European Network of
Transmission System Operators
for Electricity

CACM Congestion Income Distribution methodology – Explanatory note

Explanatory note on 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

30 June 2023

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"). After subsequents amendments to include different improvements and updates, the last proposal for amendment of the CACM CIDM was approved by the Agency for the Cooperation of Energy Regulators (hereinafter referred to asthe "ACER") on 17 December 2021 pursuant to Article 9(12) of the CACM Regulation. In their Decision, ACER requested all TSOs to submit a new proposal for amendment of the CACM CIDM providing solutions addressing unintuitive flows irrespective of their causes and also including the transfer of congestion income between CCRs no later than 18 months after the date of issuance of the decision

This document is an explanatory note accompanying the all TSOs proposal for amendment of the CACM CIDM which aims at describing the technical background of the different changes introduced, which are:

1. To include changes to provide solutions addressing unintuitive flows irrespective of their causes and also including the transfer of congestion income between CCRs.
2. To include new additional principles to distribute the congestion income resulting from the allocation process of cross-zonal capacity for the exchange of balancing capacity and/or sharing of reserves in accordance with All TSOs proposal to harmonise the methodology for the allocation processes of cross-zonal capacity for the exchange of balancing capacity or sharing of reserves per timeframe.
3. To include the necessary changes to allow the 15 min MTUs.
4. Other general changes to improve the methodology formulation.

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.

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.

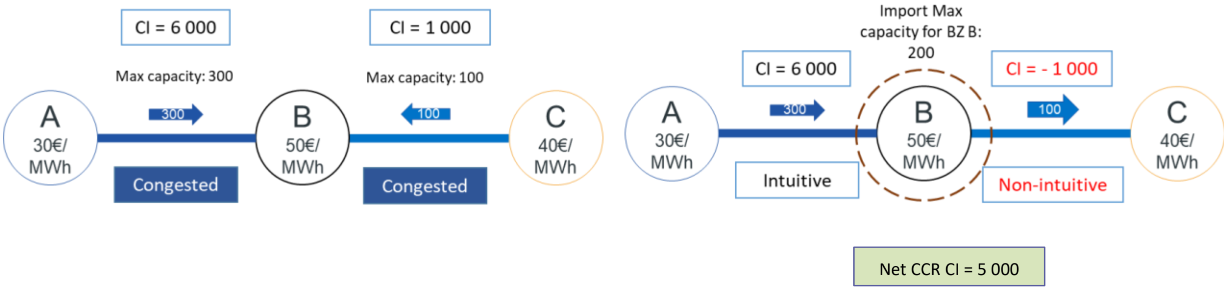
II. Main changes

1. Addressing unintutive flows

Unintuitive flows (flows from a high price to a low price bidding zone) are a result of the market optimisation to achieve the highest social welfare.

Independent borders

Interdependent borders



In the previous CID methodology, negative CI resulting from unintutive flows was socialised within the respective CCR in which it occurred by the application of the absolute value rule and scaling factor. Therefore, the methodology did not address the transfer of congestion income among different CCRs in case on unintutive flows. In this amendment TSOs have analysed the possible situations that create unintutive flows and their impact and developed a proposal to address them accordingly.

Possible situations of unintuitive flows to be addressed:

- **With impact inside a CCR**
  a. Unintuitive flows due to Flow-based Plain;
  b. Unintuitive flows due to internal allocation constraints;
  c. Unintuitive flows due to ramping constraints.
- **With impact across CCRs**
  d. Unintuitive flows due to Advanced Hybrid Coupling (AHC);
  e. Unintuitive flows due to cross-CCR Allocation Constraints.

i. With impact inside a CCR:

The different reasons for unintutive flows within a CCR could be:

a. Unintuitive flows due to Flow-based Plain;

Unintuitive flows inside a CCR can happen due to the flow-based mechanism (FB plain), where there is one capacity domain provided for the whole CCR. Due to that, the SDAC algorithm is able to optimize the MC process by considering the whole Domain at once. This can lead to unintuitive flows, which in the end provide the maximization of the overall economic welfare of the CCR. Unintuitive flows can also happen in an NTC CCR where negative ATCs (i.e. enforcing flows to alleviate overloads) are used.

b. Unintuitive flows due to internal allocation constraints;

If the allocation constraint is only applied on borders within the same CCR (i.e. allocation constraints in CCR Italy North), unintuitive flows can occur, but there is no cross-CCR CI shift due to the fact, that the allocation optimization is only done within borders of the same CCR.

c. Unintuitive flows due to ramping constraints;

Ramping constraints are applied for some HVDC interconnectors to handle the frequency stability in certain areas (e.g. Nordic CCR). In some cases the ramping restrictions are applied to some CCRs to ensure frequency stability in other CCR, an example is ramping restrictions being applied to the Hansa CCR to ensure frequency stability in the Nordic CCR.

A ramping restriction limits the allowed change in flow from one MTU to the next MTU to a certain level. This could result in a situation that the change of flow on a BZB is limited in a way that change of direction of the flow is not possible from one MTU to the next MTU. This could result in a unintuitive flow.

In the example in the figure below, the flow change from one MTU to the next MTU is restricted to 300 MW. In case the flow on the interconnector or the BZB is higher than 300 MW, the ramping constraint limits the change of the flow direction from one MTU to the next MTU. In this case, it results in a unintuitive flow of 700 MW.

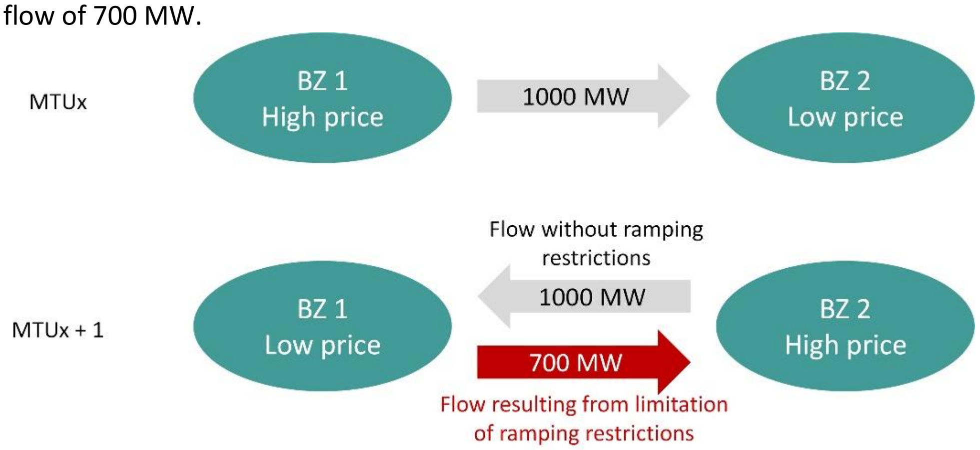


Figure 1. Example of application of ramping constraint

ii. With impact across CCRs:

Previous CACM CIDM did not sufficiently address the transfer of congestion income among different CCRs in case of unintuitive flows. While the market coupling as market optimisation for all bidding zones could lead to unintuitive flows and to influence elements between neighbouring CCRs (interdependent bidding zone borders), the previous calculation and distribution of congestion income was established at a CCR level. This could lead to a transfer of CI from one CCR to an adjacent one and to its later socialisation among the CCR, instead of across the CCRs.

For this amendment, TSOs have analysed the different allocation mechanisms with cross-CCR impact leading to such a transfer of congestion income among different CCRs, these being:

d. Unintuitive flows due to Advanced Hybrid Coupling (AHC):

Hybrid coupling (HC) is a method that refers to the combined use of Flow-Based (FB) and Available transmission capacity (ATC) in one single capacity allocation mechanism. It can be applied for coupling between two bidding zones where one is outside of the Capacity Calculation Region (CCR) and both bidding zones are in the same implicit market. Also, it can be applied for borders with DC and/or AC interconnectors .

Hybrid coupling can be designed as Standard or as Advanced. The Standard Hybrid Coupling is based on the forecast of the exchanges, while the Advanced Hybrid Coupling is PTDF based. Both of the variants are based on developments done in the CWE region. SHC approach is currently in use in the Core region with a plan to switch to AHC.

- In the SHC approach exchange over a border with a BZ outside of the own CCR is forecasted in advance of market coupling in the Single Day Ahead Coupling (SDAC). The forecast is included in the Individual Grid Model (IGM) / Generation Shift Key (GSK) as a fixed feed-in/feed-out. SDAC exchange on the border between two bidding zones is allowed to be in the range from 0 to ATC but limits caused by the impact on the flow on the Critical Network Element and Contingency (CNEC) are neglected. Also, in SHC there has to be some margin of reserve introduced for safety which leads to underestimation or overestimation of forecasted cross-CCR exchange. This has an impact on welfare losses or the risk of overheating.
- In the case of the AHC approach which is based on PTDFs that map the impact of exchanges with neighboring CCRs on the flow of the CNECs during market coupling. This allows AHC to be used for coupling between FB and ATC areas with DA cables, coupling between FB and ATC areas with AC connection, or for coupling between FB and ATC areas with both AC and DC connections. A major advantage of AHC over SHC is that there is no need for a margin of reserve on FB CNECs because of the PTDF approach. This leads to more efficient capacity allocation and flows depicted closer to reality and thus higher socioeconomic welfare. For switching from SHC to AHC introduction of Virtual Hubs (VH) is needed. The virtual hub represents the imports/exports from one BZ outside of their own CCR. CCR computes PTDFs with its own tooling that maps the changes of flows on its CNEC based on the NP of the VH. PTDFs are computed as zone-to-slack PTDFs for the respective CCR. For GSK and IGM of BZ outside of CCR, assumptions might be used that no data provided by foreign CCR is required, as in the current FB DA CC.

  Market Coupling “sees” the impact that a change in the cross-CCR imports/exports has on the utilization of CNECs in the CCR. Neighboring CCR could introduce the AHC with the same concept and vice versa hence, Market Coupling implicitly derives imports/exports optimizing the overall social welfare.

In the AHC we can also have two possibilities which are single-sided AHC or double-sided AHC:

- In the case of the single-sided AHC we have coupling between CCRs where one side is ATC border and the other is FB border.
- In the double-sided AHC we are coupling two CCRs that are on their own FB and have an ATC connection in between.

e. Unintuitive flows due to cross-CCR Allocation Constraints

Unintuitive flows can also occur due to cross-CCR allocation constraints (AC), applied by some BZs that have borders in different CCRs. In such cases, an unintuitive flow on a border in one CCR may increase exchanges in another CCR, resulting in higher social welfare and congestion income for that CCR. For example, this situation arises in Poland, which has borders within CORE CCR (PL-DE, PL-CZ, PL-SK), HANSA CCR (PL-SE4) and BALTIC CCR (PL-LT).

The approved Capacity Calculations Methodologies (CCM) for CORE CCR, HANSA CCR and Baltic CCR foresee the implementation of AC 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 allow for energy exchanges/transits through BZ applying AC, even though net export or import of such BZ is limited. Otherwise the available capacity for the market would have to be limited. However, as mentioned before, the application of AC may increase intuitive flows on borders in one CCR, resulting in positive CI but also increase unintuitive flows on other borders in other CCR(s), resulting in negative CI for that CCR (overall multi-CCR CI stays positive).

This issue is addressed in the methodology in details 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. Nevertheless, the solution concerning negative CI resulting from cross-CCR AC should be compatible with the solution concerning AHC as both mechanisms lead to similar effects and can be addressed hich filter out the impact of this mechanism on calculation of Congestion Income.

iii. Possible solutions

Solution for addressing unintuitive flows with impact inside a CCR – The absolute value and scaling

In principle, negative congestion income generated on the borders with unintuitive flows whose impact is inside a CCR should be paid from congestion income on other borders inside a CCR where the congestion income is higher thanks to these unintuitive flows. However, currently it is still not possible to find solution which could clearly and unambiguously identify beneficiaries of unintuitive flows in this case – including the solution on transit flows proposed for analysis by ACER. As unintuitive flows contribute to the maximization of the economic welfare within the entire CCR, the current implementation of absolute value rule for all borders inside a CCR and rescaling of the total CCR congestion income is deemed as the most fair and transparent solution which is accurate enough and thus accepted by all TSOs. Absolute value rule means that allocation of congestion income is based on the absolute value of the product of commercial flow and market spread on a border, thus avoiding negative congestion income on a border with unintuitive flow, as formulated in Article 7.1.

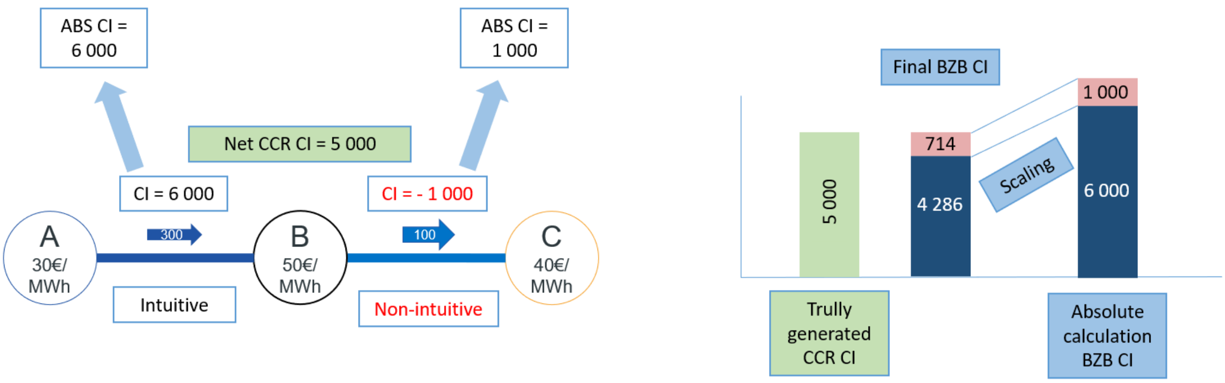


Figure 2. Explanation of the absolute value and scaling

Solution for addressing unintuitive flows with impact cross-CCR – Virtual hubs

A consequence of the implementation of AHC or the consideration of cross-CCRs allocation constraints? is that unintuitive flows, and thus negative congestion income, may occur in a CCR due to trades in an adjacent CCR. In such cases, the current CIDM prescribes that the negative congestion income is socialised within the affected CCR rather than within the CCR that benefit from the unintuitive flow. In this amendment to the CIDM, the TSOs propose a mittigation based on the AHC-metodology that is to be implemented in both CORE and the Nordics.

With the application of AHC or the consideration of cross-CCRs allocation constraints, HVDCs (and radially connected ACs grids between FB areas) are modelled by virtual bidding zones (or ”virtual hubs” as defined in the methodology) inside the home-BZ and the HVDC itself. The virtual hubs have PTDFs to monitor flows in the connected AC grid that is induced by the HVDC, and the HVDC itself is represented by the equivalent NTC. The AHC setup can be applied to either one or to both sides of an HVDC as illustrated in the figure below.

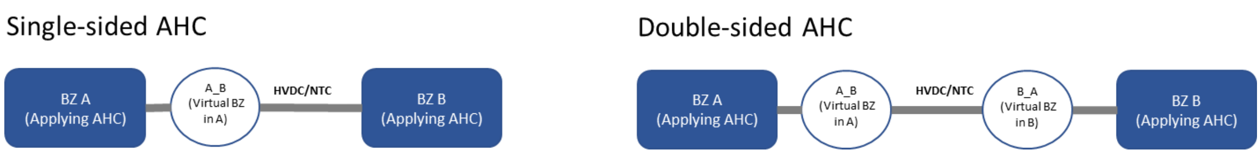


Figure 3. Representation of Virtual Hubs or Virtual Bidding Zones in single-sided AHC (left) and double-sided AHC (right)

In general, AHC is modelled using virtual hubs without any load/generation. In this case, the pricing of the virtual hubs follows the principles of flow based pricing. More precisely, the link between the shadow price of the constraining net elements and the PTDFs of different hubs will determine the price relations between hubs according to the formula below, expressed via vectors:

$$P_{Hub\ A} - P_{Hub\ B} = Shadow\ Price_{Constraining\ branch} \times (PTDF_B - PTDF_A).$$

Even though there are no sale- or buy-bids in the Virtual Hubs (VH), VH prices are defined by the same conditions as prices in a regular BZ:

$$P_j = \lambda - \sum_{o} \mu_o^{CNEC} \cdot PTDF_{o,j}$$

with

P_j clearing price of a virtual bidding zone j resulting from the SDAC

λ shadow price associated with constraint on regional balance (sum of regional net positions equal to zero)

$PTDF_{o,j}$ power transfer distribution factor for bidding zone *j* on CNEC o

μ_o^{CNEC} shadow price of CNEC *o*

The equation above defines the price P_j in BZ_j by the marginal cost of delivering power in the slack-zone (λ - shadow price associated with constraint on regional balance) in the local flowbased area, the shadow-price on limiting CNECs (μ_o^{CNEC}) in the local flowbased area and the PTDFs of BZ_j. Because the PTDFs of the VHs differs from the PTDFs of the home-BZ, the VH-prices will differ from the home-BZ price. This is reflected under Article 6.3.

In order to properly determine CI for BZBs and CCRs applying AHC, there is a possibility to use the spread of prices calculated for each virtual hub. Using prices from VHs would allow to properly distribute the CI between the BZs on the same border under the influence of AHC. This approach would correctly assign the unintuitive CI to its source and beneficiary CCR. At the same time, consideration of the absolute value rule and scaling factor would be still applicable within each CCR when addressing unintuitive flows within the CCR and unintuitive flows assigned to it due to the AHC.

Thus, in the single sided AHC setup, there will be three potentially different prices, while in the double sided setup, there will be four potentially different prices. Due to AHC, the congestion income on an interconnector between BZ-A and BZ-B can be split into several parts.

CI on the the border beetwen BZ A and BZ B is divided into two parts as presented on Figure 4.

In case of single sided AHC, the price difference between the VH and a BZ in the region applying flow-based arises solely from congestions in the region applying flow-based. Hence, it is reasonable that this part of the CI is allocated to the region applying flow-based. Additionally, if the unintuitiveness appears on the border between VH and BZ applying flow based, it is reasonable that it would be covered by the region aplying flow-based, because there is a social welfare gain in this region due to this unintuitive flow. The **ATC** part of the **CI is always positive** and only arises if there is congestion on the ATC line.

- flow based part (between BZ A and A-B virtual hub)

$$CI = (P_A - P_{A-B\,VH}) * AAF_{A-B\,VH}$$

and

- ATC part (between A-B virtual hub and BZ B).

$$CI = (P_{A-B\,VH} - P_B) * AAF_{A-B\,VH}$$

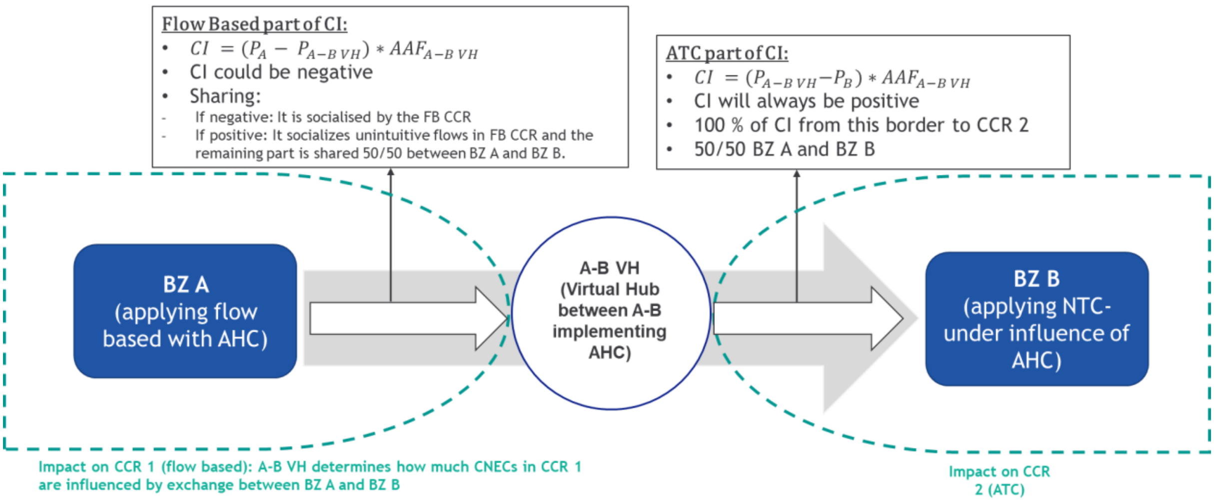


Figure 4. Solution in the case of Single Sided AHC

An example of the CI distribution for a single sided AHC is presented in Annex 1.

In case of double-sided AHC, there is a similar situation to that of one-sided AHC, with the difference being that there are two VHs present, each representing the influence of exchange on CNECs in one of the adjacent flow-based regions. In this case, the CI on the BZB is divided into three parts: two flow-based parts and one ATC part (the middle one on the Figure 5). (The flow in Figure 5 is assumed to be from BZ-A to BZ-B).

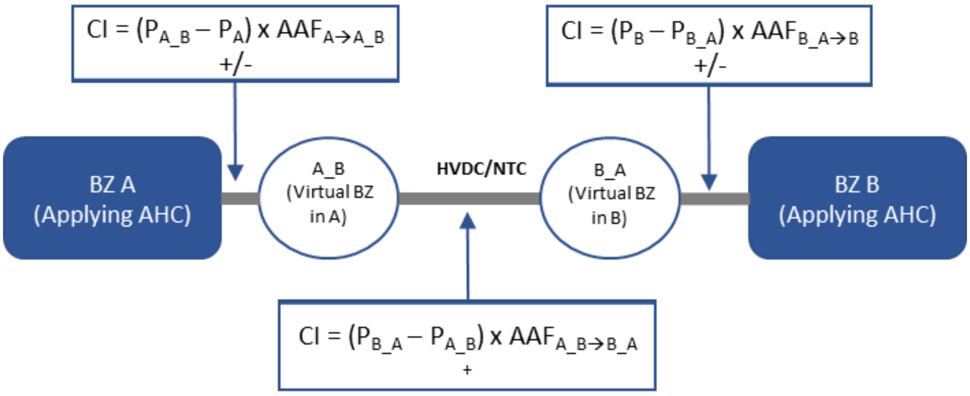


Figure 5. Solution in the case of Double Sided AHC (1/2)

The CI for the HVDC is represented by an NTC and cannot be negative, only zero or larger. The two flowbased part of the HVDC however can be either positive or negative (or zero). Thus all negative CI will remain inside an FB-area, while the CI between the two VHs, which always is positive or zero, might be located either inside one of the two FB-areas or, as in case of the Nordic, Hansa and CORE configuration, inside Hansa.

The final attributed CI between the home-BZ and the VH on either side of the HVDC should be distributed 50/50 (or the agreed fraction) between the TSOs sharing the HVDC. The CI between the two VHs should be shared 50/50 (or the agreed fraction) between the two TSOs sharing the HVDC.

The ATC part of the CI is shared among the the TSOs attributed to the BZB according to the sharing keys defined in this methodology. The flow-based part of the CI is distributed according to the following rules:

- if positive, it participates in socialisation of a relevant flow-based CCR and the remaining part is shared 50/50 between BZ A and BZ B.
- if negative, it is shared in the flow-based CCR (CCR 1), affecting the total CI of the CCR 1 and thus the scaling factor.

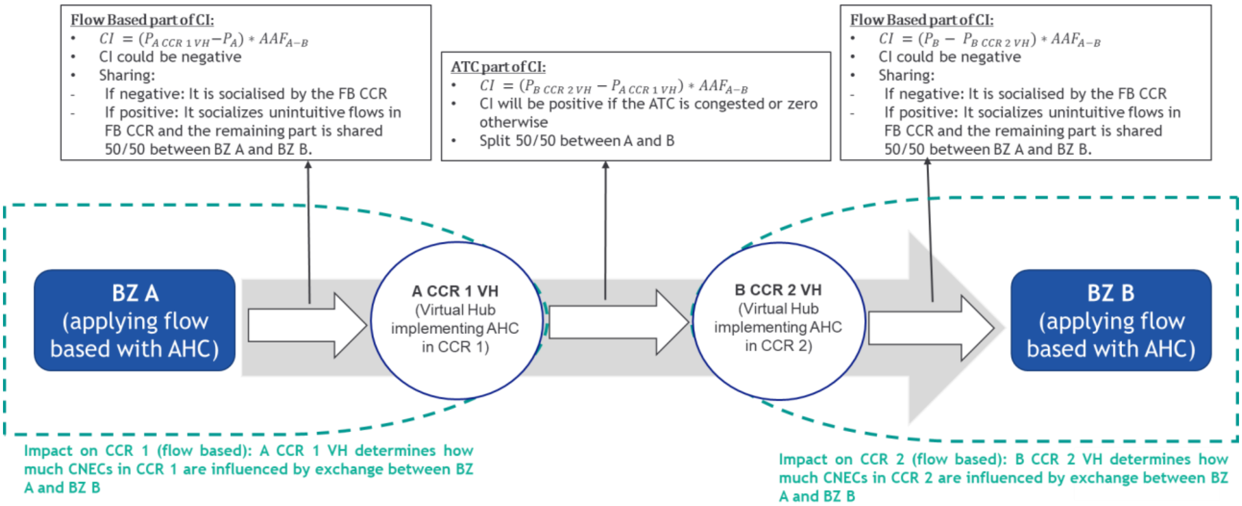


Figure 6. Solution in the case of Double Sided AHC (2/2)

Influence of cross-CCRs allocation constraints

Additionally, the CACM CIDm also needs to address the negative CI resulting from cross-CCR ACs. Cross-CCR ACs can be modelled using a virtual hub and a transmission capacity constraint between the physical zone and the virtual hub, representing the AC. When calculating the CI distribution, the price from the virtual hub should be taken into account for MTUs in which the AC is active. The price from the virtual hub represents the price of the hub after filtering out the AC effect. In CI per border calculation, the price from the physical BZ, applying AC, is replaced by the price from the virtual hub, which allows the exclusion of the impact of active AC on CID. Bidding Zone Borders linked to the Bidding Zone applying ACs would therefore receive the CI based on the market spread calculated with the adjusted price. Consequently, an additional pot of CI is gathered on the border between the physical zone and the virtual hub, referred to as the "additional pot."
This is reflected under Article 6.4.

The additional pot serves as a reward for borders that would have gained CI if there were no allocation constraints. In the case of an active export AC, a zone would export more, but the exporting directions are blocked. Similarly, if an import AC is active, the zone would import more. For the sake of simplicity, let's assume that the AC is active in the exporting direction for a specific zone.

The additional pot is distributed as follows:

1. First, we identify the exporting borders of the zone.
2. Then, we allocate the additional pot to these borders based on the CI gathered on each respective border. For example, if the AC is active in the exporting direction for the zone and the additional pot is equal to 100 €, while the exporting directions from the zone are Border A and Border B, where we have gathered 700 € and 300 € respectively (after the application of scaling), we will allocate 70% of the additional pot to Border A and 30% to Border B.
3. Next, the CI on these borders will be increased by their share of additional pot and take part in scaling of negative CI. In the end, the scaled values will be divided between the TSOs according to the defined sharing key.

An additional example of the CI distribution for a cross-CCRs allocation constraint is presented in the Annex 2.

Therefore, the proposed solution substitutes the need for an agreement to redistribute CI by TSOs whose CI share wass distorted by unintuitive flows due to the application of AC (i.e. agreement concluded between CORE TSOs-Svenska Kraftnat-Litgrid).

2. EBGL

Within the current amendment, also the impact of allocation process of cross-zonal capacity for the exchange of balancing capacity and/or sharing of reserves in accordance with All TSOs proposal[1] to harmonise the methodology for the allocation processes of cross-zonal capacity for the exchange of balancing capacity or sharing of reserves per timeframe in accordance with Article 38(3) of the Commission Regulation on (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing needs to be considered.

The approach slightly differs for coordinated NTC and Flow-based CCRs. In order to include this additional CI pot, we have amended the following Articles:

- **Whereas section:** A short description of what needs to be done.
- **Article 1.1f:** to include the additional CI pot into the CID process.
- **Article 2.2:** Added the information, that the Commercial flow is composed of the flow resulting from SDAC or IDA but also from the allocation of CZC for balancing. In order to correctly distribute the CI from balancing, the Commercial flow resulting from the EB regulation shall be considered separately.
- **Article 3.5:** The additional CI pot resulting from the EB regulation shall be provided by application TSOs separately per product. This means separately for mFRR (+/-), aFRR (+/-), RR (+/-).
- **NEW Article 5:** For the calculation of Commercial flows resulting from the allocation of CZC for balancing for a FB region (AAFs), in the first step, the allocated CZC for balancing shall be translated into Net positions.

  In the example below (which shows exchanges and sharing of reserves for aFRR+) it is explained the calculation of net positions as described in Artcile 5.2., The three different bidding zones have demands of 650 MW, 442 MW and 700 MW. The overall demand of the complete region is therefore 1792 MW, but due to sharing of reserves the overall procured volume could be reduced to 811 MW. In order to calculate the net positions, first an adjusted demand is calculated per bidding zone by scaling the original demand down to the overall procurement volume
  - BZ A = 650 MW * (811 MW/1792 MW) = 294 MW
  - BZ B = 442 MW * (811 MW/1792 MW) = 200 MW
  - BZ C = 700 MW * (811 MW/1792 MW) = 317 MW

  The net positions are now calculated from the adjusted demands and the locally procured volume:

[1] All TSOs proposal was submitted on 16 December 2022 and at the time of writing this explanatory note and its related proposal for amendments the ACER's Decision is still pending.

- NP_A = 419 MW - 294 MW = 125 MW
- NP_B = 262 MW – 200 MW = 62 MW
- NP_C = 130 MW – 317 MW = -187 MW

The further provision in Article 5.2 *"Net positions need to reflect the import or export characteristic of the allocated product" is explained in the example below:*

- *Procurement of aFRR+ , BZ A exports to BZ B 10MW, resulting in BZ A NP: +10MW, BZ B NP: -10MW*
- *Procurement of aFRR- , BZ A exports to BZ B 10MW, resulting in BZ A NP: -10MW, BZ B NP: +10MW*

The information of CZC allocated for balancing and the calculations of AAFs shall be performed separately per product and direction (aFRR +/-, mFRR +/-, RR +/-).

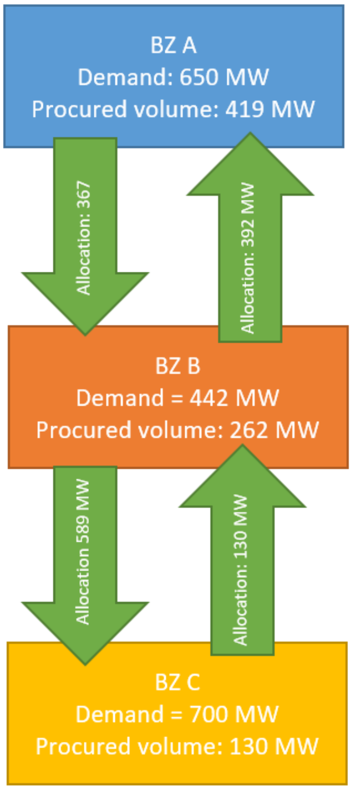


Figure 8. Example of exchanges and sharing of reserved for aFRR+

There is a special case in reserve sharing, when reserve schedules are balanced (i.e. zone A provides 10 MW to zone B and zone B provides 10 MW to zone A) and no balancing capacity is exchanged. In such a special case, the resulting NPs are equal to zero, which leads to AAFs being equal to zero. If there would be CI due to reserve sharing, it would be possible to apply such AAFs, whatwould lead to a division by zero. In such case, all AAFs assumed to be equal, which simply results in CI distribution according to price spread. This is formulated in Article 5.4 by: "In case all AAF in given CCR for given product are equal 0 then all AAFs should be equal to 1 for this CCR and this product".

- **Article 7.4:** The calculation of CI due to application of CZC for balancing is slightly different for CCRs applying a coordinated NTC approach and for CCRs applying the FB approach.

  For CCRs applying a coordinated NTC approach the CI is calculated based on the amount of allocated CZC for balancing multiplied by the Price of the CZC for balancing. It shall be calculated separately per product. There are different methods of allocating CZC for balancing (exchange of balancing capacity or sharing of reserves). There can also be marginal pricing applied or pay as bid. Due to that, the price of CZC for balancing can be defined in different ways:

1. For exchange of balancing capacity
    a. Market based with marginal pricing and Co-optimization: BC price spread [Art 21(2)*[2]]
    b. Market based with pay-as-bid: Forecasted Day-Ahead spread [Art 21(3)*]
    c. Inverted market based: Forecasted BC price spread [Art 21(4)*]
2. For sharing of reserves
    a. If there is exchange of BC in the same direction (of the same BC product)
        i. BC price spread [Art 21(6)*]
    b. If no exchange in the same direction happens
        i. Co-Optimization, inverted market based: Day-Ahead spread [Art 21(5)*]
        ii. Market based: Forecasted Day-Ahead spread [Art 21(5)*]

Based on the different options being applicable, in the Coordinated NTC approach, the prices of the CZC for balancing shall be provided by the application TSOs.

For CCRs applying the FB approach this is slightly different due to the fact that allocated CZC for balancing do not only impact the BZB where allocation has been applied but it impacts the whole FB domain. To calculate the CI on a border basis, the calculated AAFs (based on Article 5) shall be multiplied with the SDAC market spread on the relevant BZB and MTU. If the sum of CI from balancing on all BZBs is not equal to the actual balancing pot as defined in Article 3.5, a proportional adjustment shall be made in order to match the total CI from balancing.

A check on the sufficiency of the transferred congestion income per each BZB procuring capacity shall be performed on a monthly basis. If the transferred congestion income is lower than what would have been generated in the day-ahead market, this is then compensated by the application TSOs. In NTC CCRs, it is assigned to the relevant BZBs while for the CCRs applying the FB approach it is shared between all CCRs BZBs based on the average final congestion income during the monthly period per MTU. There is a different approach for the FB CCRs due to the fact that procuring capacity for balancing on one BZB impacts all CCR's BZBs. We assume this will happen rarely and to avoid a recalculation over the whole month the pro-rata sharing is chosen.

- **Article 7.5** introduces a modified market spread with the aim to ensure sufficiency of transferred congestion income due to BZB procuring capacity according Article 38(3) of EB Regulation.

[2] Methodology for a harmonised allocation process of cross-zonal capacity for the exchange of balancing capacity or sharing of reserves per timeframe in accordance with Article 38(3) of the Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing

In practice, it is possible that the CI obtained from DA and EB is insufficient to cover costs related Long-Term-Financial Transimission Rights (FTRs) in case inclusion of LTA in flow-based domain is not considered. This situation might also impact fairness of CI from DA because the energy prices do not fully represent the value of capacity used for balancing purposes. Therefore, compensation from TSOs who reserve capacity for the EB is required. The formula for calculating the amount of CI that would have been generated in the DA must utilize the modified price spreads. This is because when allocating reserves, we do not consider the relief of flows on CNECs. In this case, we need to consider the worst-case scenario on the CNECs, as only some reserves may be utilized.

For example possible formula for the modified price spread is presented below, where only the positive elements of the sum are considered:

$$P_A - P_B = \sum_{k \in i} max\left(\mu_k^{CNEC} \cdot \left(PTDF_{k,B} - PTDF_{k,A}\right), 0\right)$$

If the CI pot from EB is less than the modified price spread multiplied by the allocated capacity over the borders on which balancing capacity was allocated, then the difference must be covered by the TSOs using the EB.

All in all, the main reasoning for use of modified market spread in calculation of CI in regards to 38(3) of the EB Regulation (4) is revenue adequacy for remuneration of LTTRs (costs of FTRs).

3. Market Time Unit (MTU) definition

As the definition of "market time unit" included in Art. 2 (19) of Regulation (EU) No 543/2013, to which the reference is made in Article 2 (1) of CACM CIDM, is defining MTU only for bidding zone borders or a pair of two bidding zones. Furthermore, the approach used in Regulation (EU) No 543/2013 is to use the "shortest possible common MTU".

For the application of the CACM CIDM, where there is a calculation step to be done on CCR-level, this approach might (in a very unlikely but not to be excluded case) result in doing this calculation step on a CCR-level on an hourly basis which is not intended as the CID should be based on 15Min MTU granularity wherever possible.

To overcome this and to clarify the understanding of MTU for the application of CACM CIDM the definition of "MTU" is added in Article 2 (2) f of CACM CIDM.

Also, as mentioned there is actually no definition of a "CCR MTU", it might also be good to slightly reword the new MTU definition as follows:

a. *"MTU" means the finest market time unit occurring in the CCR within the given timeframe. If this finest market time unit is not implemented throughout the whole CCR, calculated congestion income values must be divided to match the corresponding finest market time unit breakdown. This definition deviates from the approach used in the Regulations referred to in paragraph 1 of this Article but shall* *be applicable solely within the application of this methodology.*

4. Other general changes

The methodology has updated some of the previous formulas to harmonise the formulation across the document (i.e. Formulas in Articles 3 and 4). The modifications do not modify the original meaning or purpose of them.

5. Future amendments

For the time being there is no possibility to fully study the effect of the proposed solutions and their behaviour in conjunction with other mechanisms on real data. Therefore, the proposed amendments to the CACM CIDM are based on theoretical assumptions and analysis of theoretical cases in simplified models only.

In order to identify and potentially fix possible shortcomings of the methods suggested in this amendment, a continuous assessment is needed. Future amendments to the methodology, based on experiences gained during the development phase, testing phase (parallel run) or after the first year of implementation, may be needed to ensure the objectives defined in the CACM regulation.

In addition, he current amendment proposal does not address future offshore bidding zones where AHC is expected to be applied for which a future amendment may be needed.

Annex 1

Example of a CI distribution addressing unintuitive flows with impact across CCRs caused by a single sided AHC presented on a fictional 14 node network - see figure below:

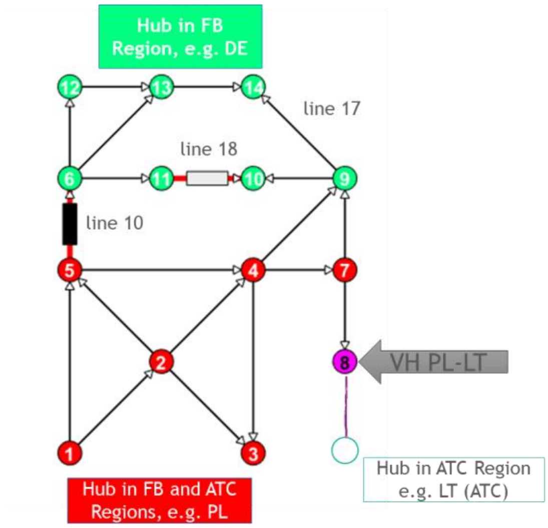


Figure 8. Scheme of a 14 nodes network representing a single-sided AHC

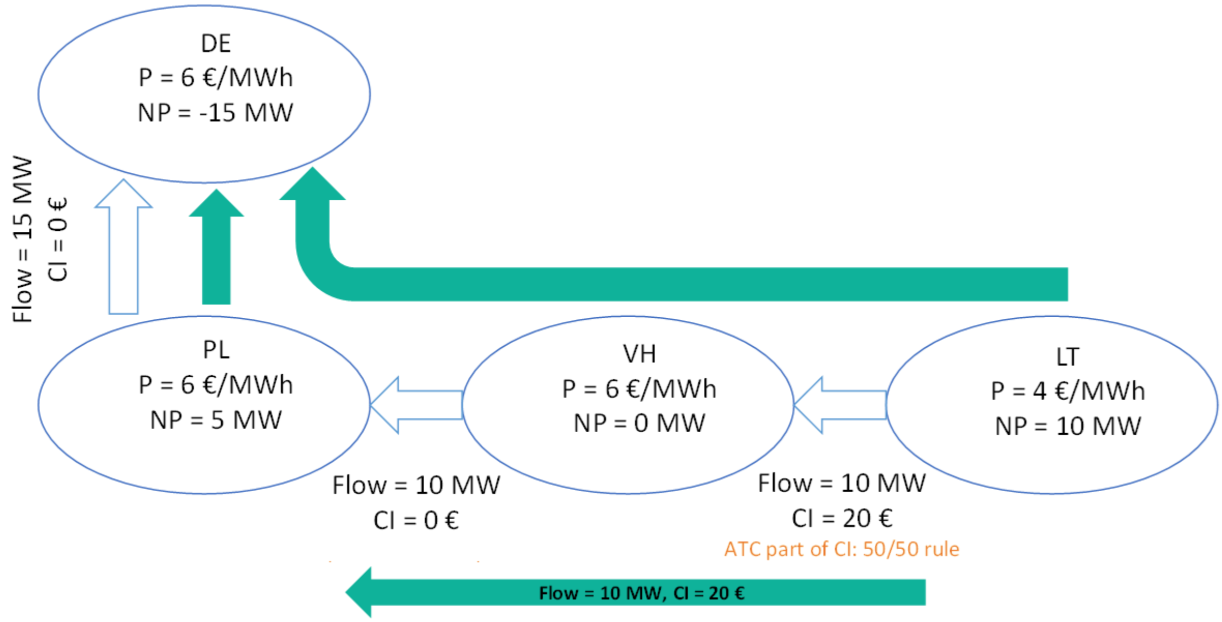
Considered cases:

1. No congestion in the FB area, with an intuitive flow from Lithuania to Poland where the ATC part is congested (see figure below).
2. Congestion in the FB area, with an intuitive flow from Lithuania to Poland where the ATC part is congested (see figure below).
3. Congestion in the FB area, with an intuitive flow from Lithuania to Poland where the ATC part is congested. However, the price in the VH is higher than in both Lithuania and Poland (see figure below).
4. Congestion in the FB area, with an unintuitive flow from Lithuania to Poland where the ATC part is congested and the VH price is higher than in both Lithuania and Poland.
5. Congestion in the FB area, not congested ATC part, with an intuitive flow from Lithuania to Poland
6. Congestion in the FB area, not congested ATC part with an unintuitive flow from Lithuania to Poland

All cases consider the following:

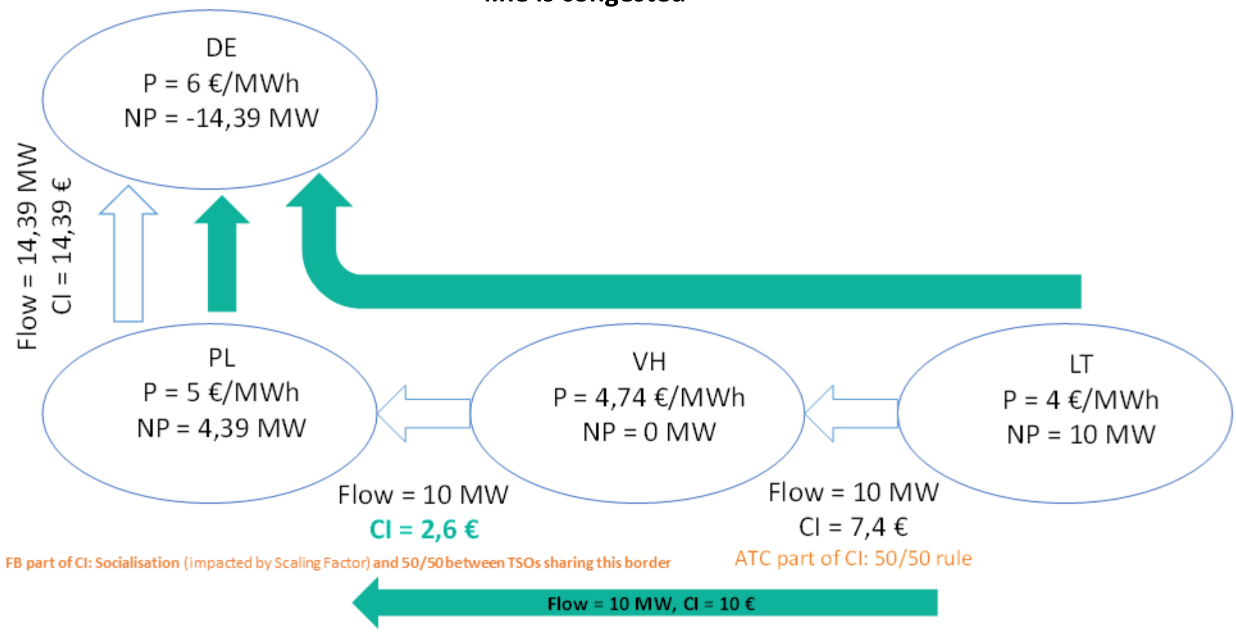
CORE positive CI from other borders	CORE negative CI from other borders	CORE CI from other borders	Sum of abs value CI from other borders	SF in only other borders
100	10	90	110	0,818182

Case 1: No congestion in the FB area, with an intuitive flow from Lithuania to Poland where the ATC line is congested



SF CORE	50Hertz	PSE Core	PSE Baltic	Litgrid	SUM	PSE	50Hertz	Litgrid	SUM	CI PL-LT
0,818	0	0	10	10	**20**	10	0	10	**20**	20

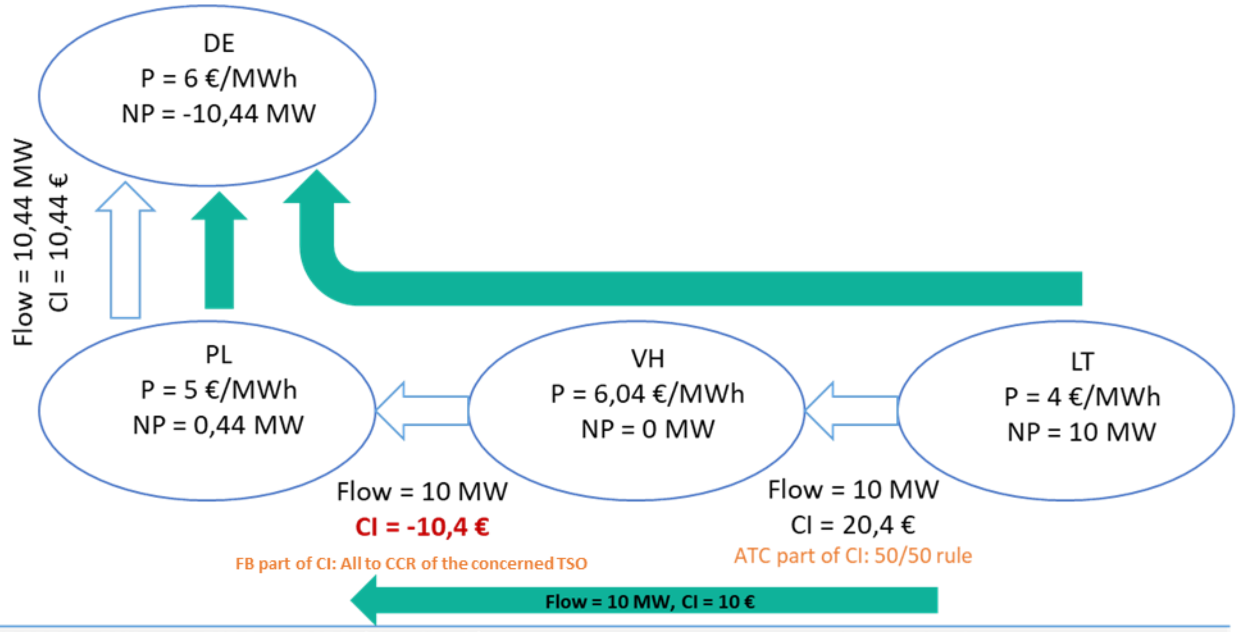
Case 2: Congestion in the FB area, with an intuitive flow from Lithuania to Poland where the ATC line is congested



SF CORE	50Hertz	PSE Core	PSE Baltic	Litgrid	SUM	PSE	50Hertz	Litgrid	SUM	CI PL-LT
0,843	6,062	7,157	3,7	4,795	**21,714**	10,857	6,062	4,795	**21,714**	9,591

In this case CI in the flow-based part equals to 2,6 € (highlighted in green) and therefore, it takes part in the socialization in the CORE region and is shared 50/50 between the TSOs sharing this border.

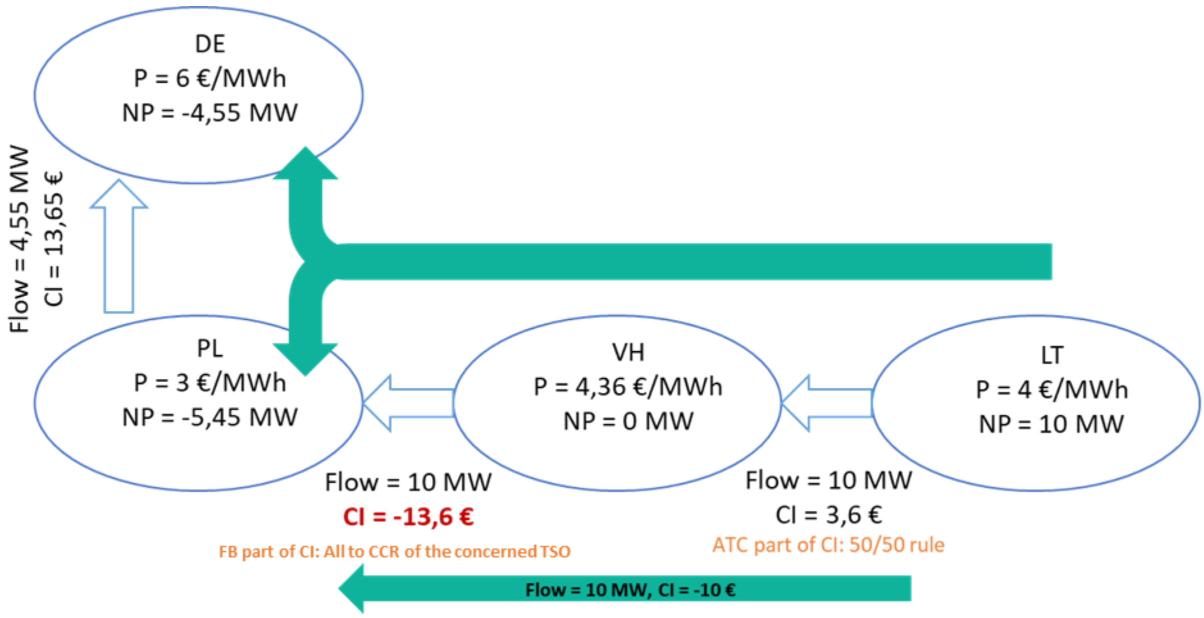
Case 3: Congestion in the FB area, with an intuitive flow from Lithuania to Poland where the ATC line is congested. However, the price in the VH is higher than in both Lithuania and Poland.



SF CORE	50Hertz	PSE Core	PSE Baltic	Litgrid	SUM	PSE	50Hertz	Litgrid	SUM	CI PL-LT
0,748	3,902	3,902	10,2	10,2	**28,205**	14,102	3,902	10,2	**28,205**	20,4

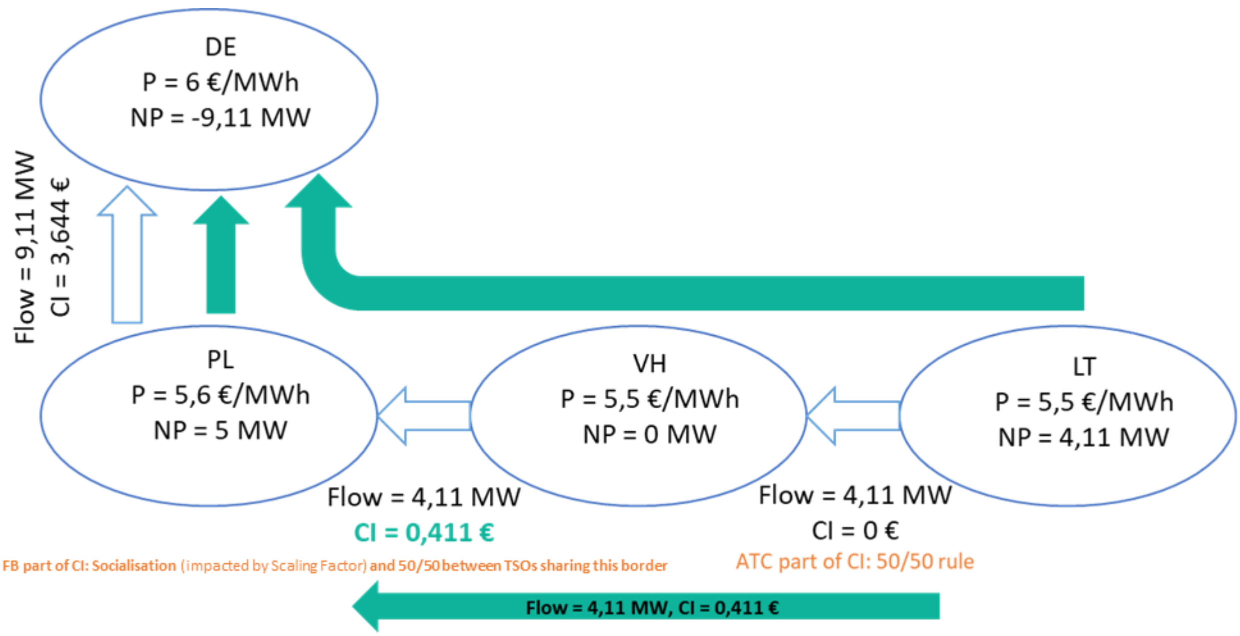
In this case, the CI in the flow-based part equals to -10,4 € (highlighted in red) and therefore, it is attributed to the CCR of the concerned TSO (CCR CORE).

Case 4: Congestion in the FB area, with an unintuitive flow from Lithuania to Poland where the ATC part is congested and the VH price is higher than in both Lithuania and Poland.



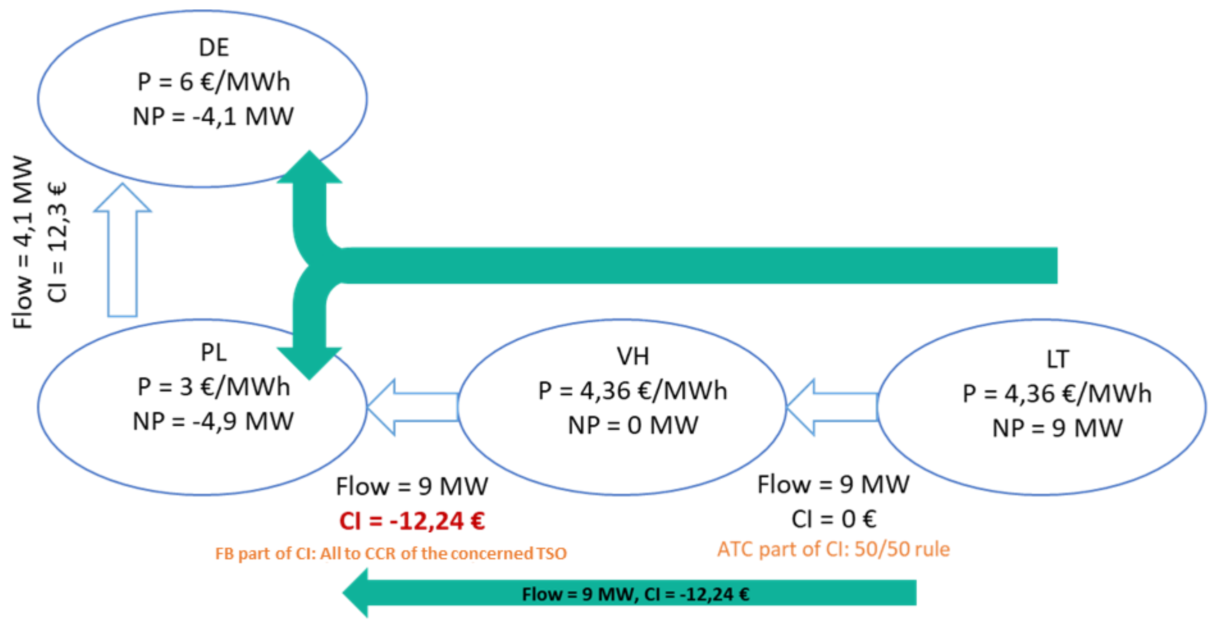
SF CORE	50Hertz	PSE Core	PSE Baltic	Litgrid	SUM	PSE	50Hertz	Litgrid	SUM	CI PL-LT
0,728	4,970	4,970	1,8	1,8	**13,541**	6,770	4,970	1,8	**13,541**	3,6

Case 5: Congestion in the FB area, not congested ATC part, with an intuitive flow from Lithuania to Poland



SF CORE	50Hertz	PSE Core	PSE Baltic	Litgrid	SUM	PSE	50Hertz	Litgrid	SUM	CI PL-LT
0,825	1,503	1,672	0	0,169	**3,344**	1,672	1,503	0,169	**3,344**	0,339

Case 6: Congestion in the FB area, not congested ATC part with an unintuitive flow from Lithuania to Poland



SF CORE	50Hertz	PSE Core	PSE Baltic	Litgrid	SUM	PSE	50Hertz	Litgrid	SUM	CI PL-LT
0,736	4,529	4,529	0	0	**9,058**	4,529	4,529	0	**9,058**	0

Annex 2

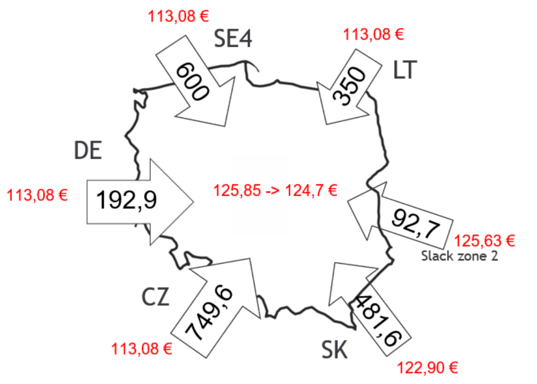
Examples for calculation of CI across CCRs due to cross-CCRs allocation constraints are based on two following models:

- **Model 1** cosidering impact of active cross-CCR allocation constraints before implementation of AHC based on examples with borders around Poland
- **Model 2** cosidering impact of active cross-CCR allocations constraints together with already implemented AHC based on a fictional 14 node network (the same as in Annex 1 above)

Model 1 considering impact of active cross-CCR allocation constraints before implementation of AHC based on example with borders around Poland

Calculation of CI considering impact of active cross-CCR allocation constraints before implementation of AHC, based on example with borders around Poland

Market situation when allocation constraint limits import to Poland



DE-PL, CZ-PL, SK-PL, SZ2-PL borders belong to the CORE CCR using FB
SE4-PL, LT-PL borders belong to Hansa and Baltic CCR respecitvely using ATC

parameter	value
additional pot	2847,21
Overall CI CORE	87734,64
abs value CI	96464,20
Scaling factor CORE	0,9095
Overall CI CORE + add pot parts	89144,49
abs value CI + add pot parts	97874,04
Scaling factor CORE with add pot	0,9108

	LT-PL	SE4-PL	CZ-PL	DE-PL	SK-PL	SZ2-PL
MS*	11,62	11,62	11,62	11,62	1,80	0,93
flow	350,00	600,00	749,69	192,92	481,63	92,76
dir consistent with AC	1,00	1,00	1,00	1,00	1,00	1,00
CI* (not scaled)	4065,56	6969,53	8708,30	2240,91	864,95	86,65
CI* (abs value)	4065,56	6969,53	8708,30	2240,91	864,95	86,65
CI* (scaled)	4065,56	6969,53	7920,24	2038,12	786,68	78,81
Sharing of additional pot	529,55	907,81	1031,64	265,47	102,47	10,27
CI*total (abs value)+add pot	4595,11	7877,34	9739,94	2506,39	967,42	96,92
final CI scaled	4595,11	7877,34	8871,22	2282,84	881,13	88,27

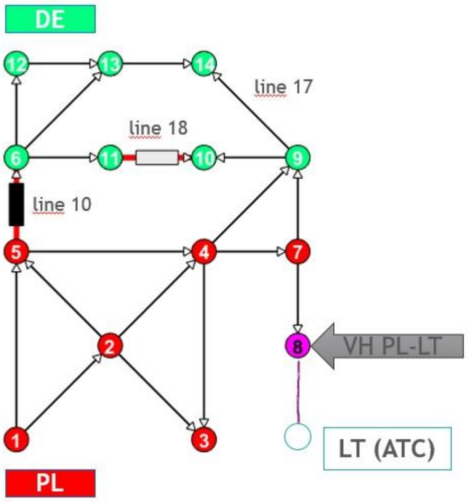
*Means that calculation are performed with consideration of alternative price for PL

Model 2 considering impact of active cross-CCR allocations constraints together with already implemented AHC based on a fictional 14 node network

Example of a CI per border calculation addressing unintuitive flows with impact across CCRs caused by cross-CCRs allocation constraints together with already implemented AHC is presented on a fictional 14 node network (the same as in Annex 1 above) depicted in the following scheme:

Congestion in the FB area, with an unintuitive flow from Lithuania to Poland where the ATC line is not congested

line	PL	DE	VH	RAM-	RAM+	congested
10	-0.01	-0.42	-0.2	-10	10	no
17	0.004	-0.29	0.08	-10	3	yes
18	0.007	0.11	0.12	-10	10	no



We add allocation constraint which made flow from LT to PL unintuitive.
dem_offers= PL: [(15, 100)], DE: [(25, 100)], LT: []
gen_offers = PL : [(20, 5)], DE : [(30, 6)], LT : [(15, 5.5)]

$$0 \leq ATC_{LT-PL} \leq 10$$
$$NP_{PL} \leq 2$$

At the optimal point, the net positions equal:

$$NP_{PL} = 2, NP_{DE} = -8.5, NP_{LT} = 6.5$$

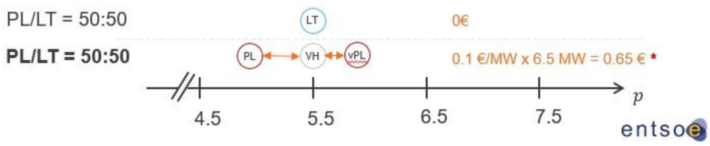
And the prices are as such:

$p_{PL} = 5$, $p_{DE} = 6$, $p_{VH} = 5.5$,
$p_{LT} = 5.5$, $p_{PL\_ALT} = 5.6$

If we use PL_ALT in CI distribution:

$CI_{PL\to LT} = 6.5 * 0.1 = 0.65$
$CI_{PL\to VH} = 0.65$
$CI_{VH\to LT} = 0$
$CI_{DE\to PL} = (6 - 5.6) * 8.5 = 3.4$

$\boldsymbol{addpot = 1.2}$



Sharing of additional pot and calculating the CI per TSO

$$\boldsymbol{addpot = 1.2}$$

1. First, we identify borders where the flow has the same direction as the direction of the cross-CCR AC, which in this case is export.

border	exporting
$PL \to VH$	no
$PL \to DE$	yes

2. Next, we calculate the percentage of additional pot that is distributed to the borders affected by the cross-CCR AC with an aligning direction to the cross-CCR AC. In this case, it is only the border $PL \to DE$.

border	exporting	add_pot_sharing_key	add_pot_share
$PL \to VH$	no	0	0
$PL \to DE$	yes	$\frac{3.4}{3.4} = 1$	$1 * 1.2 = 1.2$

3. Next, we calculate the final CI per border within each CCR.

border	CI accumulated on the border	add_pot_share	final CI
$PL \to VH$	0.65	0	0.65
$PL \to DE$	3.4	1.2	4.6

4. Next, we calculate the total CI in CCR CORE.

$$CI_{CORE} = 0.65 + 4.6 = 5.25$$

5. Next, we calculate the scaling factor in CORE, considering the additional pot parts. Since there were no unintuitive flows present in this case, the scaling factor is equal to 1.

$$SF_{CORE} = \frac{0.65+4.6}{5.25} = 1$$

6. Next, we calculate the scaled CI per border (with inclusion of add_pot parts).

border	final CI	final CI scaled
$PL \to VH$	0.65	$0.65 * 1 = 0.65$
$PL \to DE$	4.6	$4.6 * 1 = 4.6$

The ATC part of the LT-PL border does not take part in the additional pot sharing, unless there is no AHC on this border.

The CI on the ATC part of the border in this example is 0 (because the ATC line is not congested).

border	final CI
$VH \to LT$	0

7. Finally, we calculate the CI per TSO*.

TSO	CI per TSO
PSE	$CI_{PSE} = \frac{1}{2}CI_{scaled,PL\to DE} + \frac{1}{2}CI_{scaled,PL\to VH} + \frac{1}{2}CI_{VH\to LT} = 2.3 + 0.325 + 0 = 2.625$
$50Hertz$	$CI_{50Hertz} = \frac{1}{2}CI_{scaled,PL\to DE} = 2.3$
$Litgrid$	$CI_{Litgrid} = \frac{1}{2}CI_{scaled,PL\to VH} + \frac{1}{2}CI_{scaled,VH\to LT} = 0.325 + 0 = 0.325$

*Be aware that in this simplified example PL has 2 borders, while LT and DE have one border each. That is why most of the CI is distributed to PSE.

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