net Positions. Implementation of CID tools almost finished based on this principle.	YES
Nordic	A		YES
SEE			
SWE	A or B	Received market results include allocated capacities in SWE BZB. Hence formula B is currently used for determining CI on each BZB. Given the lack of non-intuitive flows and the non-consideration of losses the	NO

		addition of CI of both BZB makes the CI of the CCR. Formula A could however also be used.	

Therefore, to meet the requirements of some CCRs and to leave the options free for relevant implementation, the process of CI calculation actually generated within one CCR can be calculated either on the basis of hub net position or allocated capacity between hubs. Both formulas provide equal results but require different inputs and steps for the implementation as pictured in Annex 3 of this Explanatory Note.

Also, a new paragraph has been added in Article 3 (3). Thus, the CCR does not have to implement the CI calculation generated within the CCR and the subsequent proportional adjustment to the sum of congestion income attributed to all bidding zone borders within the CCR, if this step is considered unnecessary. This omission should occur in CCRs without non-intuitive flows and where network losses on the interconnectors are not taken into account in capacity allocation, as the CI calculated on the BZB should always correspond to the CI actually generated by the market electricity exchanges.

There are two options on how to include the process of calculation and rescaling of the calculated CI to generated CI. It can be included as the general rule with the formula and possibility of CCRs exceptions or the general rule is not to use the formula, and if needed, some CCRs can use it.

In addition, specific allocation constraints can be reflected. This topic has already been discussed in the approval process of the original CACM CIDM, specifically in the section 5.2.2 of the Decision of ACER No 07/2017 of 14 December 2017 on the CIDM.

ACER deems it appropriate that the specific problem is first addressed with adequate legal means, namely the inclusion of all interdependent bidding zone borders into a single CCR and an overall legal assessment of the justification of these allocation constraints. Furthermore, if these allocation constraints are approved by the relevant regulatory authorities in accordance with the applicable legal proceedings pursuant to the CACM Regulation, all TSOs may propose amendments to the CACM CIDM and specify the relevant exceptions directly in the CACM CIDM.

These allocation constraints occur and are approved by the relevant regulatory authorities at least for the Polish, Belgian, Dutch and Italian bidding zone. Thus, non-intuitive flows occur and so does the difference between the sum of CI assigned to all bidding zone borders within the CCR and the sum of total CI generated by electricity exchanges within a CCR. However, these inconsistencies are tied to and caused only by the interdependent BZBs of the allocation constraint. It would therefore be unfair to adjust the CI assigned to the independent BZBs in the same CCR. This solution could be applicable for each allocation constraint within one CCR applying NTC-based market coupling. In FBMC, each grid element can be influenced via the PTDF factor and CI proportional adjustment must be kept at a CCR level.

The same principles are also reflected in the approved methodology according to the Article 61 of the FCA Regulation, where it is also recognized, that non-intuitive flows and capacity usage shifts occur solely on interdependent BZBs.

Using the new wording in Article 3(4) of the proposed CACM CIDM Amendment simply and effectively introduces the possibility of the scope change for the proportional CI adjustment. CACM CIDM is kept unencumbered with lengthy specifications and these modifications are left solely on a CCR implementation.

6 Definitions and references

As part of the amendment, definitions and references were also checked. Regarding the definitions, it is worth mentioning the already explained introduction of the terms Slack hub and IDA, but also the adjustment of the Net border income.

The most noticeable change regarding references is the replacement of Regulation (EC) 714/2009, which is no longer in force, by Regulation (EU) 2019/943, including the corresponding articles.

IV. Cross-CCR transfer of CI

As part of the final implementation of CACM CIDM in individual regions, it is necessary to introduce the possibility of moving CI from one region to another in the future. However, according to the current CACM CIDM, the scope of the relevant calculations cannot be larger than one CCR. Within one market optimization algorithm, also elements between adjacent CCRs can be influenced in order to achieve maximum welfare. Correct consideration of interdependent BZBs would then need a multi-CCR scope of the calculations. Specifically, this concerns the applications of Advanced hybrid coupling (AHC) and cross-CCR Allocation Constraints (AC) applied by BZs.

AHC is a mechanism that allows the impact of energy exchanges in one CCR on the CNECs of other CCR that applies flow-based approach to be considered. Once applied, AHC leads to an increase of the overall social welfare compared to the situation without using the AHC. The social welfare maximisation in the market coupling may create non-intuitive flows in CCRs implementing FBMC with AHC due to energy exchanges between these CCRs, not being the case before AHC was implemented. This is due to that in FBMC, as described in section 5, the energy flow on each grid element is defined based the PTDF factors. The possible impact of non-intuitive flows across CCRs influences CI.

Similar effect may happen in case of cross-CCR allocation constraints applied by BZs that have borders in different CCRs – e.g. PL. Approved Capacity Calculations Methodologies (CCM) for CORE CCR, HANSA CCR and Baltic CCR foresee the implementation of allocation constraints on the global net position (i.e. the sum of all cross border exchanges for a certain bidding zone in the single day-ahead coupling), thus limiting the net position of the respective bidding zone with regard to all CCRs which are part of the single day-ahead coupling. Such way of applying allocation constraints contribute to increase social welfare and congestion income (if AC were not applied, the offered capacity would be much lower), however it might give rise to an increase of border CI in one CCR and non-intuitive flows (meaning flows against prices differences) and negative CI on other borders, in other CCR(s) (overall multi-CCR CI stays positive).

According to the current CID rules, such increase/loss of CI would be socialized within respective CCR in which it was created. In a worst-case scenario, this could also lead to negative CI for a whole CCR. However, any negative effect to one CCR should be covered from the higher CI generated in the CCR that benefits from this shift.

Treating only negative CCR CI is not enough as it is only a clearly visible extreme case. This issue should be addressed more rigorously as CI/welfare shifts happen continuously (when AC is active) and can have either a positive (CI gain) or negative (CI loss) effect on an individual CCR.

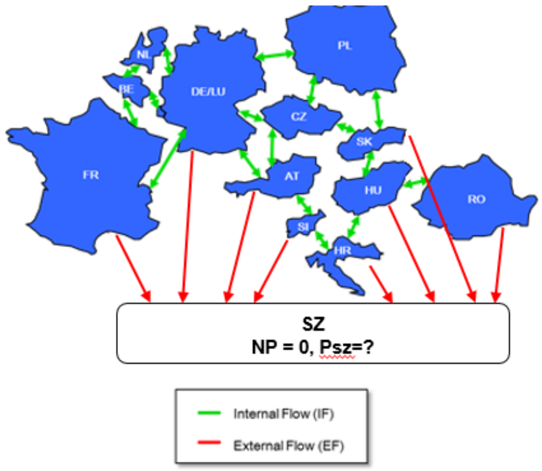
From the simulations performed for FBMC in Core CCR, it is clear that the shifts occur regularly and even the number of occurrences and magnitude of negative incomes for the whole CCR is not negligible.

The handling of Cross CCR AC (and AHC) is having an important impact on the distribution of CI within involved CCRs. Hence also impacting the existing/developed designs and functionalities. A precise wording change is not proposed for the current CACM CIDM amendment as the final solution was not discovered yet. For pragmatic reasons, a kind of interim phase could be envisaged, where the effects are acknowledged and added in the Methodology with a description of how they can be temporarily handled. Another need of an amendment is therefore foreseen in the near future to introduce the final solution.

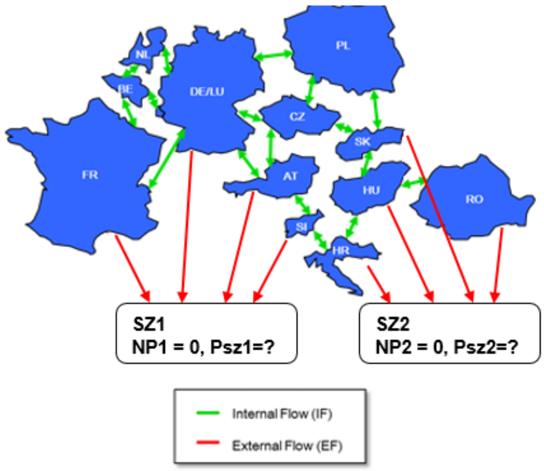
General description with numerical example based on the case of Polish bidding zone regarding the need of cross-CCR transfer of CI due to active allocation constraints is presented in Annex 4 of this Explanatory Note.

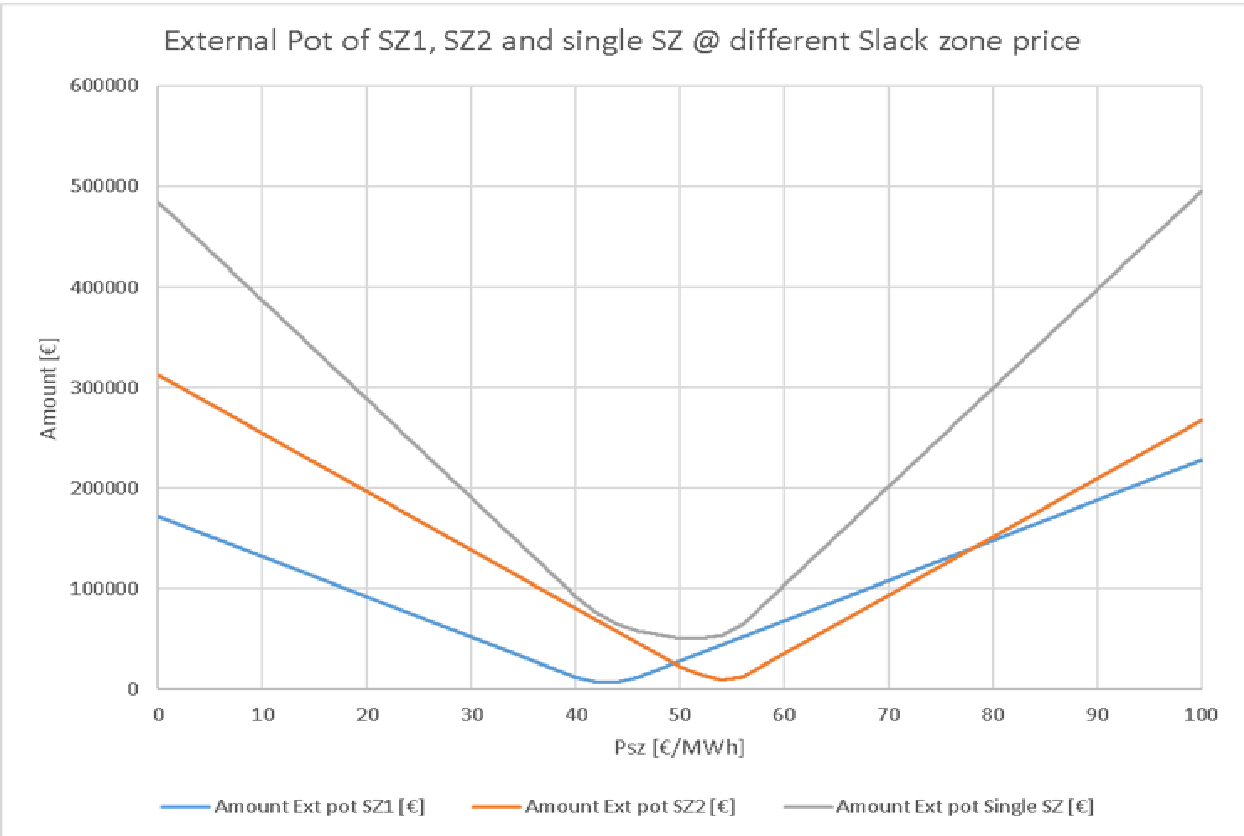
Annex 1: Single / Multiple Slack Hubs comparison

Option A: Single Slack Zone



Option B: Two Slack Zones





$$P_{SZ} = \arg\min_{P_{SZ}} \sum_{i=1}^{NOH} |(P_i - P_{SZ}) \times EF_i|$$

$$CI_{EF,i} = |EF_i \times (P_i - P_{sz})|$$

EF going from hub with higher price to hub with lower price→ non-intuitive flow

$$P_{SZ} = \arg\min_{P_{SZ}} \sum_{i=1}^{NOH} |(P_i - P_{SZ}) \times EF_i|$$

INPUT: Two Slack Zone	SZ1	CI EF
MCP_FR [€/MWh]	40	2.400
EF_FR [MW]	800	
MCP_DE [€/MWh]	42	1.200
EF_DE [MW]	-1200	
MCP_AT [€/MWh]	44	1.200
EF_AT [MW]	1200	
MCP_SI [€/MWh]	46	2.400
EF_SI [MW]	-800	
Check SUM all ext flows=0	0	
External pot SZ1 [€]	7.200	**7.200**
Psz1 [€/MWh]	**43,00**	

INPUT: Two Slack Zone	SZ2	CI EF
MCP_HR [€/MWh]	56	4.400
EF_HR [MW]	-2200	
MCP_HU [€/MWh]	54	0
EF_HU [MW]	2000	
MCP_SK [€/MWh]	52	1.400
EF_SK [MW]	-700	
MCP_RO [€/MWh]	50	3.600
EF_RO [MW]	900	
Check SUM all ext flows=0	0	
External pot SZ2 [€]	9.400	**9.400**
Psz2 [€/MWh]	**54,00**	
External pot SZ1+SZ2 [€]		**16.600**

INPUT: Single Slack Zone		CI EF
MCP_FR [€/MWh]	40	8.800
EF_FR [MW]	800	
MCP_DE [€/MWh]	42	10.800
EF_DE [MW]	-1200	
MCP_AT [€/MWh]	44	8.400
EF_AT [MW]	1200	
MCP_SI [€/MWh]	46	4.000
EF_SI [MW]	-800	
MCP_HR [€/MWh]	56	11.000
EF_HR [MW]	-2200	
MCP_HU [€/MWh]	54	6.000
EF_HU [MW]	2000	
MCP_SK [€/MWh]	52	700
EF_SK [MW]	-700	
MCP_RO [€/MWh]	50	900
EF_RO [MW]	900	
Check SUM all ext flows=0	0	
External pot Single SZ [€]	50.600	**50.600**
Psz [€/MWh]	**51,00**	
External pot Single SZ [€]		**50.600**

Non-intuitive flows

Calculated External pot higher than Actual External pot! – affecting scaling factor

Calculated External pot higher than Actual External pot! – affecting scaling factor

External pot with 2 SZ is always smaller or equal to the External pot with Single SZ because of sub optimal SZ price optimisation!

$$\text{Scaling Factor} = \frac{CI_{Total}}{\text{Internal Pot}_{Core} + \text{External Pot}_{Core}}$$

$$CI_{EF,i} = |EF_i \times (P_i - P_{sz})|$$

Only intuitive flows

$$P_{SZ} = \arg\min_{P_{SZ}} \sum_{i=1}^{NOH} |(P_i - P_{SZ}) \times EF_i|$$

INPUT: Two Slack Zone	SZ1	CI EF
MCP_FR [€/MWh]	40	2.400
EF_FR [MW]	800	
MCP_DE [€/MWh]	42	1.200
EF_DE [MW]	1200	
MCP_AT [€/MWh]	44	1.200
EF_AT [MW]	-1200	
MCP_SI [€/MWh]	46	2.400
EF_SI [MW]	-800	
Check SUM all ext flows=0	0	
External pot SZ1 [€]	7.200	**7.200**
Psz1 [€/MWh]	**43,00**	

INPUT: Two Slack Zone	SZ2	CI EF
MCP_HR [€/MWh]	56	3.000
EF_HR [MW]	-1000	
MCP_HU [€/MWh]	54	600
EF_HU [MW]	-600	
MCP_SK [€/MWh]	52	700
EF_SK [MW]	700	
MCP_RO [€/MWh]	50	2.700
EF_RO [MW]	900	
Check SUM all ext flows=0	0	
External pot SZ2 [€]	7.000	**7.000**
Psz2 [€/MWh]	**53,00**	
External pot SZ1+SZ2 [€]		**14.200**

INPUT: Single Slack Zone		CI EF
MCP_FR [€/MWh]	40	4.800
EF_FR [MW]	800	
MCP_DE [€/MWh]	42	4.800
EF_DE [MW]	1200	
MCP_AT [€/MWh]	44	2.400
EF_AT [MW]	-1200	
MCP_SI [€/MWh]	46	0
EF_SI [MW]	-800	
MCP_HR [€/MWh]	56	10.000
EF_HR [MW]	-1000	
MCP_HU [€/MWh]	54	4.800
EF_HU [MW]	-600	
MCP_SK [€/MWh]	52	4.200
EF_SK [MW]	700	
MCP_RO [€/MWh]	50	3.600
EF_RO [MW]	900	
Check SUM all ext flows=0	0	
External pot Single SZ [€]	34.600	**34.600**
Psz [€/MWh]	**46,00**	
External pot Single SZ [€]		**34.600**

Non-intuitive flows still present

Calculated External pot equal to Actual External pot! – not affecting scaling factor

Calculated External pot higher than Actual External pot! – affecting scaling factor

External pot with 2 SZ is always smaller or equal to the External pot with Single SZ because of sub optimal SZ price optimisation!

$$\text{Scaling Factor} = \frac{CI_{Total}}{\text{Internal Pot}_{Core} + \text{External Pot}_{Core}}$$

$$CI_{EF,i} = \left|EF_i \times (P_i - P_{sz})\right|$$

Only intuitive flows

$$P_{SZ} = \arg\min_{P_{SZ}} \sum_{i=1}^{NOH} \left|(P_i - P_{SZ}) \times EF_i\right|$$

INPUT: Two Slack Zone	SZ1	CI EF
MCP_FR [€/MWh]	40	2.400
EF_FR [MW]	800	
MCP_DE [€/MWh]	42	1.200
EF_DE [MW]	1200	
MCP_AT [€/MWh]	44	1.200
EF_AT [MW]	-1200	
MCP_SI [€/MWh]	46	2.400
EF_SI [MW]	-800	
Check SUM all ext flows=0	0	
External pot SZ1 [€]	7.200	**7.200**
Psz1 [€/MWh]	**43,00**	

INPUT: Two Slack Zone	SZ2	CI EF
MCP_HR [€/MWh]	56	8.000
EF_HR [MW]	-1000	
MCP_HU [€/MWh]	54	3.600
EF_HU [MW]	-600	
MCP_SK [€/MWh]	42	4.200
EF_SK [MW]	700	
MCP_RO [€/MWh]	41	6.300
EF_RO [MW]	900	
Check SUM all ext flows=0	0	
External pot SZ2 [€]	22.100	**22.100**
Psz2 [€/MWh]	**48,00**	
External pot SZ1+SZ2 [€]		**29.300**

Calculated External pot equal to Actual External pot! – not affecting scaling factor

INPUT: Single Slack Zone		CI EF
MCP_FR [€/MWh]	40	2.400
EF_FR [MW]	800	
MCP_DE [€/MWh]	42	1.200
EF_DE [MW]	1200	
MCP_AT [€/MWh]	44	1.200
EF_AT [MW]	-1200	
MCP_SI [€/MWh]	46	2.400
EF_SI [MW]	-800	
MCP_HR [€/MWh]	56	13.000
EF_HR [MW]	-1000	
MCP_HU [€/MWh]	54	6.600
EF_HU [MW]	-600	
MCP_SK [€/MWh]	42	700
EF_SK [MW]	700	
MCP_RO [€/MWh]	41	1.800
EF_RO [MW]	900	
Check SUM all ext flows=0	0	
External pot Single SZ [€]	29.300	**29.300**
Psz [€/MWh]	**43,00**	
External pot Single SZ [€]		**29.300**

Only intuitive flows

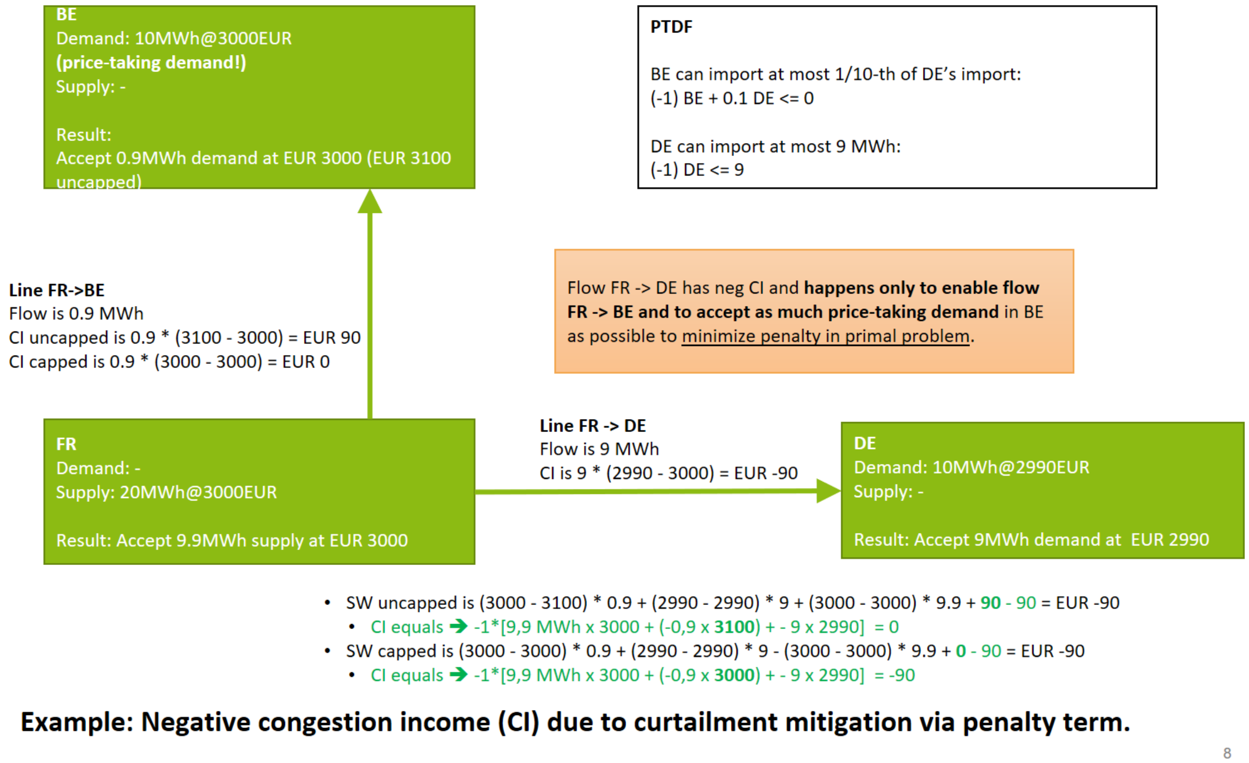
Calculated External pot equal to Actual External pot! – not affecting scaling factor

External pot with 2 SZ is always smaller or equal to the External pot with Single SZ because of sub optimal SZ price optimisation!

$$Scaling\ Factor = \frac{CI_{Total}}{Internal\ Pot_{Core} + External\ Pot_{Core}}$$

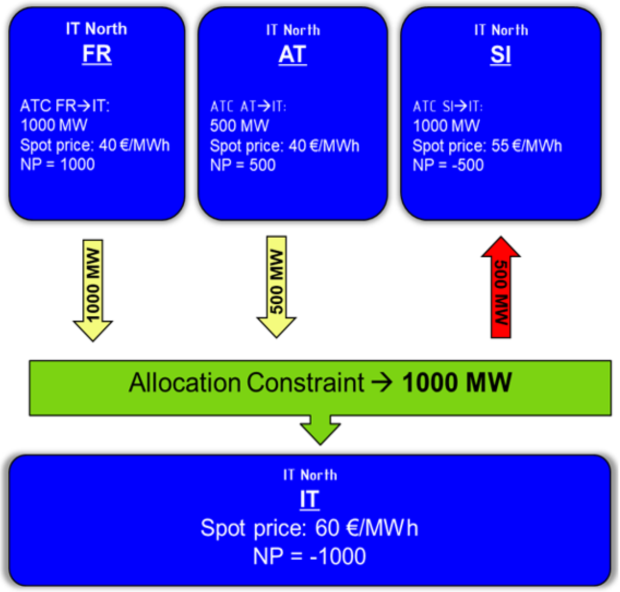
Single SZ Approach	Two SZ Approach
Less calculation steps (not the case anymore, since we decided to implement both options in Matlab)	SZ price better optimised for each SZ
Does not require an amendment of the DA CIDM (73 CACM).	External pot (SZ1+SZ2) is smaller or equal to External pot with Single SZ i.e. closer to the idea of minimizing the external pot
	No external flows between hubs of different Slack Zones (e.g. SI-RO)
	Less impact on the Scaling Factor and thus on the „actual“ CI assigned on individual BZBs

Annex 2: Negative congestion income example



Annex 3: Calculation of CI under 'non intuitive flows' caused by allocation constraints

Situation on IT-Northern BZB under Allocation Constraints of 1000MW by allowing non-int flows



$$CI_{total} = -\sum_{i=1}^{Nhubs} NP_i \times P_i$$

The resulting CI by Formula 1 now results with:

CI_{ex2} = - [1000*40 + 500*40 - 500*55 - 1000*60] = 27.500€

Same ‚CI of 27.500€ ' is resulting if calculating with neg. CI on SI-IT BZW (which is not correct because CI is always generated as a positive value by accepting bids of market participants)

CI Calculation considering not existing Neg. CI

IT-FR: 1000 * 20 = 20.000

IT-AT: 500 * 20 = 10.000

IT-SI: 500 * -5 = -2.500

Sum: = 27.500

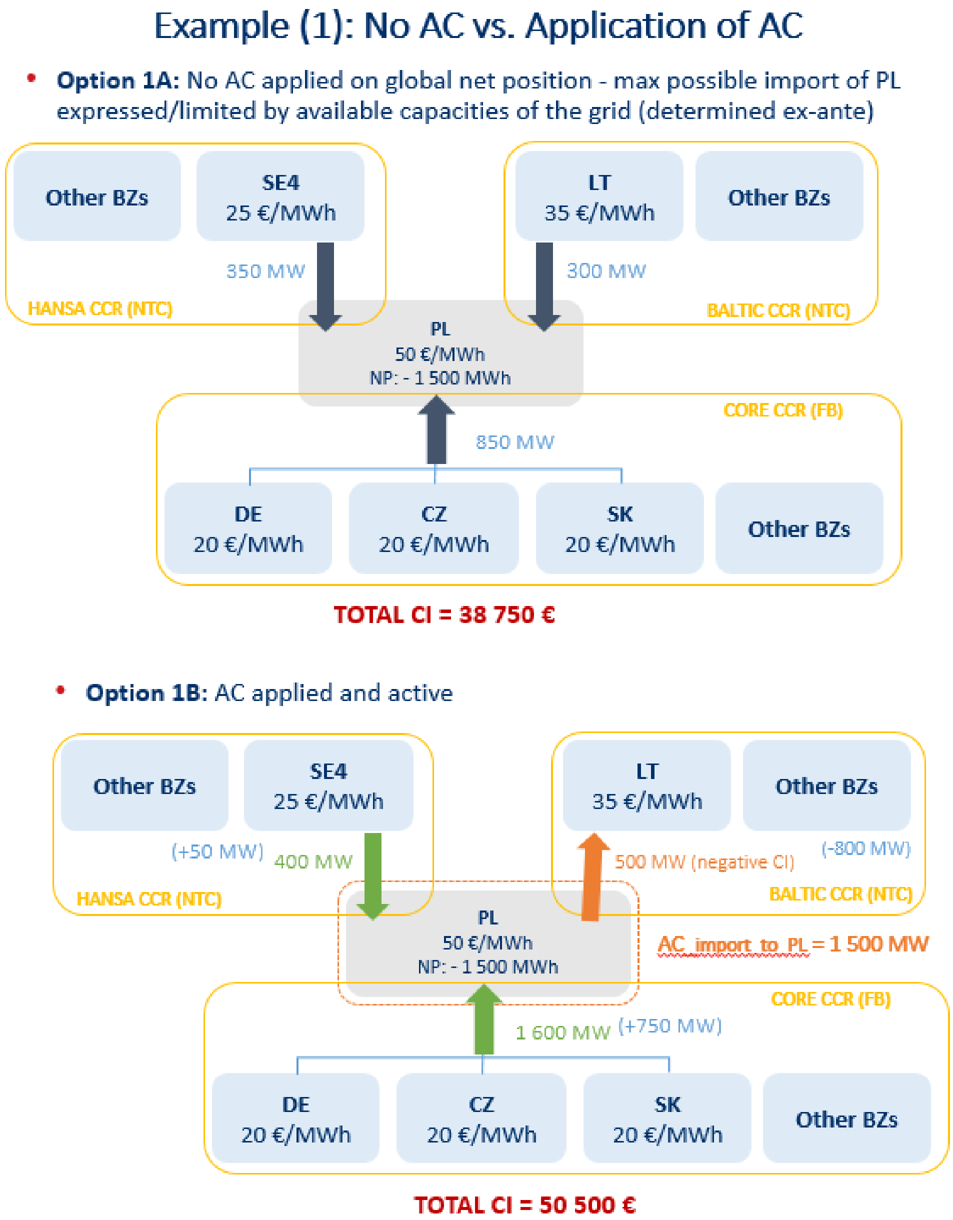
Distribution of CI to the relevant BZBs according CACM CID:

- For the calculations relevant for the sharing absolute value of flows times Marked Spread has to be used (result in Example is 32.500€)
- Next step is a proportional downscaling to effective generated CI (27.500€)
- Calculation of CI for each BZB using scaling factor (this is equal to proportional sharing of CI considering the sharing key)

Example 2					
BZB	Flow	M.Spread	CI for Skey	scalling	CI per BZB
FR-IT	1.000	20	20.000	0,8462	16.923
AT-IT	500	20	10.000		8.462
SI-IT	-500	5	2.500		2.115
Sum	1.000		32.500		27.500

As the result for CI Distribution no BZB ends up by a negative CI (as each flow, if intuitive or non intuitive, is assisting the CCR to achieve optimum wellfare under FB-MC allgorithm (Euphemia)

Annex 4: Numerical Example regarding the need of cross-CCR transfer of CI due to active allocation constraint



Observations and comments:

1. In option 1A, flows against prices difference resulting in negative CI are not possible. At the same time, available network capacities of the grid cannot be fully used since they are limited/adjusted to reflect max import position of PL;

2. In option 1B, allocation constraint (AC) is applied on global net position (NP) and active (meaning total NP of PL equals to the value of AC). This approach results in higher economical surplus and higher flows on the cross-border interconnections of PL.
3. Maximisation of flows on some borders may lead to flows against prices differences and result in negative CI on other borders (the overall CI is positive and much higher than in 1A);
4. As shown in example in Option 1B, there are additional flows (and CI) on the borders SE4-PL and DE/CZ/SK-PL (import to PL), but there is also non – intuitive flow on PL-LT border resulting in negative CI: CI = [35 €/MWh- 50 €/MWh] x 500 MWh = - 7 500 €;
5. Negative CI may occur on any PL border (in CCR CORE, CCR Baltic or CCR Hansa).
6. Due to AC active in PL, price in PL is "artificial" and border CI calculated with its use, doesn't fully reflect market situation and actual flows between BZs adjacent to PL.
7. In general, the example in option 1B shows, that: (1) there is social welfare increase (2) negative CI on one border, (3) additional CI resulting from increase of flows and active AC in PL on other borders.
8. Therefore, CI on PL borders should be properly re-distributed. This means, there is a need to implement solution allowing to shift CI between CCRs;
9. According to approved CACM CIDM:
    - CI attributed to a bidding zone border shall be calculated as the absolute values of the product of the commercial flow multiplied by the market spread.
    - In case the sum of congestion income attributed to all bidding zone borders within a CCR is not equal to the total CI generated by electricity exchanges within a CCR, the CI attributed to the bidding zone borders within a CCR (and external borders where relevant) shall be adjusted proportionally in order to match the total CI generated by electricity exchanges within a CCR.
10. The above means, that according to current CIDM, the negative CI on one border of PL would be distributed within single CCR, while the proportionally higher CI on other borders resulting from AC active in PL and "artificial" price in PL, would not be shared (as shown on the example, negative CI on PL-LT would be compensated by other borders from Baltic CCR, while the proportionally higher CI on borders in Hansa and CORE due to active AC in PL would remain untouched).
11. The large amount of CI and the unpredictability of occurrence, where a CCR is sometimes on the "winner side" and sometimes on the "loser side", lead to not fully correct CI sharing across CCRs and within CCRs when applying the principles as in the current version of CIDM.
12. Technically implementation of current version of CACM CIDM is possible, however would work as described above - not fully correctly when AC in PL are active.
13. Therefore, a CI sharing/shift system between CCRs should be put in place for a fully correct solution and fair CI distribution.
14. In CCR CORE, (FBA) source of negative border CI may be either cross-CCR AC or FB optimisation – difficulty/need to properly distinguish between them when establishing the enduring solution.