Congestion income allocation under Flow-Based Market Coupling

CWE Market Coupling

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Introduction

The sharing of the congestion income under Flow-Based Market Coupling (FB MC) between the hubs of the CWE (Central-Western Europe) region is described in this document. This description is only valid for the standard hybrid coupling method. The treatment of remuneration costs resulting from Long-Term Capacity Rights is integral part of the methodology.

Due to the inclusion of the DE-BE border via the direct current (DC) interconnector ALEGrO in CWE FB MC this document is updated especially by implementing the Evolved Flow-Based (EFB) methodology. With the help of this methodology, flows over the new DC interconnector ALEGrO within the highly meshed CWE alternating current (AC) network can be adequately considered. The EFB methodology is described in-depth in chapter 4.2.9 "Integration of HVDC interconnector on CWE bidding zone borders" of the *CWE FB DA MC approval document*.For 2020 for CWE FB-Market Coupling it is planned to switch from Flow Based Intuitive[1] (FBI) to Flow Based Plain approach jointly with the introduction of ALEGrO. The congestion income allocation methodology however is independent of the selected approach, only the absolute results may differ. Furthermore also in the past for both types (FPI and FBP) results were calculated by TSOs, but FBI was used so far for distribution of CI among TSOs. The example in this methodology is reflecting a Flow-Based Plain approach.

For transparency purposes, the DE-AT report and the SPAIC analysis for ALEGrO have been added as annex 3 and annex 4 respectively. These annexes are for information purposes only.

When updating the document, the principles of the Congestion Income Distribution Methodology (CIDM) related to CACM2, Article 73, were taken into account.

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[1] FBI is assured by a specific patch integrated to the market coupling tool to avoid any commercial flows against intuitive market direction.

[2] CACM: REGULATION (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management

CONTENT

1 General definitions

The overall congestion income (CI) can be calculated by the following formula:

$$\mathrm{CI} = -\sum_{i=1}^{\mathrm{NRH}} \mathrm{netPOS_i} \times \mathrm{CP_i} \qquad \text{(Eq. 1)}$$

Where:

$netPOS_i$: net position of real hub i ; for CWE real hubs are FR, BE, NL, DE/LU[3] and AT

CP_i: clearing price of real hub i

NRH: total number of real hubs

To calculate the CI only the real hubs are considered. Virtual hubs as shown in Figure 1 for ALBE (connection of the ALEGrO line – BE) and ALDE (connection of the ALEGrO line – DE) are only used as an enabler for increased exchanges between real hubs. In contrast to real hubs, there do not exist any bids at the virtual hubs in the market coupling algorithm Euphemia and therefore there is also no CI generated at the virtual hubs (and therefore also no CI distributed to any virtual hub).

The impact of commercial flows on the critical branches (CB) is given by the power transfer distribution factors (PTDF) which are organized in the so-called PTDF-Matrix. This matrix translates the net positions into physical flows on the critical branches. Hence, the additional aggregated flow - AAF_i - associated to network constraint i can be calculated by multiplying the according power transfer distribution factor $PTDF_{i,j}$, where j refers to the respective hub (real or virtual), by the net hub position, using the following equation (Eq. 2). For clarification and delimitation issues it might be helpful to mention that for calculating the AAFs for Congestion Income Distribution (CID) -calculation the PTDF matrix differentiate from the PTDF matrix that is used for the calculation of the Flow Based Domain in such way, that for CID-AAFs only cross border network elements within the Flow Based Region (i.e. internal cross border lines) are taken into account in a base case (N) and no hub internal ones[4].

$$\mathrm{AAF_i} = \sum_{j=1}^{\mathrm{NH}} \mathrm{PTDF_{i,j}} \times \mathrm{netPOS_j} \qquad \text{(Eq. 2)}$$

Where:

AAF_i: additional aggregated flow associated to network constraint *i*

$PTDF_{i,j}$: power transfer distribution factor of hub j on critical branch i

$netPOS_j$: net position of hub j

[3] Please note that in case there is a reference to hubs automatically always the hub DE/LU is meant, this is also the case if only DE is written here in this document

[4] Please note that the formulation is also applicable in EFB for DC interconnectors, as the flow over a DC interconnector in EFB is modelled by a network constraint with a single PTDF of 1 for the corresponding virtual hub and PTDFs of zero for all other hubs (as part of the modelling of the external constraint). This gives the AAF over the cross-border network element (the DC interconnector) which is directly equal to the corresponding virtual hub’s net position. This is elaborated in detail in Annex 2.

NH: total number of hubs (including all real hubs and all virtual hubs)

Definition of shadow price

In mathematical terms for more academic evaluation, the FBMC algorithm is an optimization procedure that generates so-called shadow prices on every Flow-Based (FB) constraint, i.e. on each modelled network element that is monitored under certain operational conditions (such as outages).

The shadow price represents the marginal increase of the objective function (Day Ahead (DA) market welfare) if the constraint is marginally relaxed. In other words: the shadow price is a good indication of the increase in DA market welfare that would be induced by an increase of capacity on the active network constraint. As a consequence, non-binding network constraints in the market coupling solution have a shadow price of zero, since an increase of capacity on those network elements would neither change the optimal market coupling solution nor the flow on the network element concerned.

The overall congestion income for flow-based market coupling can therefore also/alternatively be calculated on the basis of the shadow prices (*SP)* and the flows induced by the net positions resulting from the market coupling as well, using the expression

$$CI = \sum_{i=1}^{NC} AAF_i \times SP_i + \sum_{i=1}^{NDC} ATC_i \times SP_i \quad \text{(Eq. 3)}$$

Where:

SP_i: shadow price associated to constraint *i*

NC: total number of network constraints

ATC_i: corresponding ATC-limit of DC link *i* (hourly operational limit on the energy flow over the DC link, which is adjustable independent from the AC-grid situation)

NDC: total number of ATC constraints due to modelling DC links in Evolved Flow-Based approach

Hence, equation (Eq. 3) represents the mathematical equivalent to equation (Eq. 1).

For explanatory purposes, this document uses a consistent set of market results that have been calculated by the Price Coupling of Regions (PCR) simulation facility for one example hour. These market results are displayed in Figure 1. The same example is used throughout the document except in Annex 1.

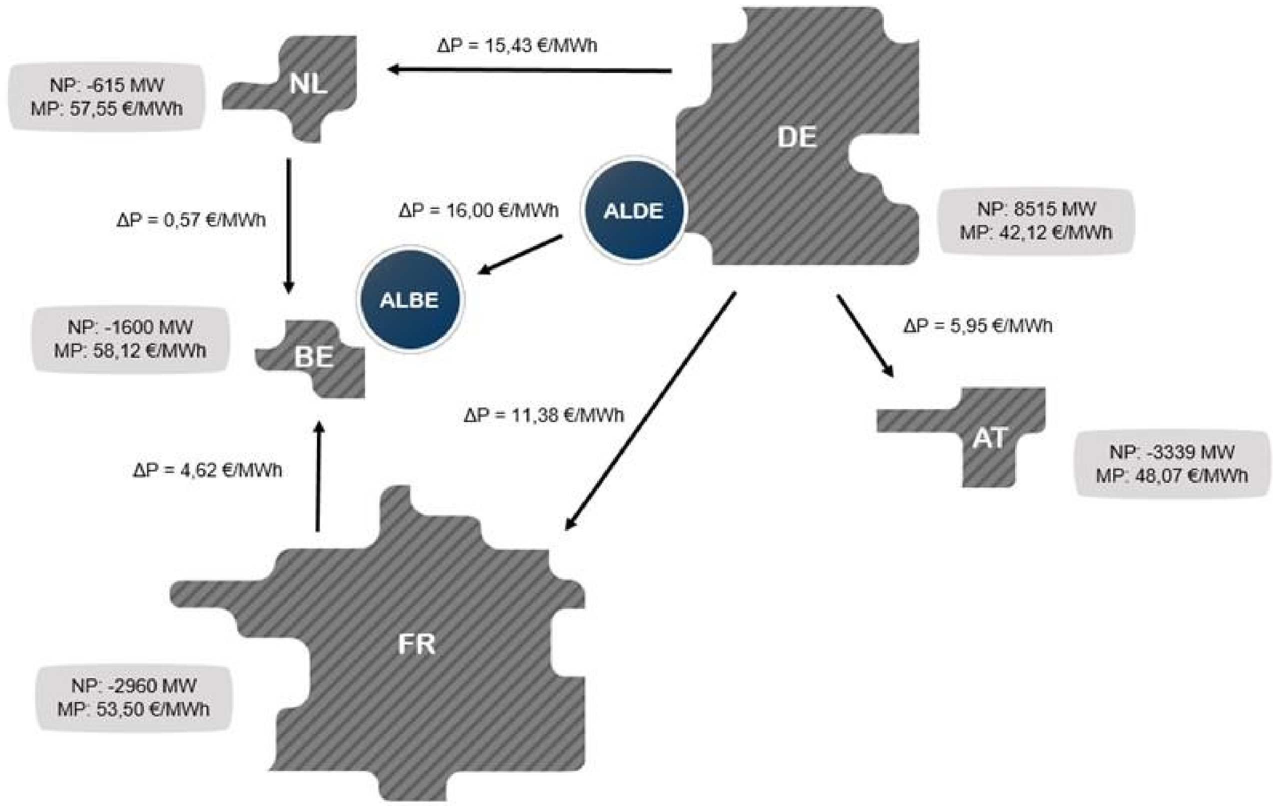

Figure 1: Flow-based market coupling results for the hour used in the example throughout this document.

In addition to the real hubs (FR, BE, NL, DE/LU, and AT), Figure 1 above shows the two virtual hubs ALBE and ALDE which help to model the flow on the DC interconnector ALEGrO in the context of EFB. It is important to note that all data given in the example used throughout this document are related to the real hubs and not the virtual hubs. For example, the price difference of 16,00 €/MWh as shown in Figure 1 is the price difference between the real hubs BE and DE. This is because the calculation of CI is based on the real hubs only, namely on the real hubs' NPs and price difference. The virtual hubs are solely used to help calculate the flow between the real hubs.

In order to model the impact on the AC grid of an exchange over the DC cable, TSOs need to be able to calculate the impact of an injection or offtake of the HVDC converter stations. This can be done by calculating the PTDFs of these HVDC converter stations, however these PTDFs cannot be linked to real bidding zones (such as BE or DE) since they already have their proper PTDF. Hence the introduction of virtual bidding zones allows TSO to calculate the PTDFs of the converter station and use the PTDFs in the FB calculation. The virtual bidding zones can thus be considered as a modelling features which allows TSOs to see the impact of an exchange over ALEGrO on the AC grid. The PTDFs calculated for the real hubs, represent the impact of a change in net position of that specific hub. For the virtual hub, the PTDFs represent a change in offtake / injection of the HVDC cable.

Back to the numbers in Figure 1 due to rounding, the sum of the net positions of the hubs does not equal zero.

From the net positions and prices we can obtain the congestion income according to (Eq. 1):

$$CI = -(-615 \times 57{,}55 - 1600 \times 58{,}12 - 2960 \times 53{,}50 - 3339 \times 48{,}07 + 8515 \times 42{,}12) = € \, 88.658{,}23$$

2 Criteria for sharing income

The qualitative criteria are depicted below in more detail.

2.1 Short & Long Term Incentive compatible

According to Article 19.1 of Regulation (EU) 2019/943 of the European Parliament and of the Council the procedure for the distribution of congestion income shall not provide a disincentive to either reduce congestion nor to distort the allocation process in favour of any party requesting capacity or energy.

Objectives: Efficient use of existing and efficient investments in transmission assets.

2.2 Transparent and easy to understand

Objectives: The distribution of congestion income should be transparent and auditable, which means that very complex sharing keys are not preferred. It should be easy to show in which way the congestion income is shared by the hubs and how this is integrated in the total picture of the congestion income cycle.

2.3 Robustness against gaming

Objectives: The sharing key should not give room for optimisation of any individual hub's share of the congestion income by gaming on data manipulation.

2.4 Fairness and Non discriminatory

Objectives: The sharing key should be based on elements related to the management of capacity for cross-border transactions.

2.5 Predictability and Limited volatility

Objectives: The sharing key should allow a forecast of the financial outcome and should not lead to a higher volatility of each share compared to the status quo, in order to allow a reasonable financial planning and cash flow management.

2.6 Smoothness of transition

Objectives: the current congestion income distribution should not be changed in a radical way in the short term in order to limit the financial impact on all parties.

2.7 Positive income per hub

Objectives: As long as the long term allocated (LTA) capacity domain is included in the FB domain, the hourly individual net income of each hub remains positive[5].

2.8 Stability in case of extension

Objectives: The current congestion income distribution for the CWE hubs should not be changed in a radical way when new hubs are joining the FB region.

Within the process of developing the sharing methodology for the congestion income, these criteria and objectives were taken into account. Therefore, the presented solution is one that fits the criteria best.

[5] As a matter of exception, by activating the so called 'Adequacy Patch' by the market coupling algorithm, the overall net congestion income could become negative. Overall negative net congestion income due to this situation will be dealt with according to the procedure of chapter 8.3.

3 Nomination proof and additional aggregated flow calculation

The part of 'Nomination proof' was relevant as long as there were on internal BZBs PTRs and FTRs allocated in parallel on different BZBs. As from 01.01.2020 on all CWE internal BZBs only FTRs are allocated, it is on the one hand for market participants no longer possible to nominate LTRs (in form of PTRs) and on the other hand the mechanism to consider different principles and nomination level for LTRs is no longer needed. Therfore the amount of LT-nomination for the whole following document shall automatically always considered to be zero. This also has the side effect, that by principle the 'nomination proof' part is no longer needed at all. However as it is currently implemented in all IT-tools, this part is also kept in this document, but always knowing that only FTRs are in place at CWE internal BZBs and therefore no LT-nomination is possible (LTN = 0 MWh).

For external BZBs and their flows (see Chapter 5) the kind of LTRs (PTRs or FTRs) is not relevant in any way for the distribution of CI as LT-remuneration of LT-capacity allocated on external BZBs is not part of that methodology at all (also only CI generated by FBMC on internal BZBs is considered).

In case where long term physical transmission rights (PTRs) were issued on any of the borders the sharing of congestion income and remuneration costs of each hub should be made independent of the actual nomination level on a border by the market participants that hold the long term physical transmission rights. In this case the sharing key should be made ´nomination proof´. This is achieved in the way that the hourly remuneration costs per hub border are calculated from the total volume of allocated long term rights multiplied by the hourly price difference that occurs on that border, instead of only considering the resold part of the LTA multiplied by the price difference. Furthermore, the net positions to derive the overall congestion income need to be corrected with the Long-Term Nominations (LTN), such that the income is shared as if all LTA have not been nominated.

Since the net positions change with (past) possibility of LT-nomination, the AAFs change accordingly (Eq. 4), which is an adaptation of the earlier shown equation (Eq. 2). The flows on the critical branches on a border are aggregated on a hub border level.

$$AAF_i = \sum_{j=1}^{NH} PTDF_{i,j} \times netPOS(FBMC + LTN)_j \qquad \text{(Eq. 4)}$$

<u>Where</u>:

$PTDF_{i,j}$: power transfer distribution factor of hub *j* on critical branch *i*

$netPOS_j$: net position of hub *j*

NH: total number of hubs

FBMC: the part of the net position allocated through the daily flow-based market coupling (resold LTA and additional margin provided by the TSOs)

LTN: a correction of the net position due to the level of Long-Term Nominations (since January 2020 this correction is 0, i.e. LTN=0 caused by FTRs on all internal CWE BZBs)[6]

[6] Starting from January 2020 long term Financial Transmission Rights (FTRs) are implemented on all internal CWE borders. Thus there are no more borders with long term Physical Transmission Rights

The resulting net positions, additional aggregated flows and prices are depicted in the Figure 2 below (as the delta price in this example hour is positive from DE to BE, but the flow goes from BE to DE, there is a non-intuitive flow between BE and DE, which is possible under FBP). The CWE net positions of Germany, France and Austria do however not balance by the aggregated flows as part of the real physical flows leave and re-enter the CWE region through external borders. The concept of internal and external pot as discussed in Chapter 5 has been designed to address this issue.

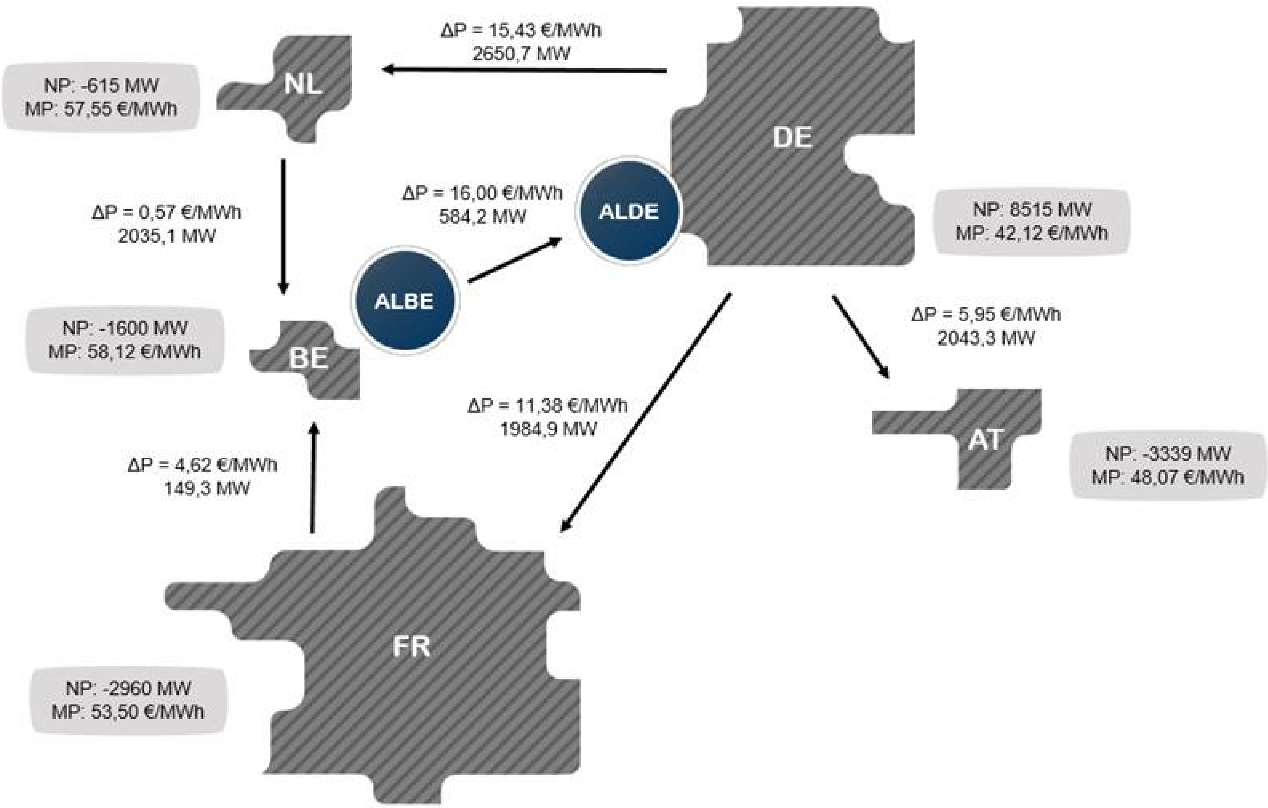

Figure 2: The calculated additional aggregated flows, based on the PTDFs and net positions.

(PTRs) within the region and consequently no Long Term Nominations based on allocated long term PTRs are needed (LTN=0). There is also no need to apply 'nomination proof' calculation. However, for the sake of completeness, the general form of equation 4 is kept as it refers to general case when either FTRs or PTRs could be used on specific borders in the region.

4 Cross Border clearing price times market flows absolute (CBCPM abs)

The Congestion Income Allocation mechanism for CWE takes up the fundamental characteristics of the well-known ATC scheme. Even though the results of CWE FB MC are hub net positions and clearing prices, the FB sharing key (CBCPM abs) – in a first step – assigns a Border Value to each individual hub-border in order to allocate the congestion income to the respective capacity holders. The idea is to share the congestion income based on economic indicators related to the allocation of cross-border capacity in zonal-markets, i.e. market price differences and allocated cross-border flow. Additionally, the FB sharing key is also in line with the principle of price formation in FB (Eq. 5):

$$\frac{\Delta CP_{hub\ i \to j}}{\Delta PTDF_{hub\ i \to j,k}} = Shadow\ Price\ \geq 0 \qquad \text{(Eq. 5)}$$

<u>Where</u>:

$\Delta PTDF_{hubi \to j,k}$: power transfer distribution factor difference between hub i and j for critical branch k

$\Delta CP_{hubi \to j}$: clearing price difference between hub i and hub j

ΔPTDF of the limiting CB is proportional to ΔCP. The ΔPTDF between the hubs close to the limiting CB is larger than the ΔPTDF between the hubs far away. Therefore, the price difference between the hubs close to the limiting CB is larger than the price difference between hubs far away.

The aforementioned Border Value is calculated by multiplying the respective AAFs by the price difference of the neighbouring hubs.

Under FB MC negative Border Values might occur if AAFs are directed against the clearing price difference (the price difference of the neighbouring hubs is – in the direction of the AAF – negative)[7]. Those flows contribute to the maximization of day-ahead market welfare within the entire Region, therefore Border Values are always taken into account in absolute terms. Since the absolute value of the Border Values is taken into account, a rescaling to the original overall congestion income is required.

4.1 Calculations of sharing key for CI

For the calculation of the CBCPM ABS key, the absolute Border Value per hub is considered as shown below:

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[7] This situation can also occur within FB Intuitive MC, since a situation is defined as intuitive if there exist at least one possible set of intuitive bilateral exchanges. The AAFs resulting from the FBI MC are different from this set of bilateral exchanges.

$$CI\_Hub_i^{CBCPM\ ABS} = \frac{1}{2} \times \frac{\sum_{j=1}^{NRH} \left| AAF_{hub\ i\to j} \times \Delta CP_{hub\ i\to j} \right|}{\sum_{i=1}^{NRH} \sum_{j>i}^{NRH} \left| AAF_{hub\ i\to j} \times \Delta CP_{hub\ i\to j} \right|} \times CI \qquad \text{(Eq. 6)}$$

Where:

CI_Hub_i: congestion income associated to real hub i

$AAF_{hub\ i\to j}$: sum of additional flows from real hub i to real hub j (includes both AC and DC exchanges)

$\Delta CP_{hub\ i\to j}$: clearing price difference between real hub i and real hub j

NRH: total number of real hubs

4.2 Properties of the proposed sharing key

The CBCPM abs sharing key can be seen as an "evolution" of the ATC sharing key principle to rationalize the sharing of congestion income. The basic idea of the CBCPM sharing key is transparency and easiness to understand.

The income is linked to congested CB(s) that set(s) the prices: the ΔPTDF close to the limiting branch is large and therefore, the price difference is also large. This means a large congestion income on the borders close to the congestion. So the price difference is an indication of the location of the congestion. As such, the congestion income is an indication of the criticality of a congestion.

The sharing key has a good stability in case of extensions. In case a hub with a border with recurrent congestions joins, the congestion income sharing is mainly attributed to that border and vice versa: if a hub without congestion on its borders joins, few congestion incomes will be attributed to this hub.

The absolute variant of the sharing key avoids negative net congestion income on a hub border.

5 Determination of the internal and external pot

As previously mentioned, the total congestion income is related to the shadow prices of the congested critical branches somewhere inside CWE. After adaption of the net positions with the Long-Term nominations and calculating AAFs, it is possible to divide this global income into an "internal" and an "external" pot. This external pot is related to the flows exiting and re-entering the CWE FB area through neighbouring hubs. The external flows are calculated as a complement to the internal flows in order to balance the net position of all hubs in the CWE CCR.

As not all CWE net positions can be balanced by internal flows (AAFs) the concept of an external pot was introduced and was updated with the implementation of DE-AT border. Without that border, there was only one external flow between FR and DE/LU/AT hubs, which was easy to calculate. Considering the DE-AT border, the situation became more complex and individual external flow components would be much more difficult to determine.

In accordance with the Congestion Income Distribution Methodology (CIDM) proposal based on CACM Article 73 and approved by ACER on December 2017, the so cold 'Slack Zone' approach was selected for the determination of external flow values. This approach was also prepared in this document by former Chapter '10.1.1 Determination of the unique price of the slack zone' for the case of extensions of the CWE-CCR. In Figure 3 the principle of this Slack Zone approach is illustrated. Therefore all external flow components between different hubs needed to balance the respective hubs in CWE (which are FR, DE/LU and AT) are substituted by only one virtual flow for each relevant hub and the Slack Zone. Of course the net position of the virtual Slack Zone is zero and a price of the Slack Zone has to be determined in an appropriate way.

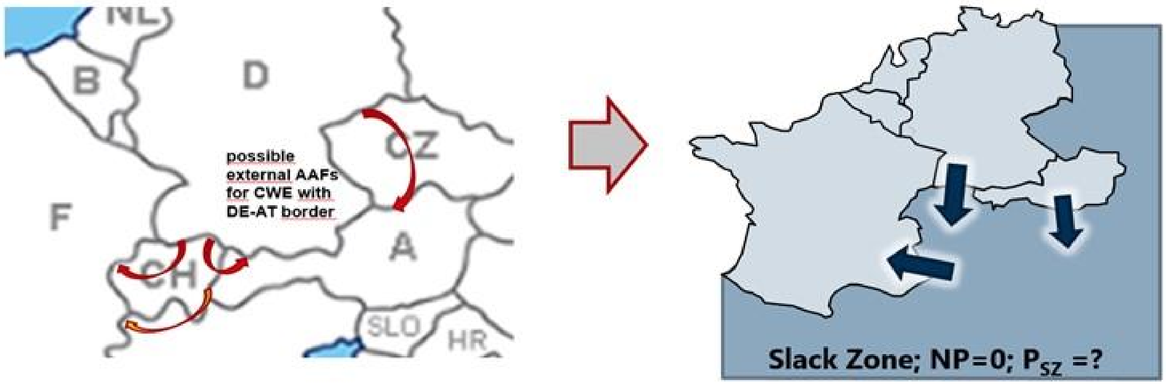


Figure 3: The principle of the Slack Zone approach.

Transferring this Slack Zone approach to the figure used before results in Figure 4, now also including the Slack Zone which acts as a source or sink for all the external flows. The external flow is calculated as the flow needed to balance the net positions in addition to the already calculated AAF.

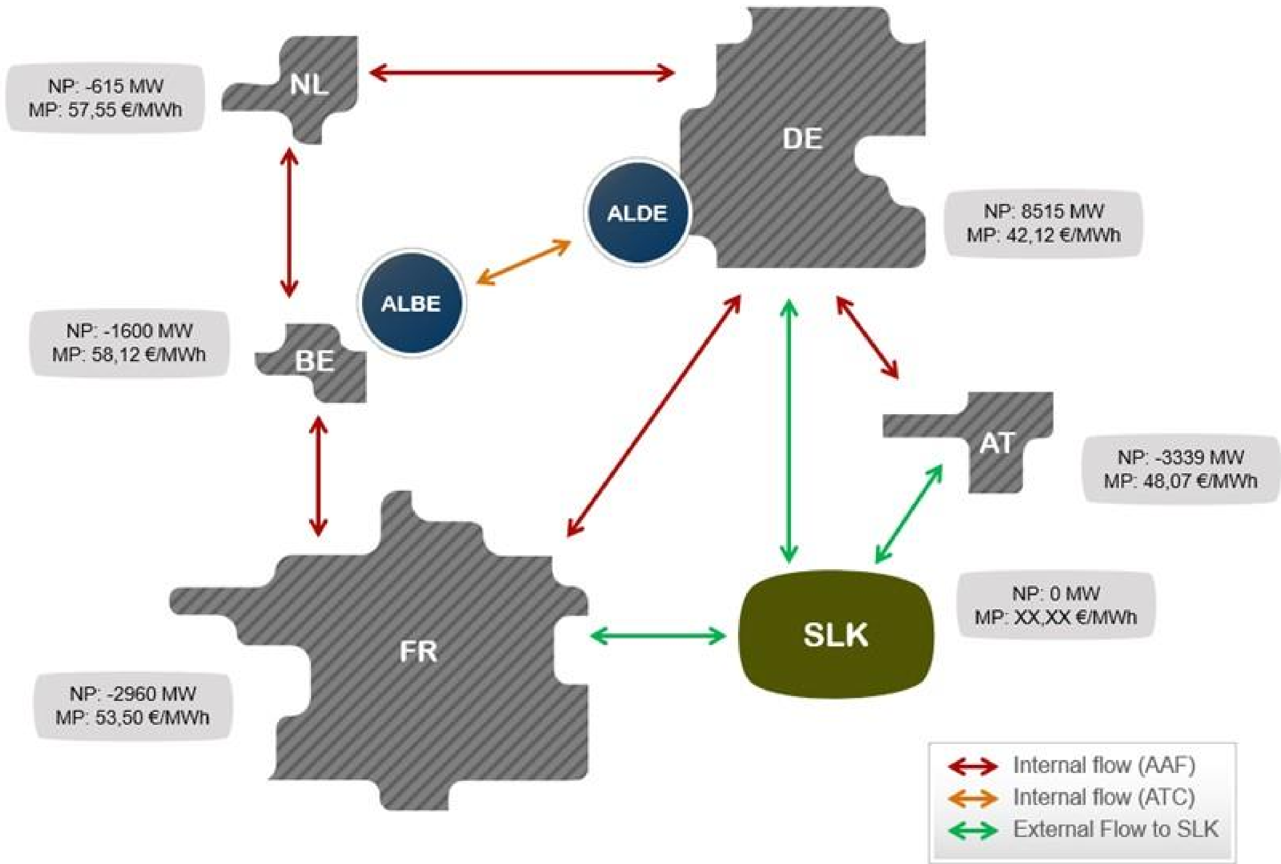


Figure 4: The principle of external flows towards the slack zone.

For bidding zones, where external flows are needed to balance the updated net position the market spread of such external flows are calculated as:

$$EMS_{j,SZ} = P_j - P_{SZ} \qquad \text{(Eq. 7)}$$

And P_{SZ} is the price that minimizes the sum of external flows flowing in the opposite direction of EMS (i.e. non-intuitive external flows) using the following optimization:

$$P_{SZ} = \arg\min_{P} \sum_{j=1}^{n} (P_j - P_{SZ}) \times EF_{j,SZ} \qquad \text{(Eq. 8)}$$

Where:

$EMS_{j,SZ}$ market spread for the external flow of a bidding zone j to the Slack Zone;

P_j clearing price of a bidding zone j resulting from SDAC (single day-ahead coupling);

P_{SZ} price of the virtual Slack Zone, which represents a common sink or source for all external flows;

$EF_{j,SZ}$ external flow of bidding zone j to Slack Zone;

n number of bidding zones having external flows.

If there is no unique solution for P_{SZ} then P_{SZ} shall be calculated as the average of the maximum and the minimum value from a set of P_{SZ} satisfying the formula above.

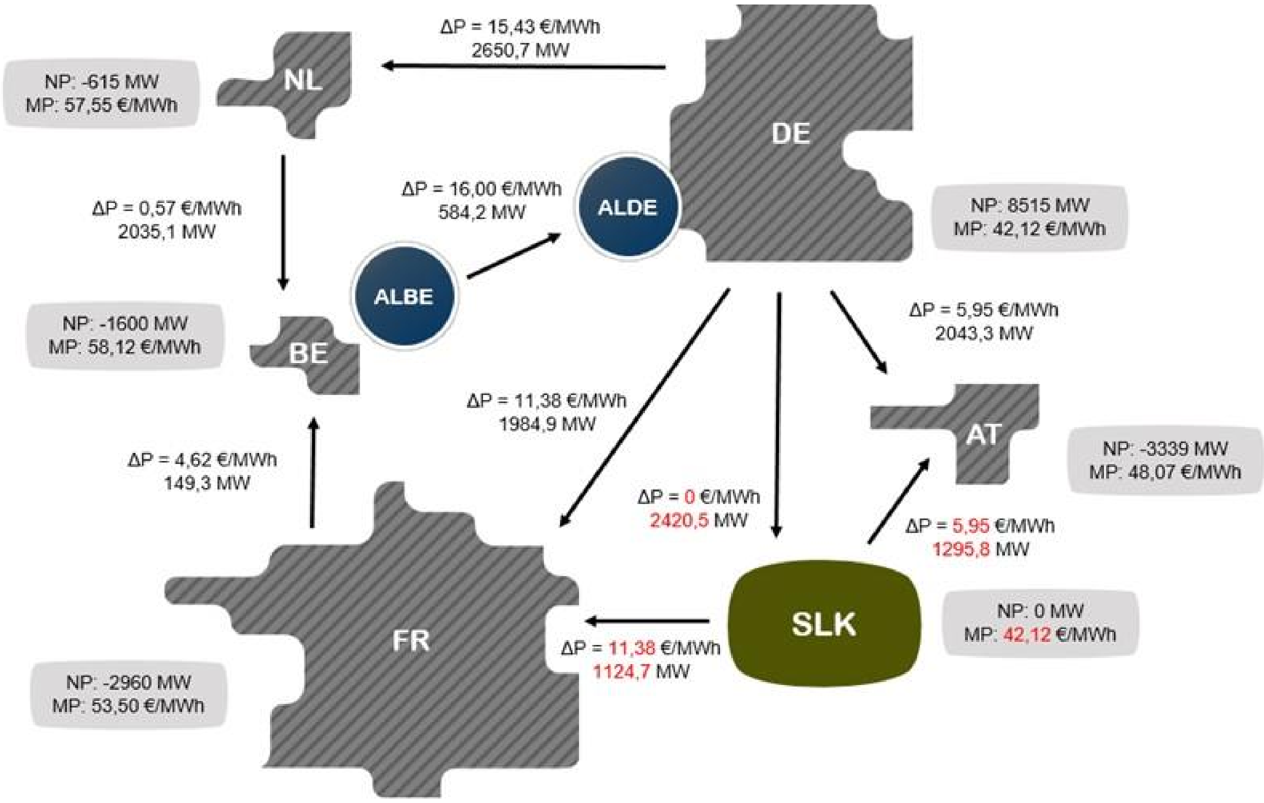


Figure 5: External flows towards the slack zone, based on the price optimization of the slack zone.

5.1 Calculation

For the computation of both the internal and external pot, we consider that all flows (AAFs) help to reach the optimum in CWE day-ahead market welfare, whatever the direction of the flow (with or against the price difference). This is in line with the choice of the CBCPM absolute key that was selected. It also ensures that both incomes are positive, which would not always be the case without considering absolute values. This means that we sum up the absolute Border Values for all internal and external hub borders respectively:

- Unscaled Internal pot = $\sum|(AAF(\text{internal hub borders}) \times \Delta P)|$ (Eq. 9)
- Unscaled External pot = $\sum|(AAF(\text{external hub borders}) \times \Delta P)|$ (Eq. 10)

The use of absolute values implies that the sum of the two pots may exceed the overall CWE congestion income. When sharing each of the pots, a pro-rata rescaling is then needed to correct this effect as shown in (Eq. 11) and (Eq.12).

- $internal\ pot = \frac{unscaled\ internal\ pot \times overall\ CI}{(unscaled\ internal\ pot + unscaled\ external\ pot)}$ (Eq. 11)

- $external\ pot = \frac{unscaled\ external\ pot \times overall\ CI}{(unscaled\ internal\ pot + unscaled\ external\ pot)}$ (Eq.12)

For the sharing of each of the pots keys based on the CBCPM absolute sharing key of internal flows (AAFs) or external flows are used:

5.2 Example

The updated net positions, market clearing prices and AAFs are already shown in Figure 6:

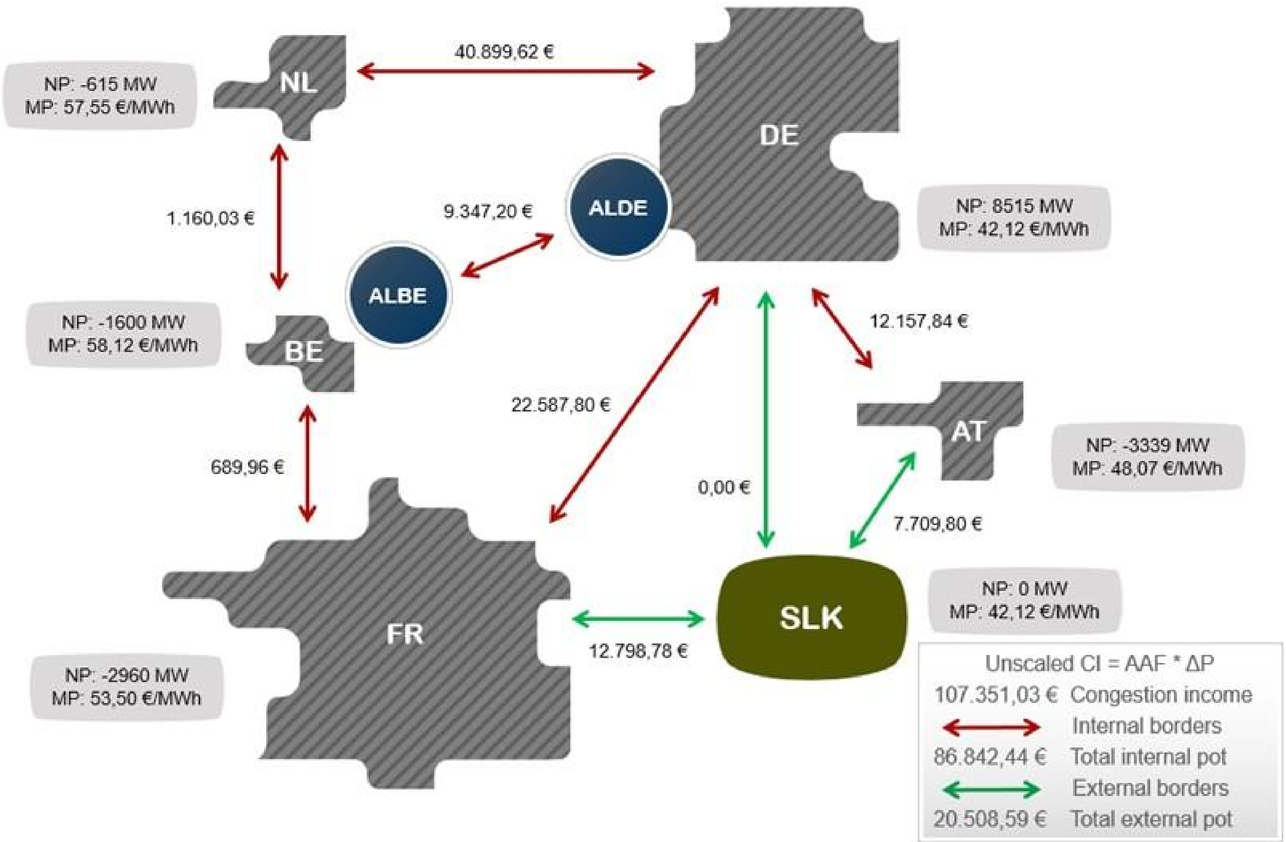


Figure 6: The unscaled congestion income per hub border, based on the market results as shown in Table 1

Applying these principles to our example leads to these computations (Table 1):

Unscaled internal pot = Σ |(AAF(internal)×ΔP)| = 86.842,44 €

Unscaled external pot = Σ |(AAF(external)×ΔP)| = 20.508,59 €

Border	**Flow×|ΔP|**
DE-FR	1.984,9 × 11,38 = 22.587,80 €
DE-NL	2.650,7 × 15,43 = 40.899,62 €

BE-NL	2.035,1 × 0,75 = 1.160,03 €
BE-FR	149,3 × 4,62 = 689,96 €
BE-DE	584,2 × 16,00 = 9.347,20 €
DE-AT	2.043,3 × 5,95 = 12.157,84 €
Sum of absolute Border Values for all internal hub borders => **Unscaled internal pot**	**86.842,44 €**
FR-SZ	1.124,7 x 11,38 = 12.798,78 €
DE-SZ	2.420,5 x 0,00 = 0,00 €
AT-SZ	1.295,8 x 5,95 = 7.709,80 €
Sum of absolute Border Values for all external hub borders => **Unscaled external pot**	**20.508,59 €**

Table 1: Calculation of the border values

As the sum of the unscaled internal pot and unscaled external pot (107.351,03 €) exceeds the overall CWE congestion income (88.658,23 €), a proportional rescaling is applied to unscaled CI amounts of the internal and external pot (Table 2) by a scaling factor of 88.658,23/107.351,03 = 0,8259

Border	**Rescaled Congestion Income**
DE-FR	22.587,80 x 0,8259 = 18.654,63 €
DE-NL	40.899,62 x 0,8259 = 33.777,86 €
BE-NL	1.160,03 x 0,8259 = 958,03 €
BE-FR	689,96 x 0,8259 = 569,82 €
BE-DE	9.347,20 x 0,8259 = 7.719,59 €
DE-AT	12.157,84 x 0,8259 = 10.040,82 €
Internal pot	**71.720,76 €**
FR-SZ	12.798,78 x 0,8259 = 10.570,16 €
DE-SZ	0 €
AT-SZ	7.709,80 x 0,8259 = 6.367,31 €
External pot	**16.937,47 €**

Table 2: Calculation of the rescaled congestion income on borders of the internal and external pot

Internal pot = 71.720,76 €

External pot = 16.937,47 €

The congestion income on the borders is shown in Figure 7.

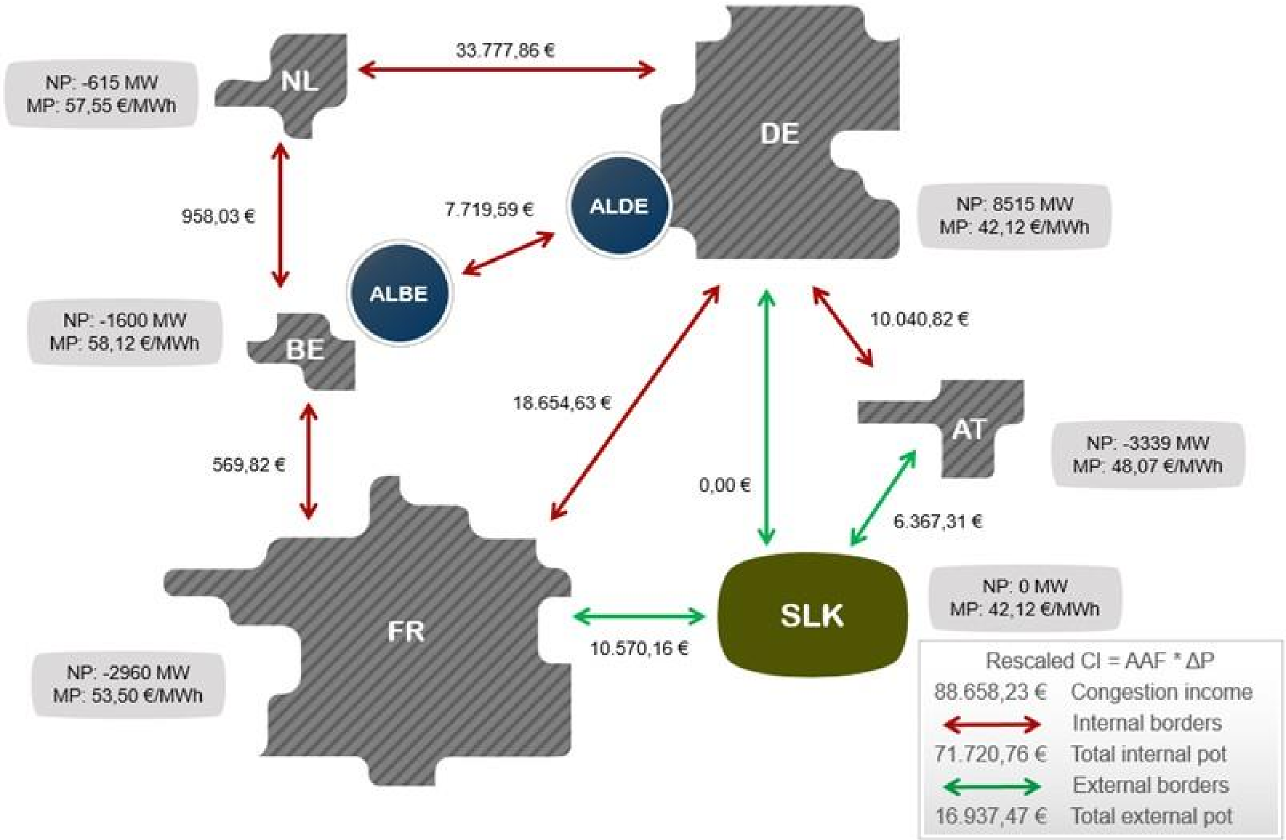


Figure 7: The scaled congestion income per hub border.

6 Sharing of the hub border income

The (rescaled) congestion income on the hub borders is shared equally (50/50) between the neighbouring hubs as shown in Figure .

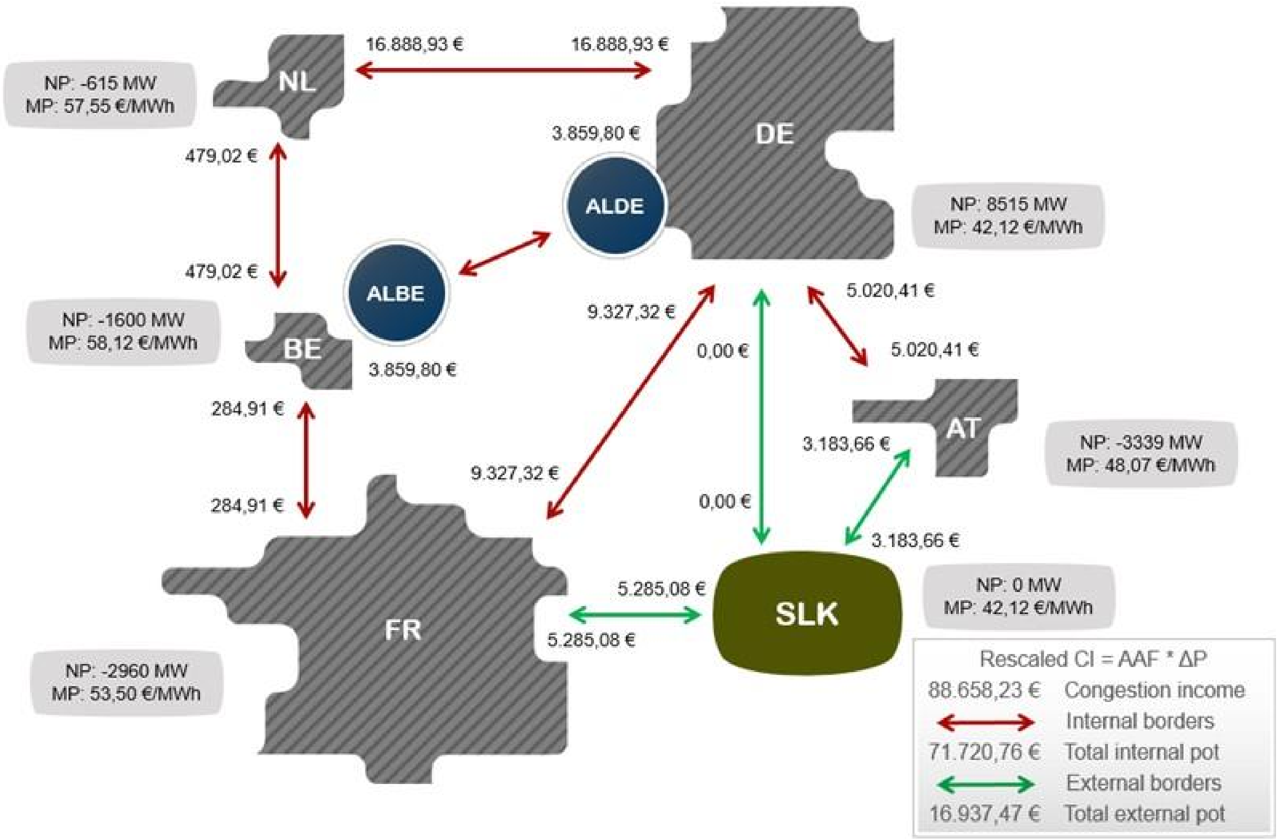


Figure 8: The scaled congestion income per hub border shared equally between each side of the border.

7 Principles of the remuneration of LTRs under Flow-Based MC

7.1 Cost for remuneration of Long-Term remuneration cost

The TSOs, through the "Use It Or Sell It" principle, enable the Market Participants that acquire some bilateral Long-Term capacities (based on ATC) in Yearly and Monthly auctions to automatically remunerate these capacities at the daily allocation in case they do not nominate these capacities in case of physical transmission rights (PTRs) on a border. In case of financial Transmission rights (FTRs) all allocated long-term rights are self-acting financially remunerated and no nomination is possible. Such remuneration will lead, in ATC but also in Flow-Based, to the payment of the positive price spread between the two hubs multiplied with the volume of Long-Term capacity remunerated. The remuneration costs in Flow-Based can be defined in 2 ways as shown in (Eq. 13) and (Eq.14);

$$Remuneration\ Cost = \sum_{i,j}\left(LTA_{i\to j} - LTN_{i\to j}\right) \times \max\left(0, \Delta CP_{hub\ i\to j}\right) \quad \text{(Eq. 13)}$$

$$Remuneration\ Cost = \sum_{NC} AAF_{rem,i} \times SP_i + \sum_{i=1}^{NDC} ATC_{rem,i} \times SP_i \quad \text{(Eq.14)}$$

Where:

$LTA_{,i\to j}$: long term allocated capacity on the border in the direction from i to j.

$LTN_{,i\to j}$: long term nominated capacity on the border in the direction from i to j (since January 2020 LTN=0)[8]

$\Delta CP_{hub\ i\to j}$: clearing price difference between hub i and hub j

$AAF_{rem,I}$ positive margin freed by the remuneration on critical branch i.

SP_i: shadow price associated to constraint *i*

NC: total number of network constraints

$ATC_{rem,i}$: positive margin freed by the remuneration on DC link *i* modelled by Evolved-Flow-Based approach

NDC: total number of ATC constraints due to modelling DC links in Evolved Flow-Based approach

7.2 Maximum amount available for remuneration of the return of LTRs

From (Eq.14), one can see that if the overall margin freed by all returns of LTRs to daily markets on each critical branch is lower than the margin made available by the TSOs to the Market Coupling, the congestion income from Flow-Based Market Coupling is higher than the remuneration cost as shown in Figure . We can conclude that if the Long Term ATC domain is included in the Flow-Based domain, the remuneration costs are covered by the hourly congestion income. The numerical proof that the remuneration costs are smaller than or equal to the overall congestion income is assured because of the automatic LTA inclusion in the FB domain. An explanation can be found in Annex 1.

[8] As already stated in chapter 3 starting from January 2020 long term FTRs are implemented on all internal CWE borders and consequently no Long Term Nominations based on allocated long term PTRs are needed (LTN=0). However, for the sake of completeness, the general form of equation 13 is kept as it refers to general case when either FTRs or PTRs could be used on specific borders in the region.

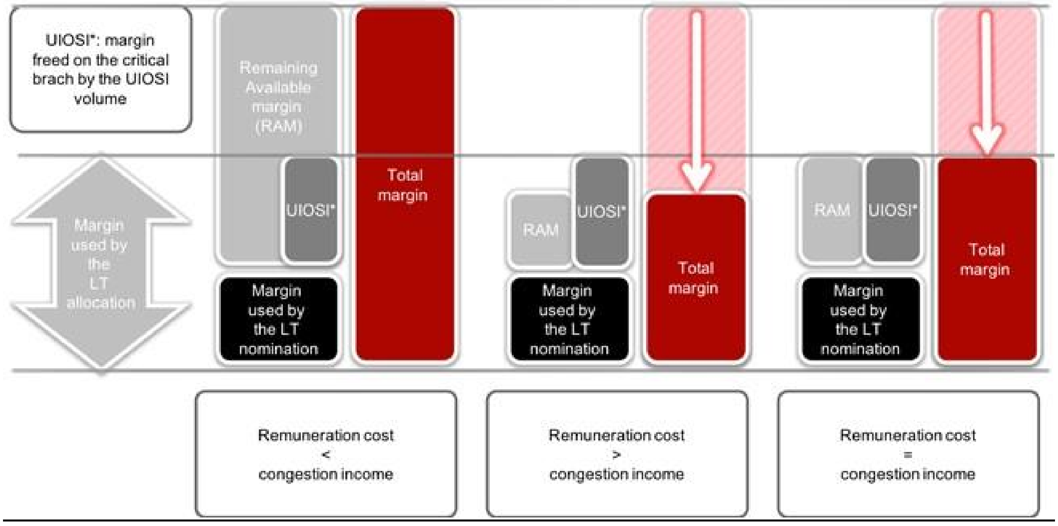


Figure 9: Relationship between overall congestion income, remuneration cost and margin on a critical branch

Following Eq. 13, the total remuneration cost can be calculated. This amount in total has to be remunerated to the market participants. Following the same calculation principle, also the remuneration cost per direction of a BZB respectively per BZB can be calculated (please be aware that remuneration costs only exist in case of positive market spread). For each BZB the resulting remuneration costs were shared 50% to 50% between the TSOs of a border and have to be remunerated to market participants by TSOs. Figure 10 is showing the netted (allocated minus nominated) LT-capacity relevant for remuneration, whereas Figure 11 is showing the effective remuneration cost per BZB considering market spread orientation.

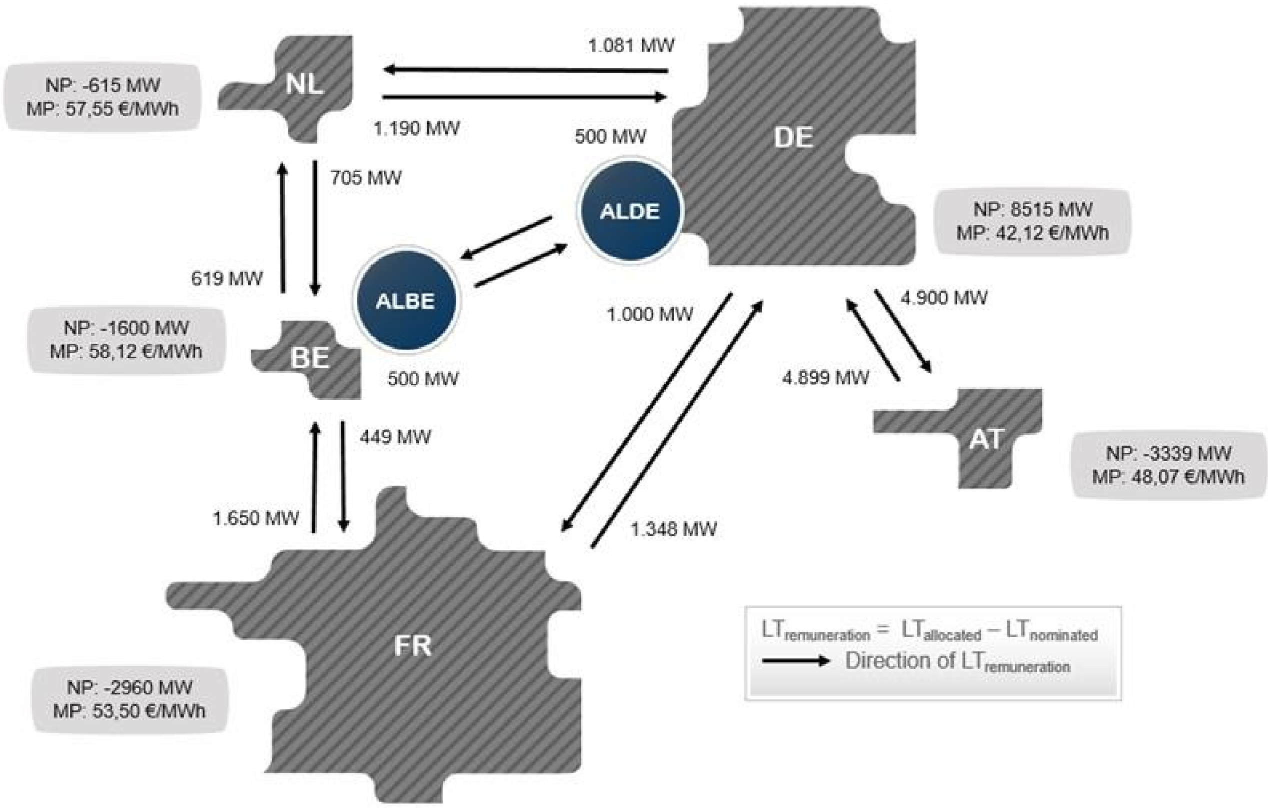


Figure 10: Amount of LT-Capacity for remuneration per BZB and direction

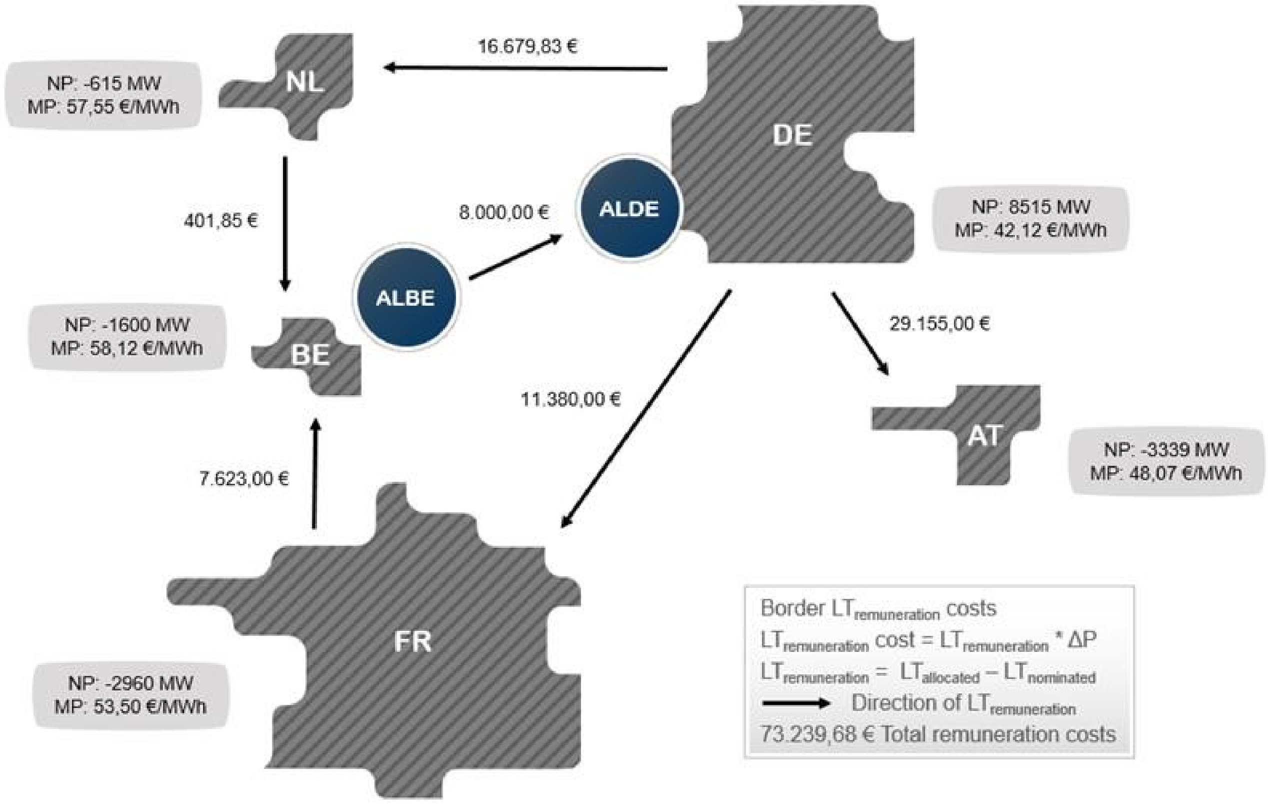


Figure 11: Effective remuneration cost per BZB caused by LT-remuneration

The total sum of remuneration cost according to (Eq. 13) is 73.239,68 € as shown in Figure 11. This is the amount which has to be paid to market participants for LT-remuneration.

7.3 Remuneration methodology in line with treatment of external pot

Remuneration costs for TSOs to market participants are based on a scheduled flow and resulting as already shown in Figure 11.

To make the remuneration cost independent of the nomination level (nomination proof; which is especially important if on a CCR PTRs with LT-nomination are in place on some borders in parallel to other borders based on FTR principle), in a first step theoretical remuneration cost are calculated again following (Eq. 13) for each BZB, however without any nomination considered (remuneration cost based on allocated capacity and positive Market Spread).

In our Example there is no LT-nomination, so no rescaling needs to be performed.

In a next step the (rescaled) remuneration cost per BZB are further distributed because CI sharing key for TSOs is based on physical flows considering AAFs and external flows. To avoid an inconsistency between the remuneration methodology and the CI sharing principles, the remuneration cost shall also be assigned to internal and external borders (with external flows).

Therefore the following principle is applied:

- For a hub with closed borders the remuneration cost divided by two is assigned to its side of the respective closed border.

- For a hub with open borders, the part of the remuneration cost that is linked to the internal flow (AAF), divided by two, is assigned to its side of the closed border, whereas the part of the remuneration cost that is linked to the difference between the remunerated volume and the external flow, divided by two, is assigned to the open border to the Slack Zone. As a consequence, both sides of a border can have a different remuneration cost as shown in Figure 12

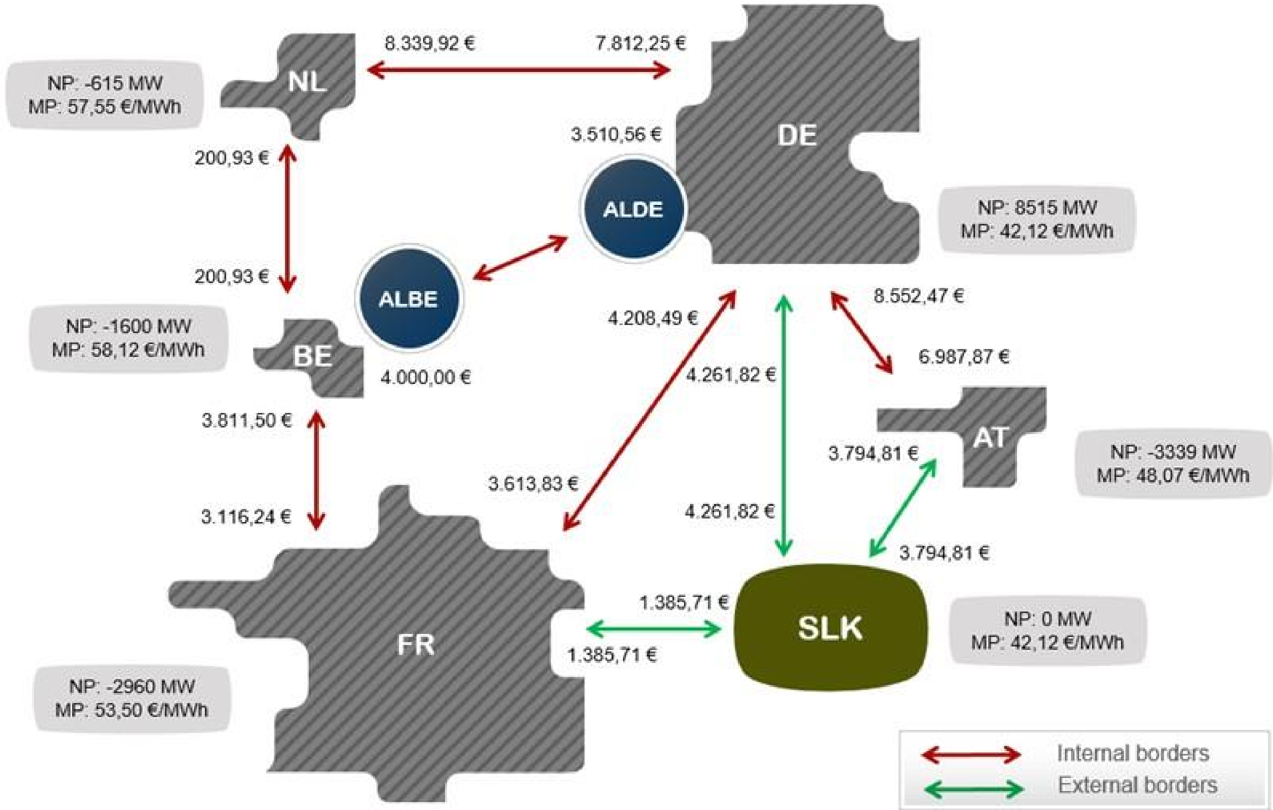


Figure 12: Assigned remuneration cost per border after distribution to internal and external borders

In Figure 12, between Belgium and the Netherlands the remuneration cost are equally at 200,93 €, because both hubs have only closed borders (no external flows), whereas on all physical hubs with external flows (FR, DE/LU, AT) the remuneration cost on their BZB are different. The remuneration cost between those hubs with external borders and their SZ-border however is also equal, because the Net Position of the Slack Zone is always zero and therefore no flows relevant for remuneration are generated by this virtual hub.

7.4 Socialization methodology

The remuneration cost is calculated on a hub border basis; for internal and external borders. Each TSO is responsible for compensating the remuneration costs on its side of the border (based on hourly CI-income according distribution methodology). The steps to arrive at the remuneration cost per side of a hub border are reflected in the chart below (Figure 13).

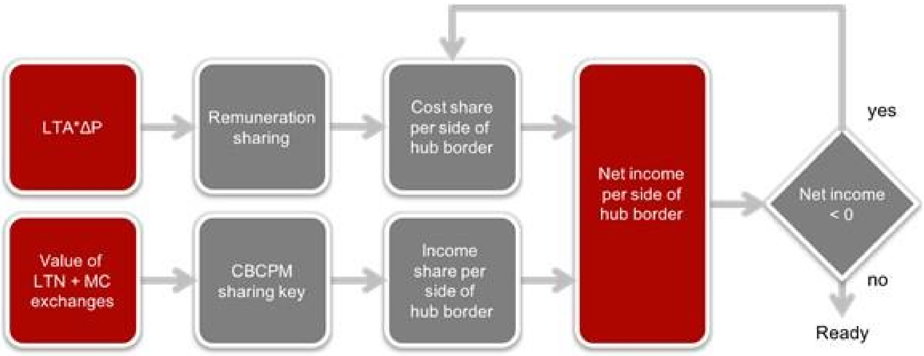


Figure 13: Socialization methodology principle

Figure shows the congestion income per hub border on each side of the hub border and Figure shows the remuneration costs on each side of the hub border. The difference between these values is the net congestion income per hub border (i.e. income after considering of cost for LT-remuneration) as shown in Figure 16.

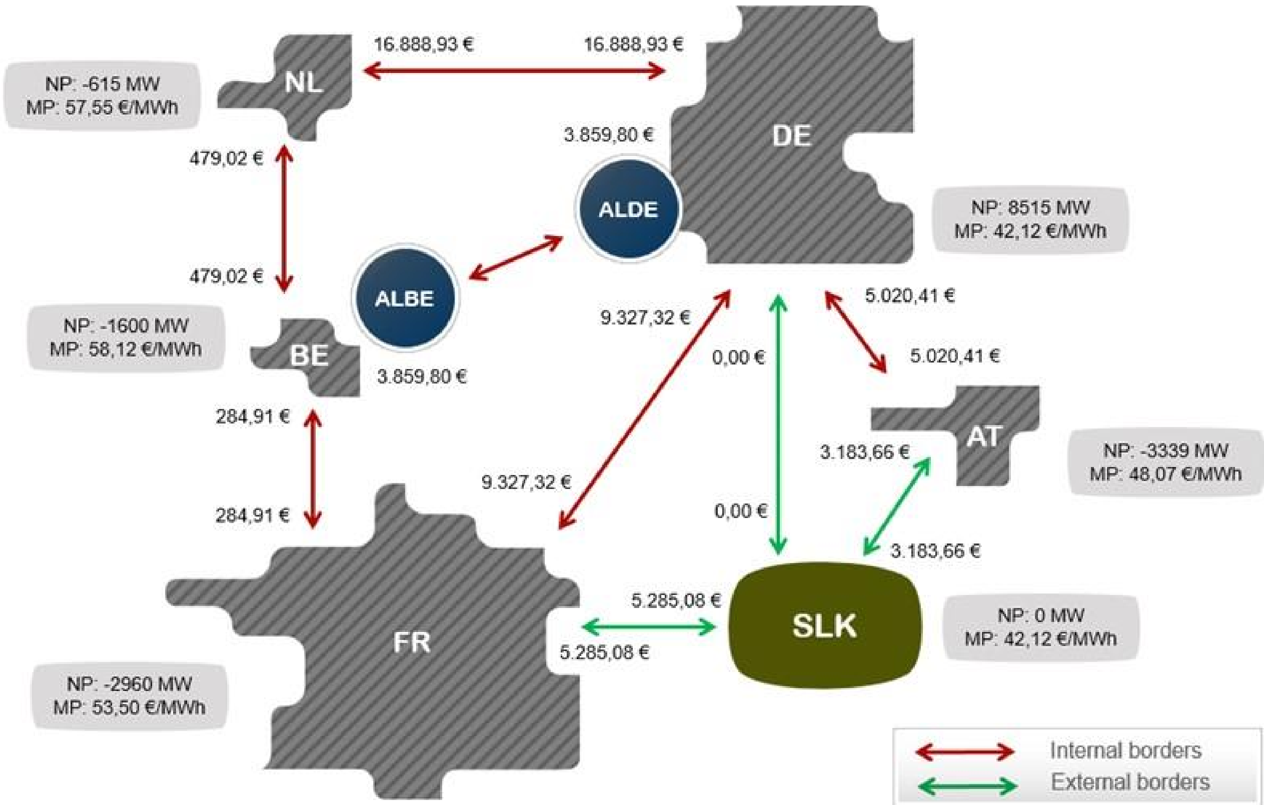


Figure 14: The congestion income per hub border on each side of the border, as calculated in paragraph 5.2.

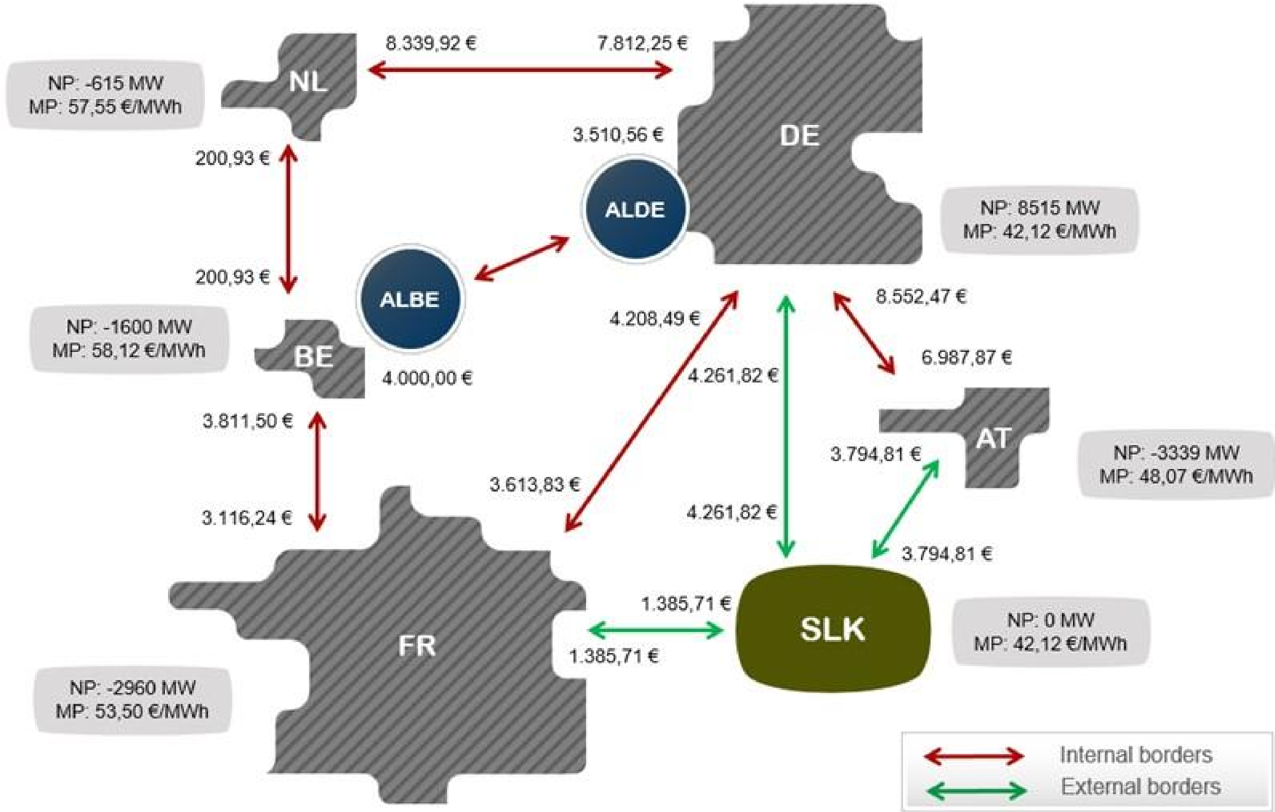


Figure 15: Long-term remuneration cost per hub border on each side of the border.

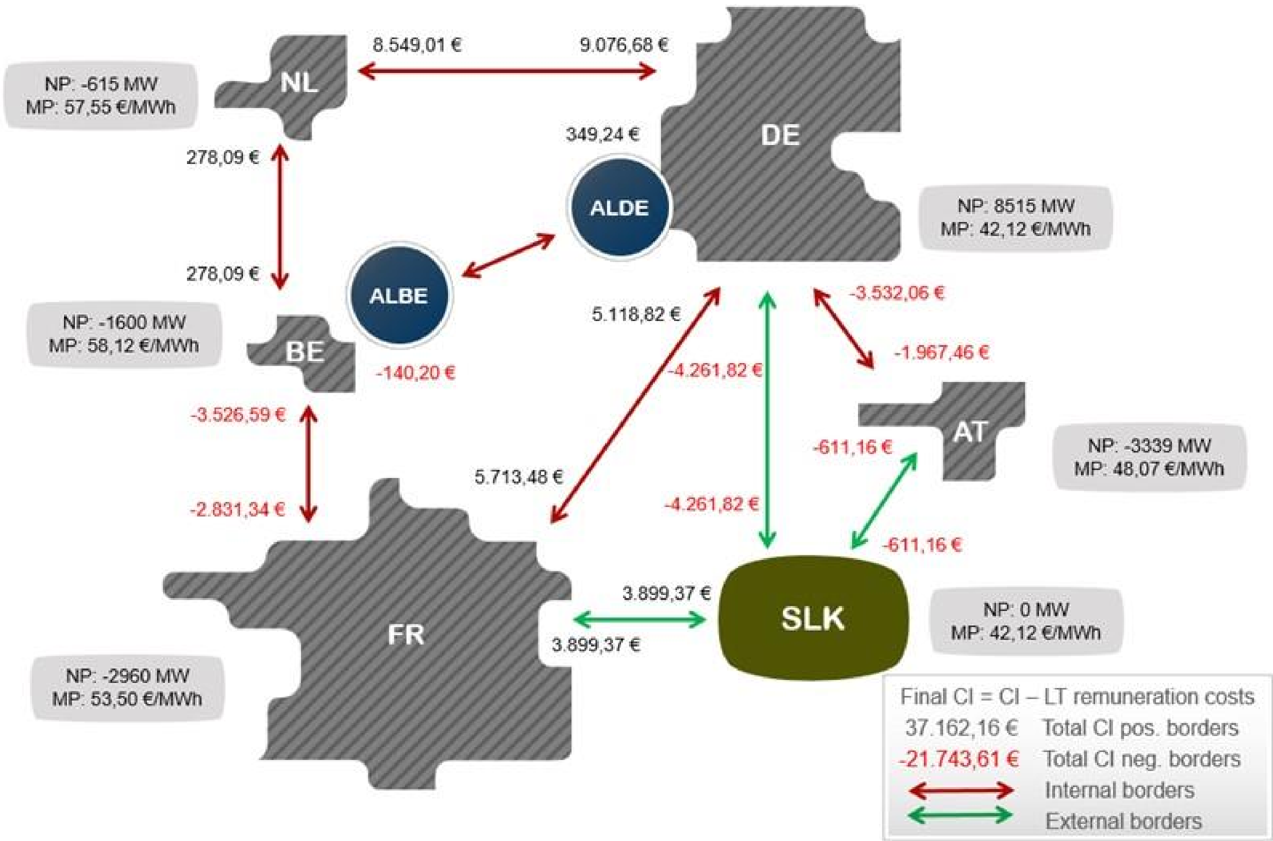


Figure 16: Combination of congestion income and long-term remuneration costs per hub border on each side of the border.

The hourly net income (income minus remuneration cost) should not lead to negative income per side of a hub border. In line with the remuneration methodology, the remuneration for any side of the hub border will initially be borne by its TSO. However, in case the income on a particular side of the hub border is not sufficient to cover these remuneration costs, these costs will be borne pro rata by the other hub borders (shown in the iteration of the cycle in Figure 1). This is referred to as 'socialization'.

In the given example only on the borders BE-NL, DE-FR, DE-NL and FR-SZ the resulting CI for both directions are positive and also the border direction BE-DE:DE is positive. For all other borders, the amount of remuneration is larger than the CI. However the total CI of the positive borders with 37.162,16 € is larger than the outstanding remuneration cost of -21.743,61 € for negative borders and therefore the CI of the positive borders will be proportionally assigned to the negative borders to balance them to zero (in fact based on LTA-inclusion principle of the DA-FB domain, the total CI shall be always larger or at least equal to the total remuneration cost).

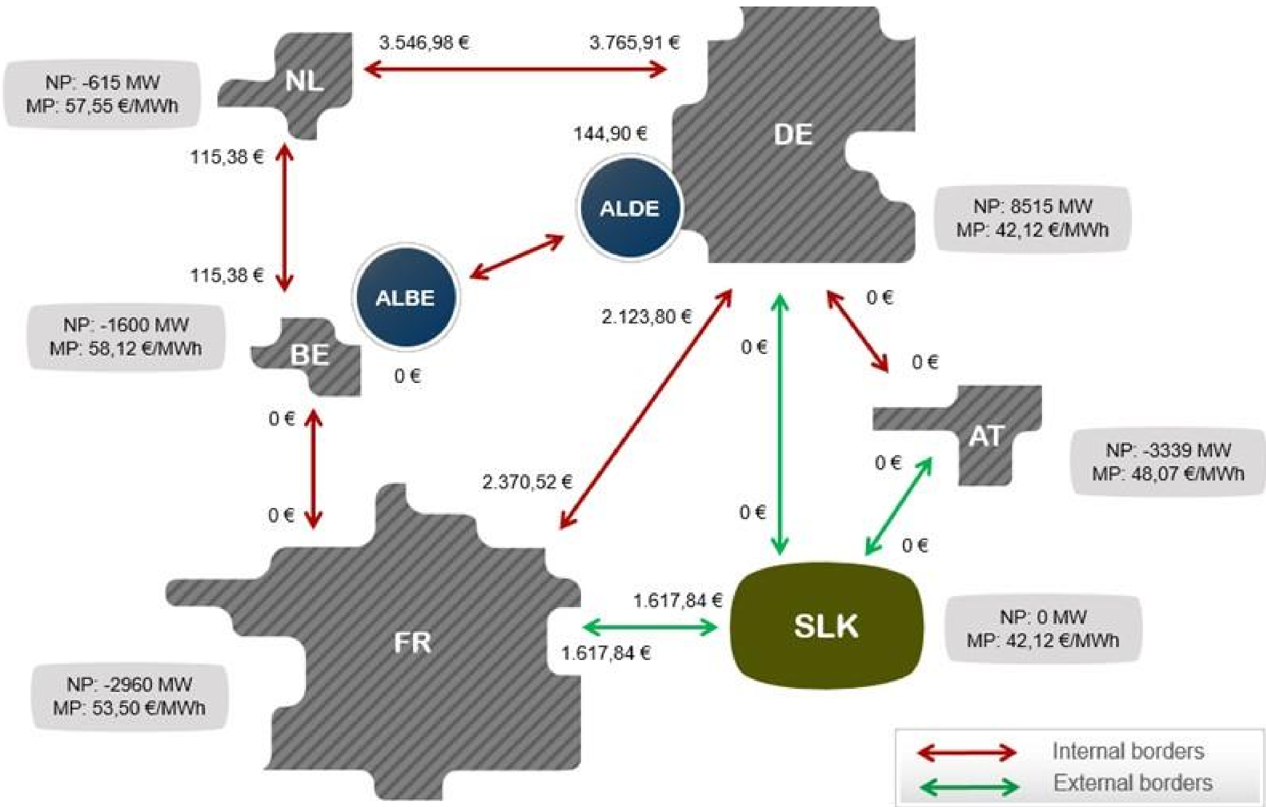


Figure 17: Net congestion income after socialization to all borders

After this socialization step it may occur that some CI is also assigned to the Slack Zone. As this is only a virtual hub, this does not make sense and therefore in a last step the CI resulting for the Slack Zone (1.617,84 € in our example) is proportional to the AAFs distributed to the internal BZBs. Summing up this to the CI per direction of BZBs resulting after consideration of remuneration cost and socialization, the final CI per direction of BZB is calculated as shown in Figure 18 and in Table 3. For the example the CI for evaluated sample hour is equal to 15.419 €. Based on the CI per side of BZB it is easy to sum up the CI per hub respectively per TSO(s).

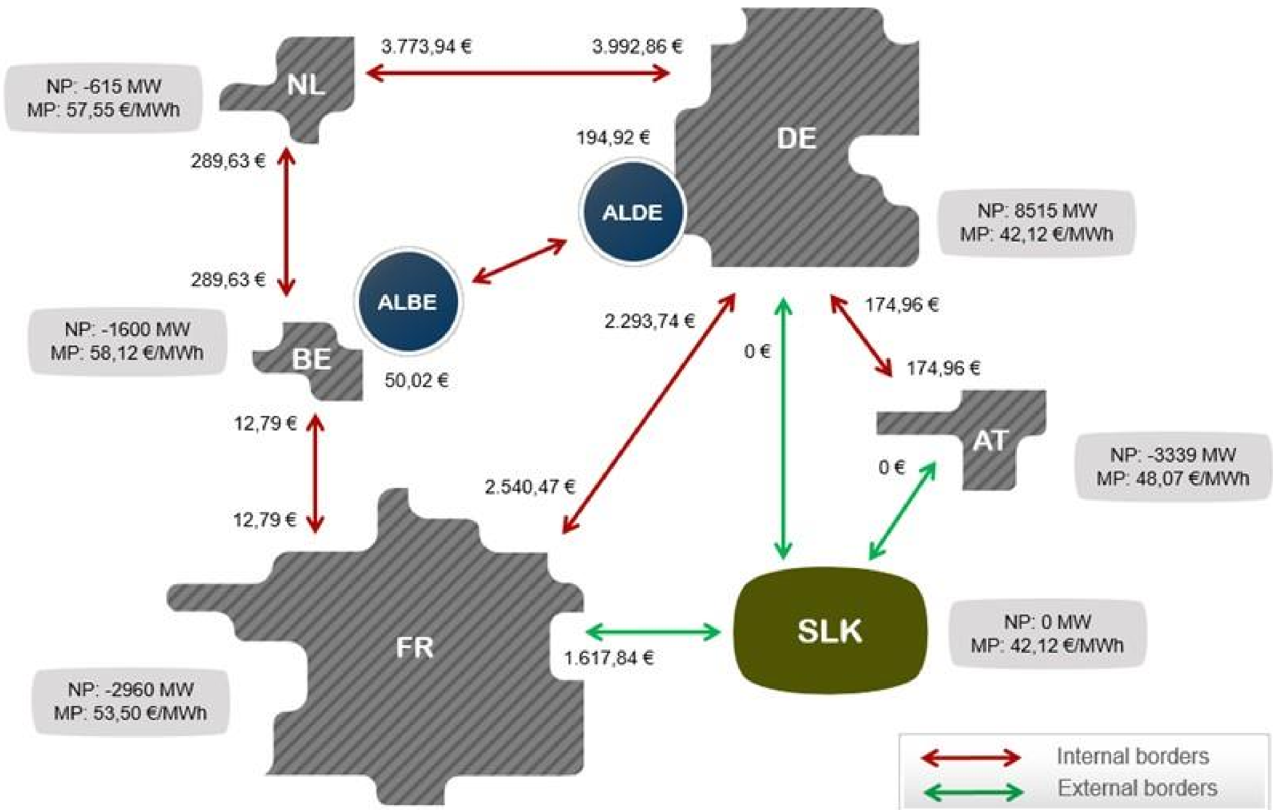


Figure 18: Net congestion income per hub border on each side of the border, after consideration of LT remuneration costs, socialization and sharing of the CI of the Slack Zone

Border	**Final CI per side of BZB** **15.419 €**
DE-FR.DE	2.293,74 €
DE-FR.FR	2.540,47 €
DE-NL.DE	3.992,86 €
DE-NL.NL	3.773,94 €
BE-FR.BE	12,79 €
BE-FR.FR	12,79 €
BE-NL.BE	289,63 €
BE-NL.NL	289,63 €

BE-DE.BE	50,02 €
BE-DE.DE	194,92 €
DE-AT.DE	174,96 €
DE-AT.AT	174,96 €
DE-SZ.DE	0 €
FR-SZ.FR	1.617,84 €
AT-SZ.AT	0 €

Table 3: Final congestion income on each side of the BZB

7.5 Additional issue linked to the remuneration with Flow-Based daily allocation

In the previous chapters, we have already seen that there is a one-to-one relation between the Long Term ATC capacity and the available margins on day-ahead critical branches.

For the above-mentioned reason, TSOs need to evaluate clearly what are the possible effects on the congestion income sharing, of the Long Term (non-harmonised) bilateral allocation of capacity on the one hand and of the fully coordinated Flow-Based allocation of capacity on the other.

Indeed, TSOs know that the Long-Term allocation income will be received by the two TSOs issuing the capacity on that border. In line with the remuneration methodology, the remuneration will initially be borne by those TSOs. However, in case their income through the Flow-Based allocation is not sufficient to cover this, the costs for that border might be borne by other/all TSOs (socialization), therefore also the Long-Term Rights need to be coordinated within the region.

8 Fallback Solutions

8.1 Application of Spanning

In case of application of the Spanning methodology as described in section 4.6 (*Backup and Fallback procedures for Flow Based capacity calculation*) of the Documentation of the CWE FB MC solution, the Congestion Income Allocation methodology cannot be applied due to missing input parameters. As a fallback solution, CWE TSOs will share the net congestion income based on a predefined distribution key in the hours that are affected by Spanning. This distribution key is equal to the relative shares of the total net congestion income of the month prior to the Spanning event. For example, if Spanning is applied during a single hour on 12 February 2020, each CWE TSO will receive a share of the CWE net congestion income of that hour that is equivalent to the TSO's share of the total monthly CWE congestion income that was generated in January 2020. For the avoidance of doubt, it should be noted that the regular allocation methodology[9] will be applied to the remaining hours that were not affected by the Spanning event.

8.2 Decoupling Situations (following the principles as defined in FCA article 61)

In case of decoupling of CWE bidding zones as described in section 6.2 (Fallback solutions) of the Documentation of the CWE FB MC solution, no congestion income from implicit market coupling is generated on CWE bidding zone borders. In such a situation, the income from explicit shadow auctions and the remuneration costs of LTRs will be shared on a per-border basis. Income and remuneration costs of a bidding zone border will be shared between the TSOs based on the distribution key that is applied to the sharing of income from the allocation of LTRs. For the avoidance of doubt, it should be noted that this principle also applies if the remuneration costs exceed the income from explicit shadow auctions.

The sharing keys for the distribution of income from the allocation of LTRs are subject to local arrangements and are not covered by the Congestion Income Allocation methodology at hand.

Section 8.2 is without prejudice to the provisions of the methodology FCA Art 61 currently under discussion.

8.3 Situation with activation of adequacy patch

In case the 'adequacy patch' in the market coupling algorithm as defined in Annex 14.31 – CWE Report: Comparison of Flow-Based Plain and Flow-Based Intuitive (2020) of the FBMC document is activated, the total net congestion income for TSOs could become negative. In such exceptional situations10, the sharing key of this negative net congestion income between the CWE TSOs will be elaborated ex-post by the CWE TSOs in coordination with CWE NRAs. The expectation is that costs resulting from such negative congestion income are recoverable as cost for allocation of capacity.

[9] In case of spanning, for the relevant hour(s) the CRDS-data shall be prepared without the PTDF values to avoid calculation of CIA-results based on incorrect input-data. For NRA-reporting however hors with spanning shall be considered for all evaluation where correct data (in accordance with data used for JAO invoicing) are available.

[10] Since the start of CWE Flow-Based Market Coupling in May 2015, the adequacy patch has not ever been activated.

9 Glossary

AAF	Additional aggregated flow
AC	Alternating current
ATC	Available Transfer Capacity
ATC MC	ATC Market Coupling
BZB	Bidding Zone Border
CB	Critical Branch
CBCPM	Cross Border Clearing Price x Market flows
CI	Congestion Income (from day-ahead Market Coupling)
CIA	Congestion Income Allocation
CIDM	Congestion Income Distribution Methodology
CP	Clearing Price
CRDS	Congestion Rent Distribution System
CWE	Central Western Europe
D-1	Day Ahead
DA	Day Ahead
DC	Direct current
EF	External Flow
EMS	Market Spread of External Flow
FB	Flow-Based
FBI	Flow Based Intuitive
FBP	Flow Based Plain
FBMC	Flow-Based Market Coupling
FTR	Financial Transmission Right
EFB	Evolved Flow-Based methodology
JAO	Joint Allocation Office
LT	Long Term
LTA	Allocated Long Term Transmission Capacity
LTN	Nominated Long Term Transmission Capacity
MC	Market Coupling
NP	Net Position (sum of commercial exchanges for one bidding area)
PCR	Price Coupling of Regions
PTDF	Power Transfer Distribution Factor
PTR	Physical Transmission Right
RAM	Remaining Available Margin
SZ	Slack Zone
SP	Shadow Price
TSO	Transmission System Operator
UIOSI	Use It or Sell It

Annex 1: Numerical example and proofs of remuneration costs versus flow-based income

1.1 Example: Remuneration costs higher than hourly congestion income in Flow-Based.

In order to understand better how the remuneration costs ‘work’ in Flow-Based, let’s assume the following example, for illustration purpose:

- Critical Branch CB1: internal line with increasing flows for any export outside hub A - margin available 100MW
- Remuneration of capacity from Hub A towards Hub B: 200MW – influencing factor on CB1 = 20%
- Remuneration of capacity from Hub A towards Hub C: 250MW – influencing factor on CB1 = 30%
- The double export of energy from Hub A is unrealistic since there is not enough production in Market A for this configuration.

In this situation, we know that we have sold too much capacity simultaneously, on both interconnections, however there is no physical risk due to the constraint on the production availability in hub A.

Nevertheless, if the clearing result of Market Coupling leads to the congestion of the Critical Branch CB1, we will have the following situation (by assuming a shadow price on CB1 = 50€):

- Overall congestion income :
  Margin on CB1 × Shadow Price on CB1 = 100 × 50 = **5 000€**
- Remuneration cost linked to 200MW of capacity between Hub A and Hub B
  (Capacity resold × influencing factor CB1)[11] × Shadow Price CB1[12]= 200 × 20% × 50 = **2 000€**
- Remuneration cost linked to 250MW of capacity between Hub A and Hub C
  (Capacity resold × influencing factor CB1 × Shadow Price CB1[13] = 250 × 30% × 50 = **3 750€**

In this situation, we have a remuneration cost that is higher than the total hourly congestion income from the Flow-Based Market coupling. In addition, we have to point out the fact that the congestion of this Critical Branch might appear even if the market results is not a double export from Hub A.

1.2 Example for the remuneration proof

The example described in this section shows that the remuneration cost are covered by the hourly congestion income as long as the LTA domain is within FB domain. The three nodes (shown in Figure) are connected by three lines that have equal impedance. Node C acts as the swingbus / slacknode. Let’s assume that the lines are unloaded and have a maximum capacity of 9MW.

---

[11] Margin freed by the resale of capacity on the critical branch

[12] Calculation linked to the high Level Property of Flow-Based allocation. In that respect, the Price in market A will be 2 000/200 = 10€ less expensive than in Market B.

[13] Calculation linked to the high Level Property of Flow-Based allocation. In that respect, the Price in market A will be 3 750/250 = 15€ less expensive than in Market C.

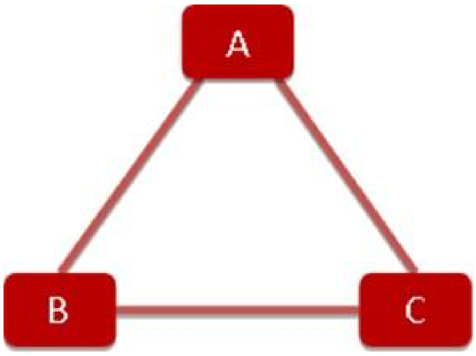


Figure 19: Example with three nodes

$$\begin{matrix} AB: \\ BC: \\ AC: \\ AB: \\ BC: \\ AC: \end{matrix} \begin{bmatrix} 1/3 & -1/3 \\ 1/3 & 2/3 \\ 2/3 & 1/3 \\ -1/3 & 1/3 \\ -1/3 & -2/3 \\ -2/3 & -1/3 \end{bmatrix} \begin{bmatrix} NP(A) \\ NP(B) \end{bmatrix} \leq \begin{bmatrix} 9 \\ 9 \\ 9 \\ 9 \\ 9 \\ 9 \end{bmatrix}$$

Figure 20: PTDF matrix

The FB domain is visualized in Figure .

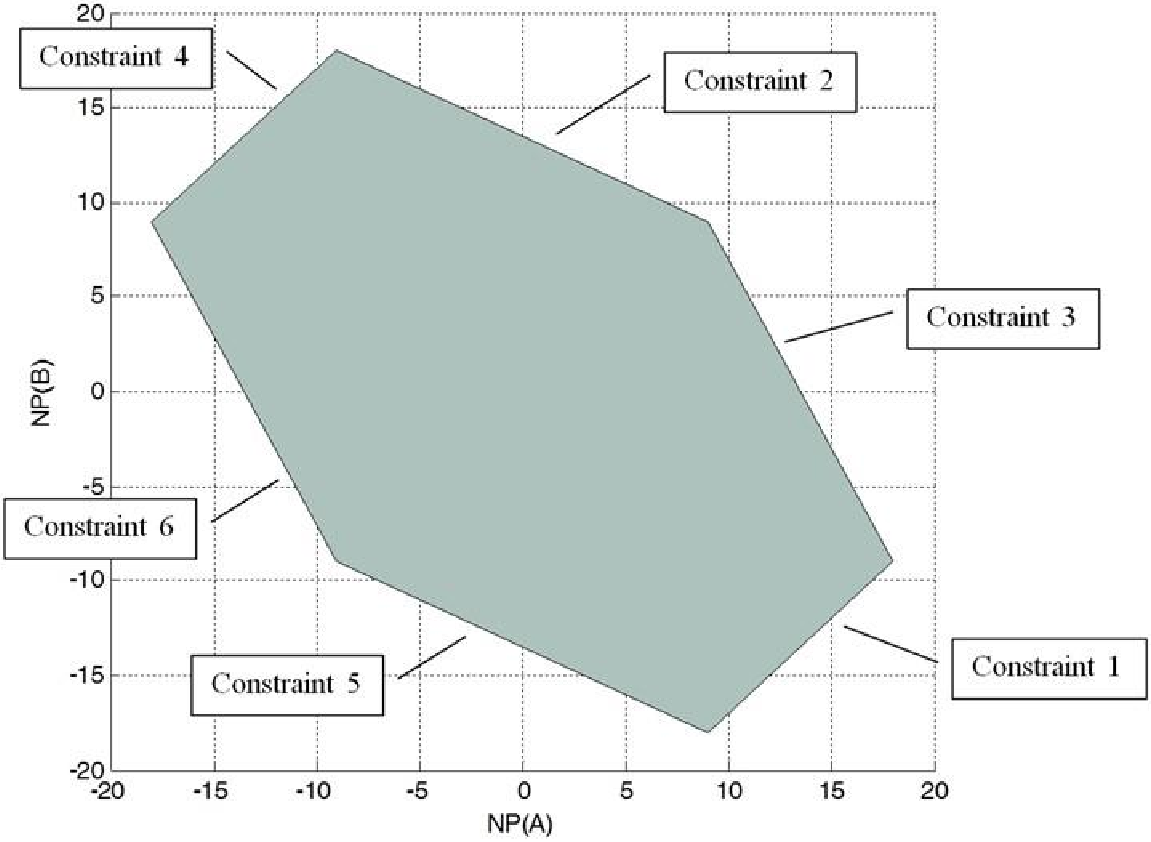


Figure 21: FB domain

The LTA are as follows: $\begin{bmatrix} A > B \\ A > C \\ B > C \\ B > A \\ C > A \\ C > B \end{bmatrix} = \begin{bmatrix} 13.5 \\ 0 \\ 13.5 \\ 0 \\ 13.5 \\ 0 \end{bmatrix}$

The LTA domain is shown, together with the FB one, in the following figure.

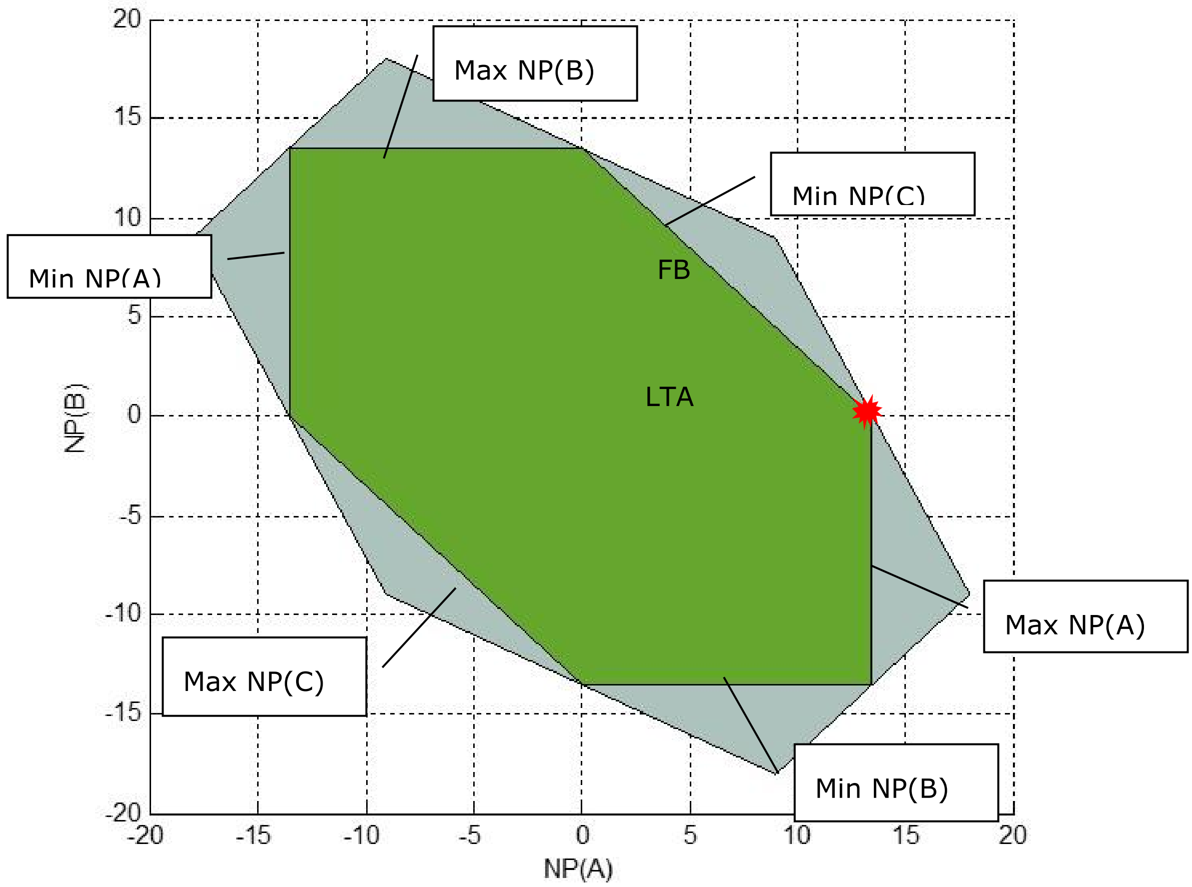


Figure 22: FB and LT domain

After the FBMC, a congested situation appears. Constraint 3 is hit (✸), and the following shadow price results: $\mu = 30$ €.

The resulting prices and net positions are:

$P_A = 10$ €, $NP_A = 13.5$

$P_B = 20$ €, $NP_B = 0$

$P_C = 30$ €, $NP_C = -13.5$

Maximum Remuneration Costs compensated at price spread is "Max RC":

$$\text{Max RC} = \sum_i \sum_{j \neq i} LTA_{i \to j} . \max\left(\left(P_j - P_i\right), 0\right) = 13.5 * 10 + 13.5 * 10 \ + 0 = 270 \text{ €}$$

For each border i→j, a set of bilateral exchanges $BE_{i \to j}$ is:

$$\begin{cases} BE_{i \to j} = LTA_{i \to j} & \text{if } P_j > P_i \\ BE_{i \to j} = -LTA_{j \to i} & \text{if } P_j < P_i \\ BE_{i \to j} = 0 & \text{if } P_j = P_i \end{cases}$$

$BE_{A \to B} = 13.5$, $BE_{B \to A} = -13.5$

$BE_{A\to C} = 0,\ BE_{C\to A} = 0$

$BE_{B\to C} = 13.5,\ BE_{C\to B} = -13.5$

Consider Q'_i as the net position associated with this set of exchanges $BE_{i\to j}$:

$\forall i \quad Q'_i = \sum_{j\neq i} BE_{i\to j}$ [b]

$\forall i,j \ \ BE_{i\to j} = -BE_{j\to i}$

$\sum_i Q'_i = \sum_i \sum_{j\neq i} BE_{i\to j} = 0$ [c]

$Q'_A = BE_{A\to B} + BE_{A\to C} = 13.5$

$Q'_B = BE_{B\to A} + BE_{B\to C} = -13.5 + 13.5 = 0$

$Q'_C = BE_{C\to A} + BE_{C\to B} = 0 - 13.5 = -13.5$

Indeed, $\sum_i Q'_i = 0$.

With [a] and [b], we are now able to rewrite:

$\text{Max RC} = \sum_i \sum_{j>i} BE_{i\to j} \cdot (P_j - P_i) = -\sum_i (Q'_i \cdot P_i)$ [d]

$\text{Max RC} = BE_{A\to B} * (P_B - P_A) + BE_{A\to C} * (P_C - P_A) + BE_{B\to C} * (P_C - P_B) = -P_A * (BE_{A\to B} + BE_{A\to C}) - P_B * (-BE_{A\to B} + BE_{B\to C}) - P_C * (-BE_{A\to C} - BE_{B\to C}) = -P_A Q'_A - P_B Q'_B - P_C Q'_C = -10 * 13.5 - 20 * 0 - 30 * -13.5 = 270$ €

Moreover the net position Q'_i is within the FB domain. Then:

$\forall l \in CB, \sum_i Q'_i \cdot PTDF_{i,l} \leq m_l$ [e]

Where CB is the group of all critical branches and m_l is the margin (available for DA MC) on the critical branch l. This margin is positive if the LT domain is included in the FB domain.

Indeed, the net positions are within the FB domain:

$$\begin{matrix} AB: \\ BC: \\ AC: \\ AB: \\ BC: \\ AC: \end{matrix} \begin{bmatrix} 1/3 & -1/3 \\ 1/3 & 2/3 \\ 2/3 & 1/3 \\ -1/3 & 1/3 \\ -1/3 & -2/3 \\ -2/3 & -1/3 \end{bmatrix} \begin{bmatrix} 13.5 \\ 0 \end{bmatrix} = \begin{bmatrix} 4.5 \\ 4.5 \\ 9 \\ -4.5 \\ -4.5 \\ -9 \end{bmatrix} \leq \begin{bmatrix} 9 \\ 9 \\ 9 \\ 9 \\ 9 \\ 9 \end{bmatrix}$$

The Congestion Income « CI » collected in D-1 can be written as:

$CI = -\sum_i (Q_i \cdot P_i) = \sum_{l\in CB} (\mu_l \cdot m_l)$ [f]

where μ_l is the shadow price of the critical branch l.

The Congestion Income in our example amounts

based on the computation with net positions and prices:

$\mathrm{CI} = -10 * 13.5 - 20 * 0 - 30 * -13.5 = 270$ €

based on the computation with shadow price and margin:

$\mathrm{CI} = 9 * 30 = 270$ €

Flow-Based clearing also has the following properties[14] :

$\forall \mathrm{l} \in \mathrm{CB}, \mu_{\mathrm{l}} \geq 0$ [g]

$\exists \mathrm{P_{ref}}$ such that $\forall \mathrm{i}, \mathrm{P_i} = \mathrm{P_{ref}} - \sum_{\mathrm{l} \in \mathrm{CB}} \mathrm{PTDF_{i,l}} \cdot \mu_{\mathrm{l}}$ [h]

With [f] and [d], we finally have:

$$\mathrm{CI} - \mathrm{Max\ RC} = \sum_{\mathrm{l} \in \mathrm{CB}} \mu_{\mathrm{l}} \cdot \mathrm{m_l} - (-\sum_{\mathrm{i}} \mathrm{Q'_i} \cdot \mathrm{P_i})$$

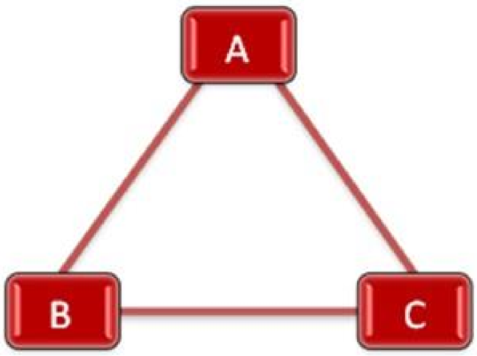
With [h], $= \sum_{\mathrm{l} \in \mathrm{CB}} \mu_{\mathrm{l}} \cdot \mathrm{m_l} + \sum_{\mathrm{i}} \mathrm{Q'_i} \cdot \left(\mathrm{P_{ref}} - \sum_{\mathrm{l} \in \mathrm{CB}} \mathrm{PTDF_{i,l}} \cdot \mu_{\mathrm{l}}\right)$

$= \sum_{\mathrm{l} \in \mathrm{CB}} \mu_{\mathrm{l}} \cdot \mathrm{m_l} + \mathrm{P_{ref}} \cdot \sum_{\mathrm{i}} \mathrm{Q'_i} - \sum_{\mathrm{i}}\left(\mathrm{Q'_i} \cdot \sum_{\mathrm{l} \in \mathrm{CB}} \mathrm{PTDF_{i,l}} \cdot \mu_{\mathrm{l}}\right)$

With [c], $= \sum_{\mathrm{l} \in \mathrm{CB}} \mu_{\mathrm{l}} \left(\mathrm{m_l} - \sum_{\mathrm{i}} \mathrm{Q'_i} \cdot \mathrm{PTDF_{i,l}}\right)$

1.3 Example (non-intuitive) for the remuneration proof

The example described in this section shows that the remuneration cost are covered by the hourly congestion income as long as the LTA domain is within the FB domain. The three nodes are connected by three lines that have equal impedance as shown in Figure . Node C acts as the swingbus / slacknode. Let's assume that the lines are unloaded and have different maximum capacities.



$$\begin{matrix} AB: \\ BC: \\ AC: \\ AB: \\ BC: \\ AC: \end{matrix} \begin{bmatrix} 1/3 & -1/3 \\ 1/3 & 2/3 \\ 2/3 & 1/3 \\ -1/3 & 1/3 \\ -1/3 & -2/3 \\ -2/3 & -1/3 \end{bmatrix} \begin{bmatrix} NP(A) \\ NP(B) \end{bmatrix} \leq \begin{bmatrix} 14.67 \\ 9.67 \\ 15.33 \\ 3.33 \\ 8.33 \\ 2.67 \end{bmatrix}$$

[14] Based on the following FB equation: $\frac{P_j - P_i}{PTDF_i - PTDF_j} = \mu_l \geq 0$

Figure 23: Example with three nodes

Figure 24: PTDF matrix

The FB domain is visualized in the graph hereunder.

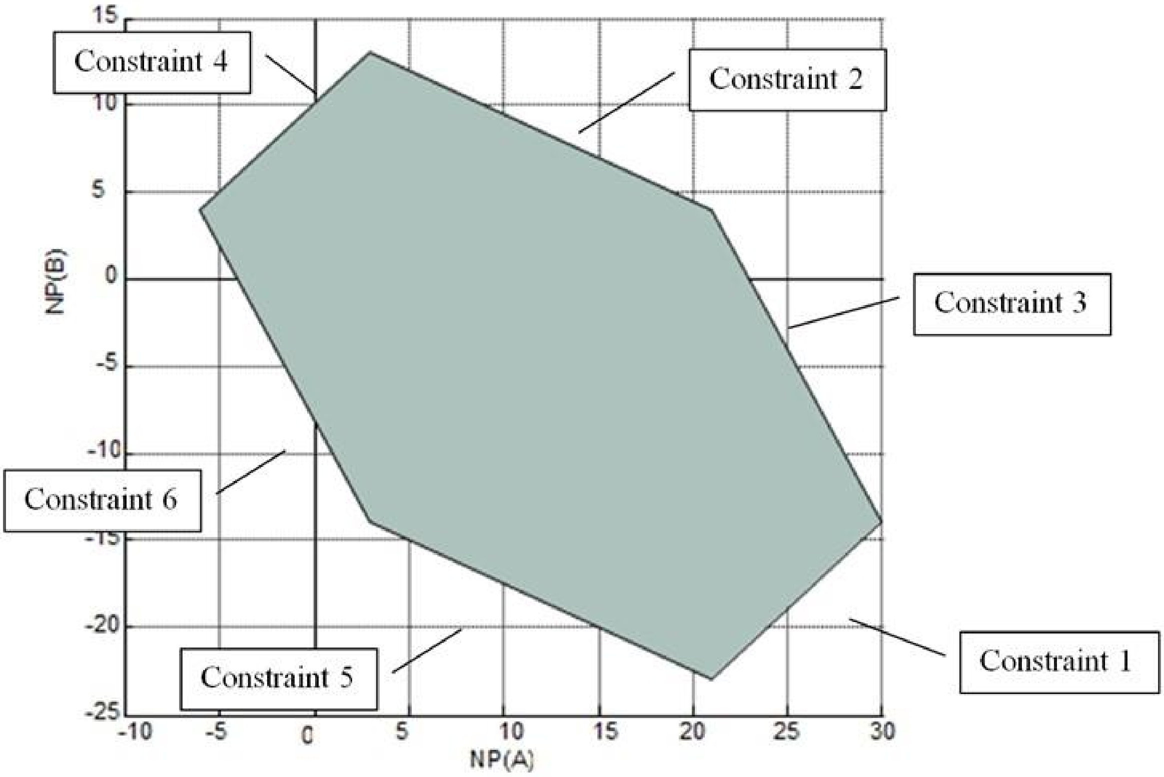


Figure 25: FB domain

The LTA are as follows: $\begin{bmatrix} A > B \\ A > C \\ B > C \\ B > A \\ C > A \\ C > B \end{bmatrix} = \begin{bmatrix} 7 \\ 8 \\ 10 \\ 0 \\ 0 \\ 8 \end{bmatrix}$.

The LTA domain is shown, together with the FB one, in the following figure.

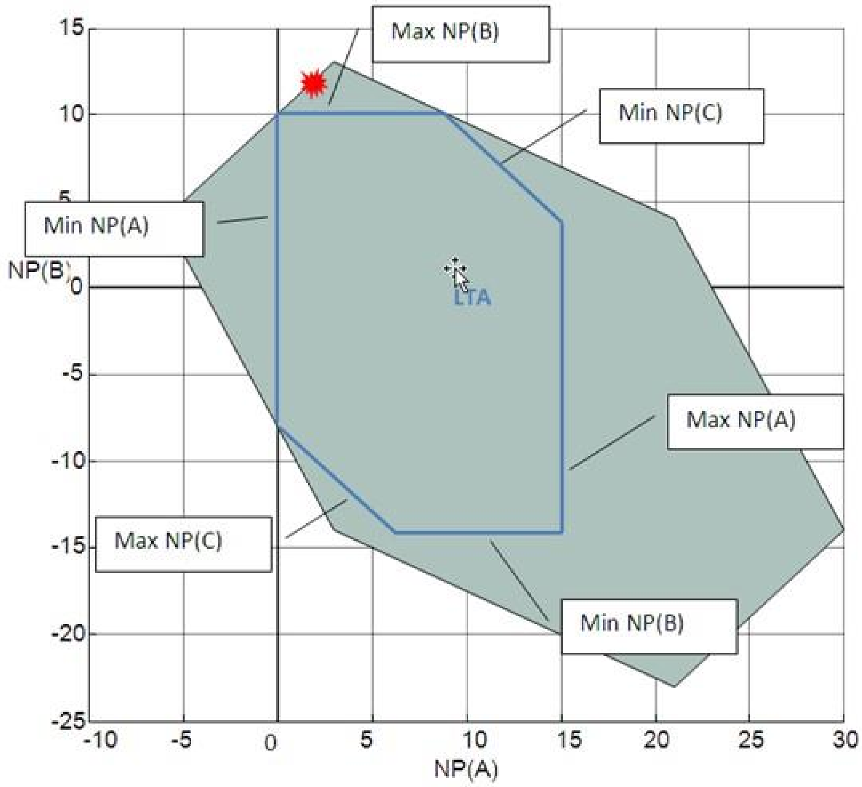


Figure 26: FB and LTA domain

After the FBMC, a congested non-intuitive situation appears. Constraint 4 is hit (✹), and the following shadow price results: $\mu = 30$ €.

The resulting prices and net positions are:

$P_A = 0$ €, $NP_A = 2$

$P_B = -20$ €, $NP_B = 12$

$P_C = -10$ €, $NP_C = -14$

Maximum Remuneration Costs compensated at price spread is « Max RC » :

$$\text{Max RC} = \sum_i \sum_{j \neq i} LTA_{i \to j} . \max\left(\left(P_j - P_i\right), 0\right) = 0 + 0 + 10 * (-10 + 20) + 0 = 100 \text{ €}$$

For each border i→j, a set of bilateral exchanges $BE_{i \to j}$ is:

$$\begin{cases} BE_{i \to j} = LTA_{i \to j} & \text{if } P_j > P_i \\ BE_{i \to j} = -LTA_{j \to i} & \text{if } P_j < P_i \\ BE_{i \to j} = 0 & \text{if } P_j = P_i \end{cases}$$

$BE_{A \to B} = 0$, $BE_{B \to A} = 0$

$BE_{A \to C} = 0$, $BE_{C \to A} = 0$

$BE_{B \to C} = 10$, $BE_{C \to B} = -10$

Consider Q'_i as the net position associated with this set of exchanges $BE_{i\to j}$:

$$\forall i \quad Q'_i = \sum_{j\neq i} BE_{i\to j} \qquad [b]$$

$$\forall i,j \quad BE_{i\to j} = -BE_{j\to i}$$

$$\sum_i Q'_i = \sum_i \sum_{j\neq i} BE_{i\to j} = 0 \qquad [c]$$

$$Q'_A = BE_{A\to B} + BE_{A\to C} = 0 + 0 = 0$$

$$Q'_B = BE_{B\to A} + BE_{B\to C} = 0 + 10 = 10$$

$$Q'_C = BE_{C\to A} + BE_{C\to B} = 0 - 10 = -10$$

Indeed, $\sum_i Q'_i = 0$.

With [a] and [b], we are now able to rewrite:

$$\text{Max RC} = \sum_i \sum_{j>i} BE_{i\to j} \cdot (P_j - P_i) = -\sum_i (Q'_i \cdot P_i) \qquad [d]$$

$\text{Max RC} = BE_{A\to B} * (P_B - P_A) + BE_{A\to C} * (P_C - P_A) + BE_{B\to C} * (P_C - P_B) = -P_A * (BE_{A\to B} - BE_{A\to C}) - P_B * (BE_{A\to B} - BE_{B\to C}) - P_C * (BE_{A\to C} - BE_{B\to C}) = -P_A Q'_A - P_B Q'_B - P_C Q'_C = 0 * 0 - (-20 * 10) - (-10 * -10) = 200 - 100 = 100$ €

Moreover the net position Q'_i is within the FB domain. Then:

$$\forall l \in CB, \sum_i Q'_i \cdot PTDF_{i,l} \leq m_l \qquad [e]$$

where CB is the group of all critical branches and m_l is the margin (available for DA MC) on the critical branch l. This margin is positive if the LT domain is included in the FB domain.

Indeed, the net positions are within the FB domain:

$$\begin{array}{l} AB: \\ BC: \\ AC: \\ AB: \\ BC: \\ AC: \end{array} \begin{bmatrix} 1/3 & -1/3 \\ 1/3 & 2/3 \\ 2/3 & 1/3 \\ -1/3 & 1/3 \\ -1/3 & -2/3 \\ -2/3 & -1/3 \end{bmatrix} \begin{bmatrix} 0 \\ 10 \end{bmatrix} = \begin{bmatrix} -3.33 \\ 6.67 \\ 3.33 \\ 3.33 \\ -6.67 \\ -3.33 \end{bmatrix} \leq \begin{bmatrix} 14.67 \\ 9.67 \\ 15.33 \\ 3.33 \\ 8.33 \\ 2.67 \end{bmatrix}$$

The Congestion Income « CI » collected in D-1 can be written as :

$$CI = -\sum_i (Q_i \cdot P_i) = \sum_{l\in CB} (\mu_l \cdot m_l) \qquad [f]$$

where μ_l is the shadow price of the critical branch l.

The Congestion Income in our example amounts

based on the computation with net positions and prices:

$$\mathrm{CI} = -0 * 2 - (-20 * 12) - (-10 * -14) = 240 - 140 = 100\,€$$

based on the computation with shadow price and margin:

$$\mathrm{CI} = 3.33 * 30 = 100\,€$$

Flow-Based clearing also has the following properties15 :

$$\forall \mathrm{l} \in \mathrm{CB},\ \mu_{\mathrm{l}} \geq 0 \qquad [g]$$

$$\exists \mathrm{P_{ref}} \text{ such that } \forall \mathrm{i}, \mathrm{P_i} = \mathrm{P_{ref}} - \sum_{\mathrm{l} \in \mathrm{CB}} \mathrm{PTDF_{i,l}} \cdot \mu_{\mathrm{l}} \qquad [h]$$

With [f] and [d], we finally have:

$$\mathrm{CI} - \mathrm{Max\ RC} = \sum_{\mathrm{l} \in \mathrm{CB}} \mu_{\mathrm{l}} \cdot \mathrm{m_l} - \left(-\sum_{\mathrm{i}} \mathrm{Q'_i} \cdot \mathrm{P_i}\right)$$

With [h] $= \sum_{\mathrm{l} \in \mathrm{CB}} \mu_{\mathrm{l}} \cdot \mathrm{m_l} + \sum_{\mathrm{i}} \mathrm{Q'_i} \cdot \left(\mathrm{P_{ref}} - \sum_{\mathrm{l} \in \mathrm{CB}} \mathrm{PTDF_{i,l}} \cdot \mu_{\mathrm{l}}\right)$

$$= \sum_{\mathrm{l} \in \mathrm{CB}} \mu_{\mathrm{l}} \cdot \mathrm{m_l} + \mathrm{P_{ref}} \cdot \sum_{\mathrm{i}} \mathrm{Q'_i} - \sum_{\mathrm{i}} \left(\mathrm{Q'_i} \cdot \sum_{\mathrm{l} \in \mathrm{CB}} \mathrm{PTDF_{i,l}} \cdot \mu_{\mathrm{l}}\right)$$

With [c], $= \sum_{\mathrm{l} \in \mathrm{CB}} \mu_{\mathrm{l}} \left(\mathrm{m_l} - \sum_{\mathrm{i}} \mathrm{Q'_i} \cdot \mathrm{PTDF_{i,l}}\right)$

With [g] and [e], ≥ 0

In our example, the Congestion Income is equal to the Remuneration Costs:

$$\mathrm{CI} - \mathrm{Max\ RC} = 100 - 100 = 0$$

[15] Based on the following FB equation: $\frac{P_j - P_i}{PTDF_i - PTDF_j} = \mu_l \geq 0$

Annex 2: Detailed modelling of the special ALBE-/ALDE-PTDFs for the BE-DE border

The impact of ALEGrO on the CIA is twofold

(1) Impact on the AAFs of all AC-borders

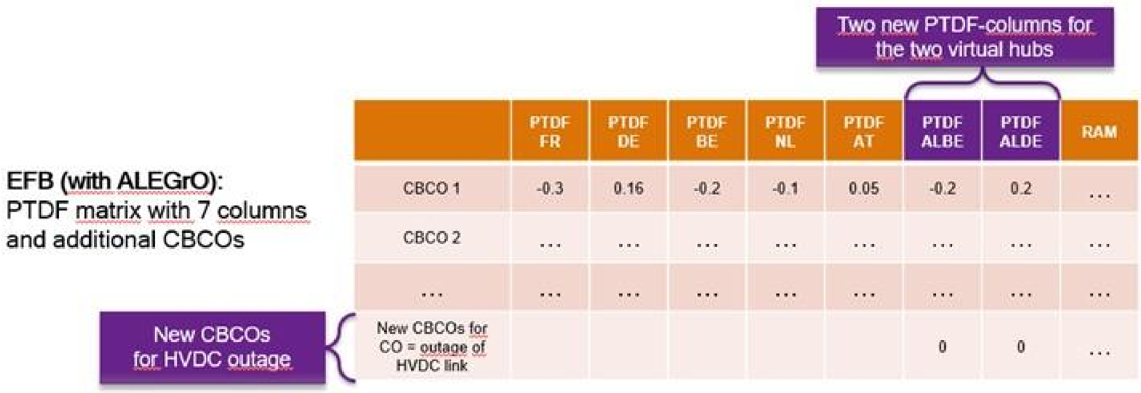
- For this the classical relationship AAFs = PTDFs * NetPositions holds directly true, also with virtual hubs (see Eq. 2).

(2) A new AAF at the DC-border BE-DE

- For this the same equation should hold true, which requires some care in the used PTDFs

Difference of an active DC link (e.g. ALEGrO) vs. passive AC lines

- The DC link is an active, controllable element of the grid. The flow through it is actively chosen (a setpoint, selected in the day-ahead by market coupling).
- This is a significant contrast to a passive AC element: the flow through an AC element depends on the topology and the generation/load situation
  - In FB, the flow through an AC element is described as a function of zonal PTDFs and net positions
  - The same applies to the AAF for a border where the XB-lines are AC links (current status quo of CIA)



	PTDF FR	PTDF DE	PTDF BE	PTDF NL	PTDF AT	PTDF ALBE	PTDF ALDE	RAM
CBCO 1	-0.3	0.16	-0.2	-0.1	0.05	-0.2	0.2	…
CBCO 2	…	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…
New CBCOs for CO = outage of HVDC link						0	0	…

The AAF for the DC link on the BE-DE borders is obtained as follows:

- The flow through ALEGrO is not a result of all other net positions. Nevertheless, the AAF of the BE-DE border is modelled in the same way as for all AC-borders (see Eq. 2).
- This is ensured by making use of the ALEGrO modelling in EFB by two virtual hubs. The net positions of these virtual hubs are equal to the flow through the DC link (e.g. a flow from Germany to Belgium is 100 MW leads to a net position in ALBE of +100 and in ALDE of -100).

The flow through ALEGrO can be deducted directly from the net position of either one of the virtual hubs. This is represented by a "virtual tie-line" for CIA purposes in the PTDF matrix file, where we find the following.

Constraint	PTDF ALBE	PTDF ALDE	All other PTDFs
BLIXHE12 XLI_OB1B 1	1	0	0
D7OBZI1A XLI_OB1A 1	0	1	0

It must be considered that this information is available **twice**, because we have two virtual hubs while there is only one single flow through the interconnector.

Hence, for determining correct AAFs for CIA, we only need to take into account the flow through ALEGrO once. Hereby it is ensured that the Equation 2 still holds true also for the AAF of the BE-DE border. Therefore only one of the PTDF values of the virtual hubs needs to be taken into account (the other one should be "neglected") to ensure a correct congestion income allocation[16].

[16] This attention point is operationally ensured in two ways. Within the Matlab scripts used in the CRDS tool it is directly encoded that only one PTDF value of a virtual hub is considered. For the delivery of the excel CRDS files by JAO on a daily basis to TSOs. JAO only takes into account the hubs/border directions which are predefined in the CRDS Input file. For the BE-DE border this is the direction BE>DE. This means that the border direction ALBE-BE>DE (0) and ALDE-BE>DE (1) is used. And the border direction ALBE-DE>BE (1) and ALDE-DE>BE (0) is ignored, which gives as outcome that only once the PTDF value of a virtual hub is considered.

Report on Congestion Income Distribution in Central Western Europe Flow Based Market Coupling after Twelve Months of Operation of the Bidding Zone Border between Austria and Germany/Luxembourg

1. Introduction

With the introduction of the bidding zone border between Germany/Luxembourg and Austria, the approval documents of the CWE Flow Based Market Coupling have been amended. This also included an amendment of the Congestion Income Allocation approval document, which was adjusted in order to detail the distribution of congestion income between the five bidding zones of the CWE region. At the time the approval document was submitted to regulatory authorities, CWE parties did not have reliable information regarding the development of market parties behavior and the evolvement of order books after the introduction of the additional bidding zone border. Consequently, there was very little insight into the actual distributional effects of the amended Congestion Income Allocation methodology. Therefore, a disclaimer was included in the amended methodology document which stated that an analysis of these distributional effects needs to be performed after six and after twelve months of operation of the German-Austrian bidding zone border within the CWE region.

The document at hand is the final report on the distributional effects of the Congestion Income Allocation methodology after the introduction of the German-Austrian bidding zone border, covering twelve months of operational data from 01 October 2018 until 30 September 2019. In order to evaluate the observations, the distribution of income is compared against a period of twelve months before the introduction of the additional bidding zone border, with data from 01 October 2017 until 30 September 2018 as reference period. The report aims at giving insights into the distributional effects of the CWE Congestion Income Allocation methodology, with a clear focus on the socialization principle and on the treatment of external flows.

2. Background and Approach

Flow Based Market Coupling has been introduced on 20 May 2015 in the bidding zones of Belgium, France, Germany/Austria/Luxembourg and the Netherlands. The flow based allocation of cross-zonal capacities required a completely new design of congestion income distribution principles, as this income could not be calculated and distributed on the basis of simple bilateral flows. Therefore, a distribution methodology has been implemented that coped with the complexities of this allocation approach. This methodology is based on a principle that is called *Cross Border Clearing Price times Market Flows Absolute (CBCPM ABS)*, which best met the nine selected design criteria. Since its introduction, CWE Flow Based Market Coupling has undergone several changes, e.g. the inclusion of a minimum Remaining Available Margin (RAM) of 20% in April 2018.

However, it was only until the introduction of an additional bidding zone border that a change in the congestion income allocation methodology was required, namely the split of the German/Austrian/Luxembourgian bidding zone into separate German/Luxembourgian and Austrian bidding zones and the addition of the new bidding zone border between these separated bidding zones. This new setup resulted in two changes in the congestion income allocation methodology, with the mere addition of an additional bidding zone as one change. However, the treatment of external flows also required a design change. External flows have always been handled in the CWE congestion income allocation methodology, as not all CWE net positions can be balanced by internal flows only (the so-called *additional aggregated flows, AAF*). Before the introduction of the separate Austrian hub, the external flow was easily determined as the flow that balanced the hubs of France and Germany/Austria/Luxembourg after considering their relevant AAFs (internal flows), as these were the only hubs with an open (i.e. non-CWE) AC border. With the introduction of the Austrian bidding zone, there are now three hubs with open borders. As a consequence, the provisions in the CWE congestion income allocation methodology regarding the determination and the sharing of the external pot needed to be completely revised, which resulted in the introduction of the *Slack Zone* approach. Three external separate flows are determined (Austria to Slack Zone, France to Slack Zone and Germany/Luxembourg to Slack Zone) such that these flows balance the internal net position of the Austrian, French and German/Luxembourgian hubs. The virtual price of the Slack Zone is calculated such that it minimizes the value of the so-called external pot.

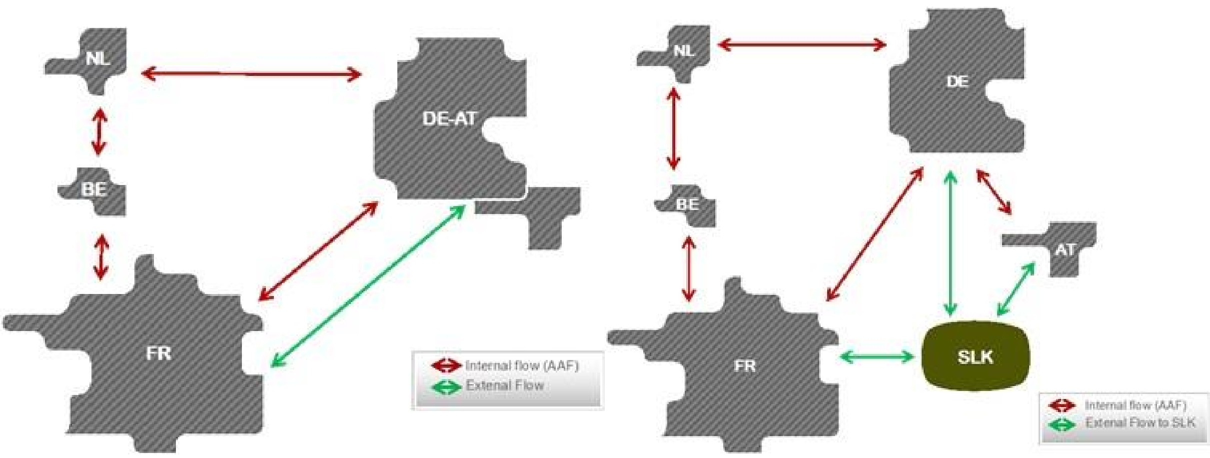


Figure 1: Structure of CWE CCR before- and after the split

The report at hand therefore aims at evaluating the distributional effects of the abovementioned two changes. The interest in this evaluation is even higher against the background of the amount of 4.9 GW of Long Term Transmission Rights, which are allocated on the bidding zone border between Germany/Luxembourg and Austria in the form of Financial Transmission Rights (FTRs). As one of the features of Flow Based Market Coupling, there is no immediate link between the allocation of cross-zonal capacities in different timeframes, meaning that – even though 4.9 GW of LTTRs have been allocated on the DE/AT border, there does not need to be a flow in the day-ahead timeframe that is equivalent to these 4.9 GW. Even though the so-called Long Term Inclusion guarantees that sufficient cross-zonal capacity is available that would allow for a flow of 4.9 GW in the day-ahead timeframe, the utilization of these capacities is determined by the welfare-optimizing market coupling algorithm. Consequently, the remuneration of LTTRs (which is equivalent to the day-ahead price spread times the volume of LTTRs) is not necessarily covered by the congestion income that has been generated in the day-ahead timeframe (this is in contrast to ATC DA-Market Coupling,, where the remuneration of LTTRs from income that is generated in the day-ahead timeframe is a well-established principle). Against this background, the CWE congestion income allocation methodology foresees a socialization principle. This means that any deficit for the remuneration of LTTRs on an individual border is covered pro-rata by day ahead congestion income of other borders, following the rationale that these other borders have gained from using the margins that have not been allocated to the border with insufficient day ahead income. This principle is also in line with an orientation on welfare distribution, as the welfare optimizing market algorithm distributes the margins to those flows that generate the highest additional welfare. If a bidding zone profits from this additional welfare, it is in the position to support those bidding zone borders where the day ahead congestion income is not sufficient to cover the remuneration costs of LTTRs (socialization principle). Moreover, the total congestion income of the region that applies flow based market coupling is always sufficient to cover all LTTR remuneration costs of the region, provided that the volumes of LTTRs are covered within the flow based capacity domain (so-called Long Term Inclusion). This reports aims at investigating to what the extent the bidding zone border between Germany/Luxembourg and Austria with its 4.9 GW of LTTRs behaves proportionally in comparison to other bidding zone borders of the CWE region. This includes aspects of the overall amount of socialization volumes, and their distribution between borders and bidding zones.

In order to exclude as much as possible seasonal effects, the approach of this evaluation has been to compare twelve calendar months from before and after the implementation of the bidding zone border between Germany/Luxembourg and Austria. Twelve months of operational data from 01 October 2018 until 30 September 2019 is compared against twelve months of operational data from 01 October 2017 until 30 September 2018. Operational data was taken from the monthly Congestion Income Allocation reports to CWE regulatory authorities and from the daily input and output files of the Congestion Revenue Distribution System (CRDS), which is operated by the Joint Allocation Office on behalf of CWE TSOs. Quantitative indicators were defined and calculated from this data, and additional indicators were defined to structure the analysis and enable to answer above questions.

3. Factual Information

This report compares operational data from two different periods (01 October 2017 until 30 September 2018 against 01 October 2018 until 30 September 2019) in order to evaluate methodological changes that were introduced with the go-live of the bidding zone border between Germany/Luxembourg and Austria on 01 October 2018. However, the operational results of the congestion income allocation methodology are highly dependent on the overall market conditions. Therefore, all results in this report only give an indication of possible effects of the amended distribution methodology; however there are multiple other factors of influence on the final congestion income allocation. These factors include, among others, changes in generation costs of thermal power plants which are linked to commodity prices like steam coal, natural gas or emission certificates. Additionally, also the availability of thermal power plants, especially of nuclear power plants, has an effect on market results and thus on the congestion rents. Moreover, the availability of renewable energies is an exogenous factor with impact on the indicators that are observed here. It should be also noted that this report also covers the extremely dry summer season of 2018, which was characterized by low availability of hydro power plants and high transportation costs for steam coal on river barges. Generally, and as has already been noticed in multiple other reports, the actual infeed from renewable energy sources and the load are very sensitive to weather conditions, especially during the winter period.

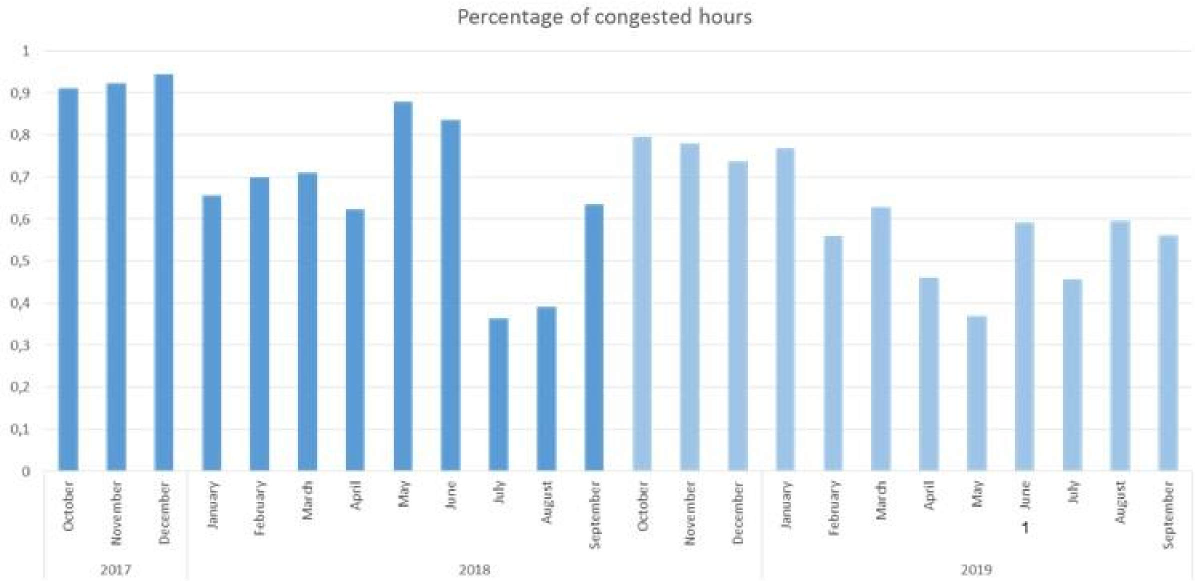
The introduction of the 20% minRAM measure on 26 April 2018 also constituted a structural change in the availability of cross-zonal capacities and thus in the overall market conditions. Furthermore, the split of the German/Austrian/Luxembourgian bidding zone itself resulted in changes in the bidding behavior of market participants, as OTC trades between Germany and Austria were not possible anymore and all trades had to be shifted to Nominated Electricity Market Operators (NEMOs). This structural change of the bidding behavior distorts the calculation of producer surplus and consumer surplus for the German/Luxembourgian and the Austrian bidding zone, as results before and after the split of the joint bidding zone cannot be compared to each other.[17]

All these considerations underline that the changes that can be observed in the different indicators of this report cannot be ultimately linked to the go-live of the bidding zone border between Germany/Luxembourg and Austria, as it was not possible to isolate different factors of influence.

[17] The shift of trading activities to the NEMOs increases welfare by definition, as previously the OTC trades within the joint German/Austrian/Luxembourgian bidding zone have not been included in the calculation of welfare indicators

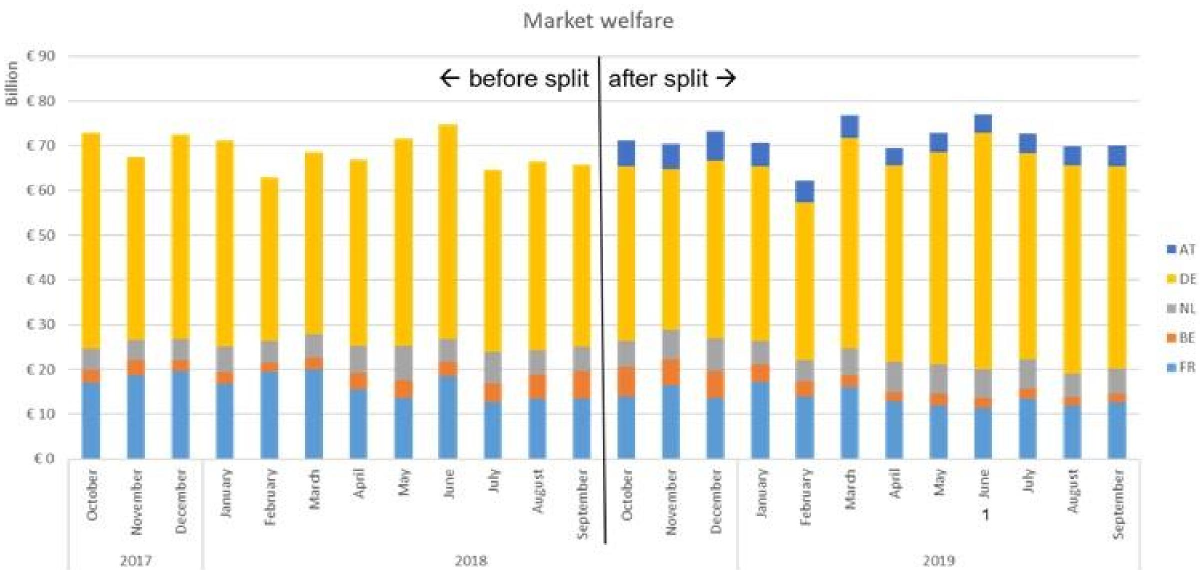
a. Percentage of congested hours

This indicator details the percentage of hours in which at least two different prices occurred in the flow-based capacity calculation region. Price convergence (i.e. all bidding zones of the CWE region had the same market clearing price) increased after the split by about 10 percentage points (from 71% of congested hours to 61%).

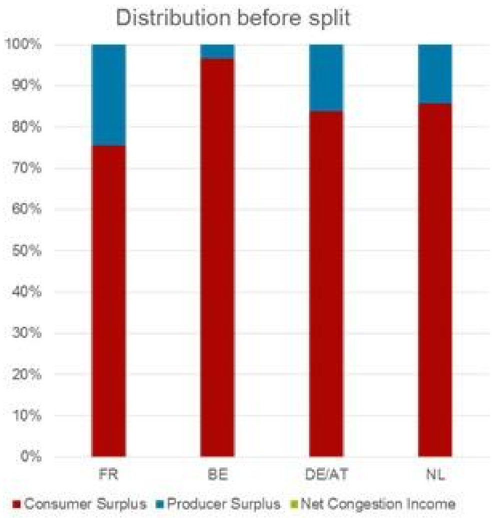


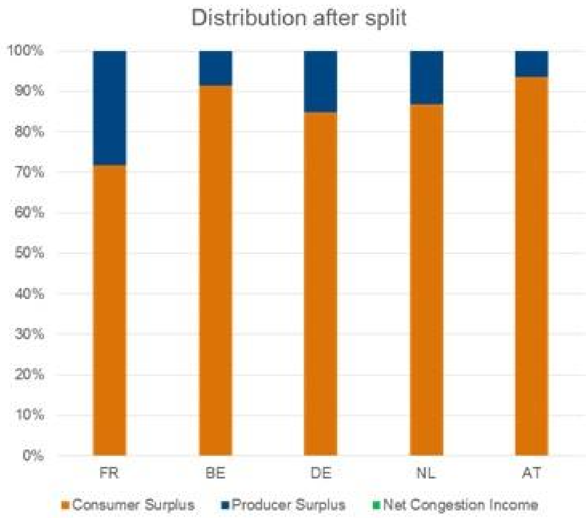
b. Total market welfare

This indicator describes the development of total market welfare (i.e. the total of consumer surplus, producer surplus and congestion rents) over time and per bidding zone, as calculated by the market coupling algorithm. Again, it should be noted that welfare indicators for the separated German/Luxembourgian and Austrian bidding zones are hard to be compared before and after the split of the joint bidding zone, as the shift of orders from OTC trade to the Single Day Ahead Coupling inevitably resulted in increased trading volumes, and consequently higher welfare numbers.



1) For June 2019 the day of the decoupling was excluded.

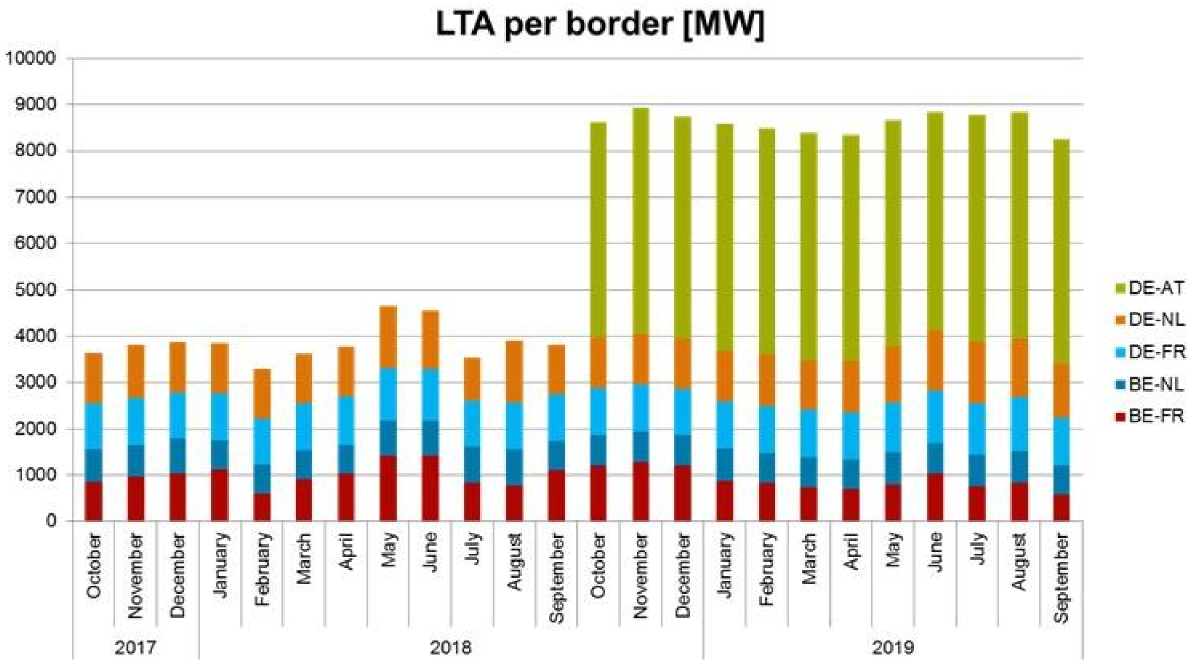




In line with the overall development of total social welfare, the individual share of consumer surplus, producer surplus and congestion income can be displayed for each bidding zone separately. Most notably, the share of congestion income is negligible in comparison to consumer and producer surplus.

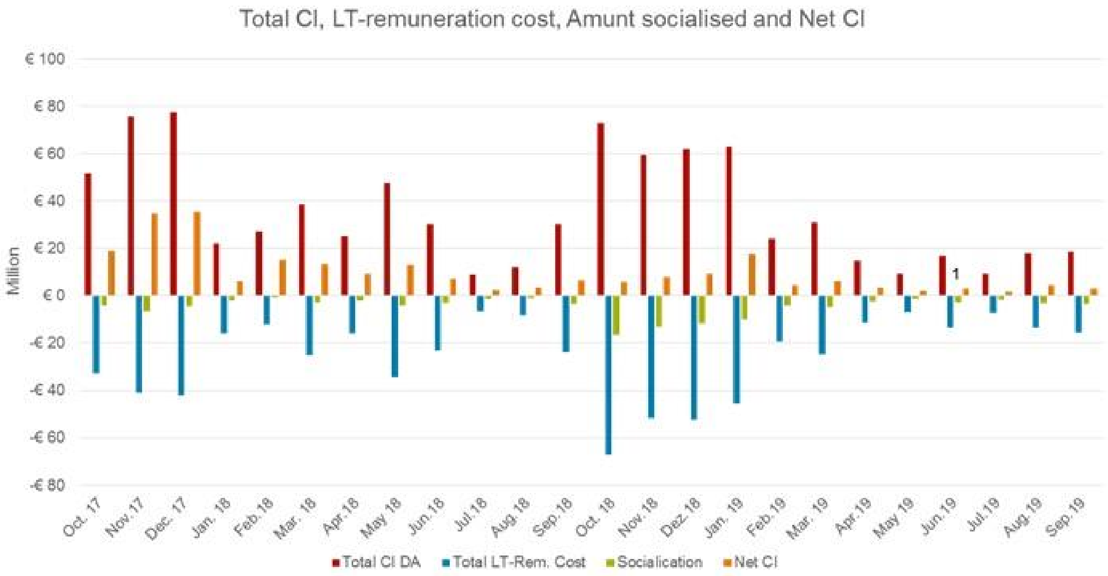
c. Long Term Transmission Rights (LTTRs) allocated per border

This indicator displays the Long Term Transmission Rights (LTTRs) allocated per border by JAO as sum of yearly and monthly auctions.



d. Overview of Congestion Income, remuneration costs and socialization of LTTRs

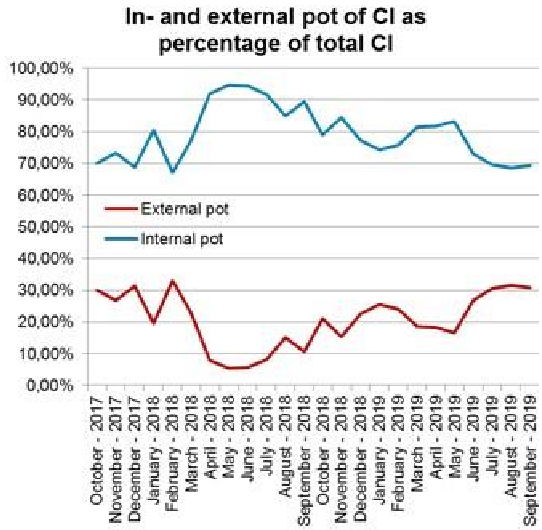
The below graph comprises four different indicators. The total congestion income is the absolute value of congestion income generated by day ahead market coupling before remuneration of LTTRs (gross congestion income). Additionally, the costs for the remuneration of LTTRs are shown, as well as the amount of remuneration costs which are not covered by the day ahead congestion income on a given bidding zone border and which consequently are socialized (socialization), and finally the resulting net congestion income. All indicators are summed up over all CWE internal borders and are therefore totals for the entire CWE region.

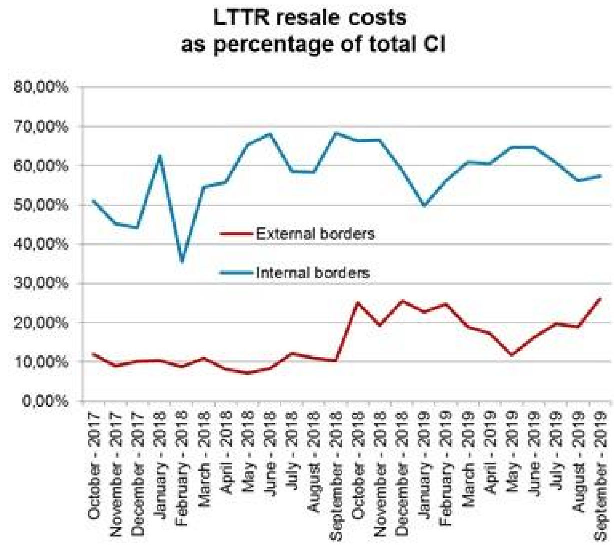


1) For June 2019 the day of the decoupling was excluded.

e. Remuneration costs

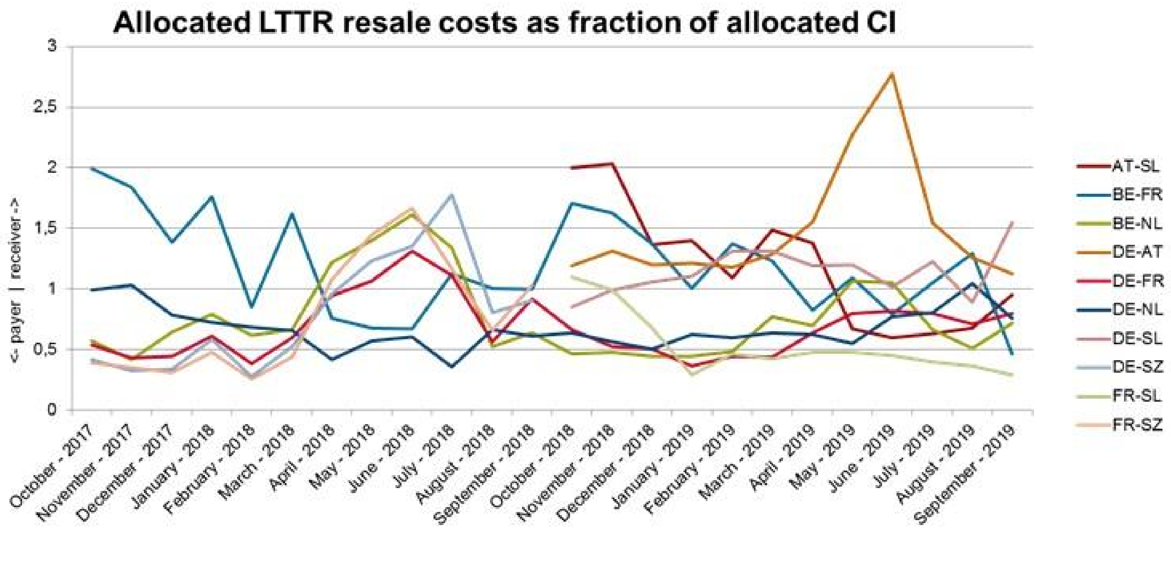
The two graphs below compare the relative distribution of remuneration costs for LTTRs in the internal and external pots. The left graph indicates the division of the total Congestion Income between the internal and external pots for the entire CWE region, whereas the right graph indicates the remuneration costs of LTTRs relative to the total congestion income, and split up according to their allocation to internal and external borders.





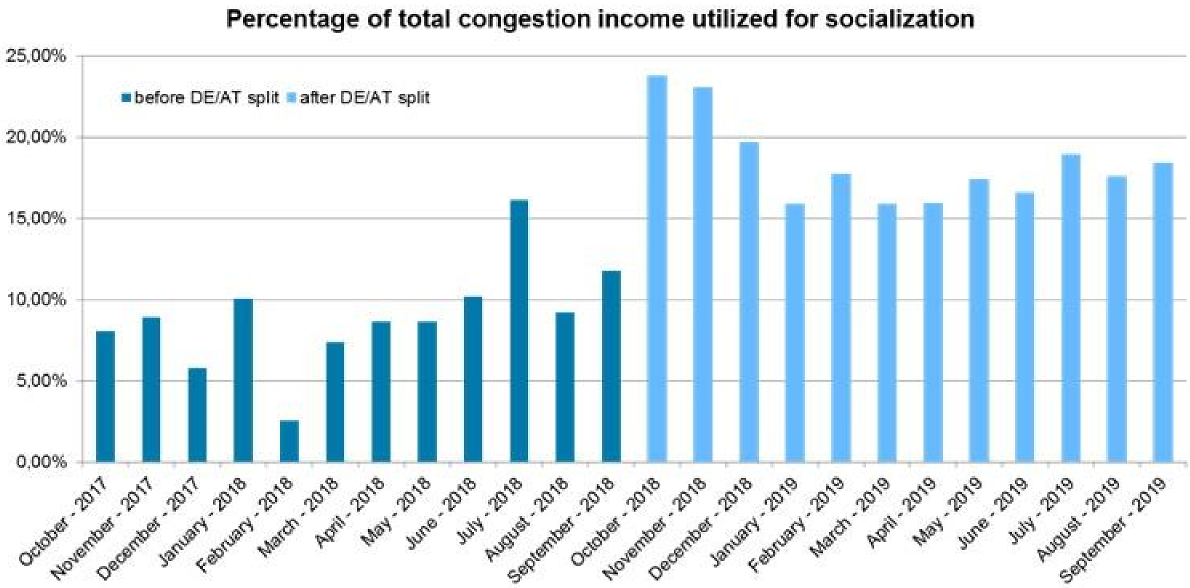
f. Allocated LTTR remuneration costs as fraction of allocated congestion income per border

The graph below indicates the amount of remuneration costs per border divided by the congestion income per border. A value larger than unity indicates that the remuneration costs exceed the day ahead gross congestion income that is assigned to an individual bidding zone border.



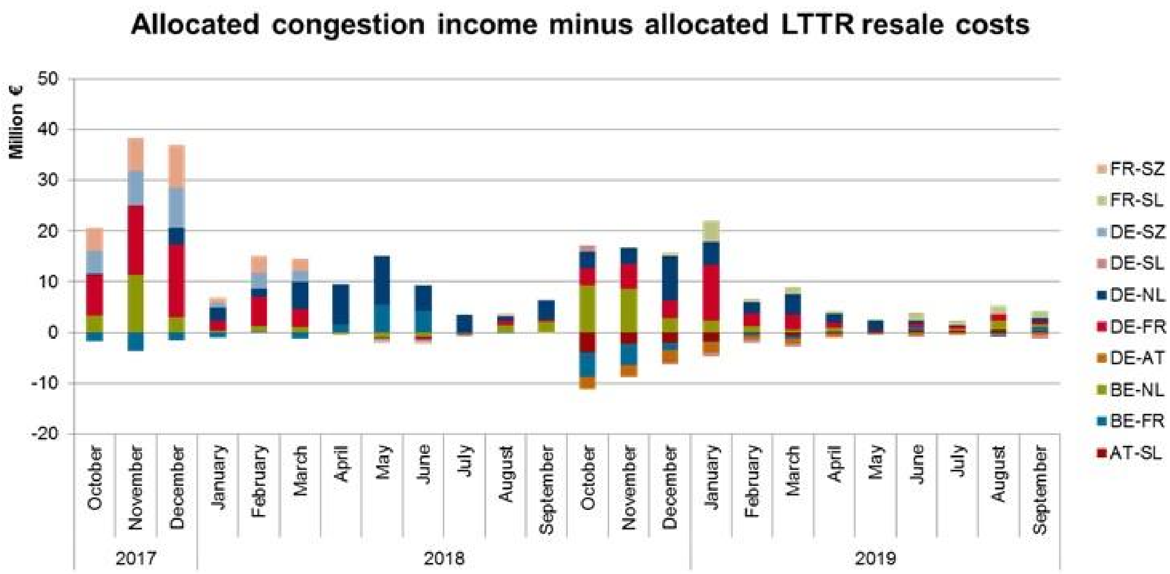
g. Percentage of total Congestion Income utilized for socialization for the region

The graph below shows the percentage of total congestion income of the CWE region that is used for socialization purposes. A higher value indicates that a higher share of congestion income was redistributed due to the socialization principle.



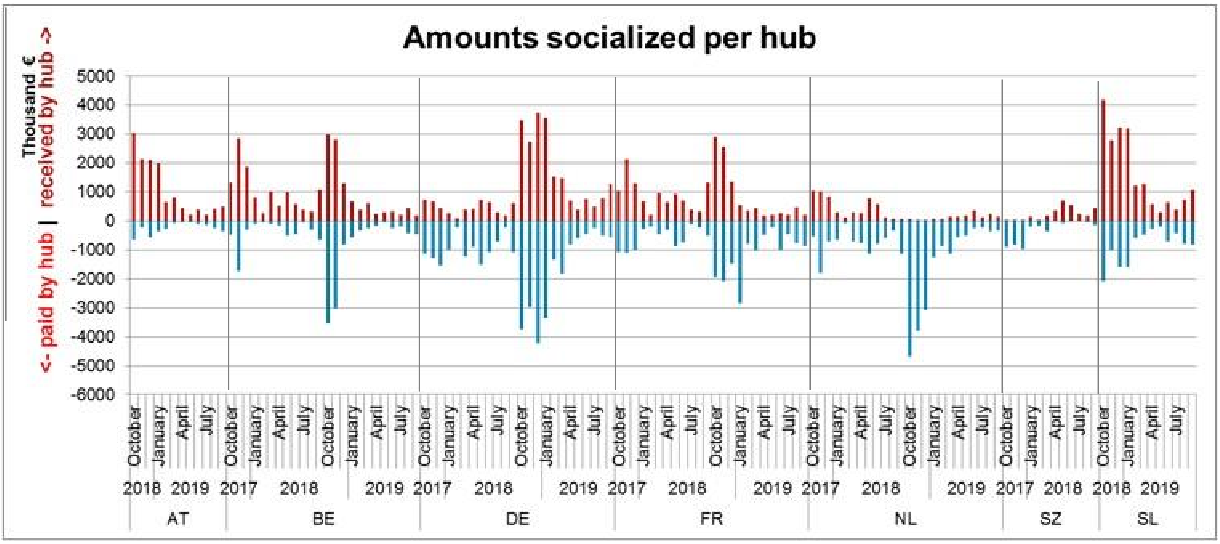
h. Allocated congestion income minus allocated LTTR remuneration costs per border

The graph below displays the difference between the allocated congestion income and the remuneration costs for LTTRs for each bidding zone border, summed up over all hours of a month. If the congestion income from day ahead market coupling is sufficient to cover the remuneration costs for LTTRs of a given border, this difference results in a positive number, and the bidding zone border is shown above the horizontal axis of the below graph. However, if the congestion income from day ahead market coupling does not suffice to cover the remuneration costs of LTTRs of a given border, this difference results in a negative number, and the respective bidding zone border is shown below the horizontal axis in the graph below.



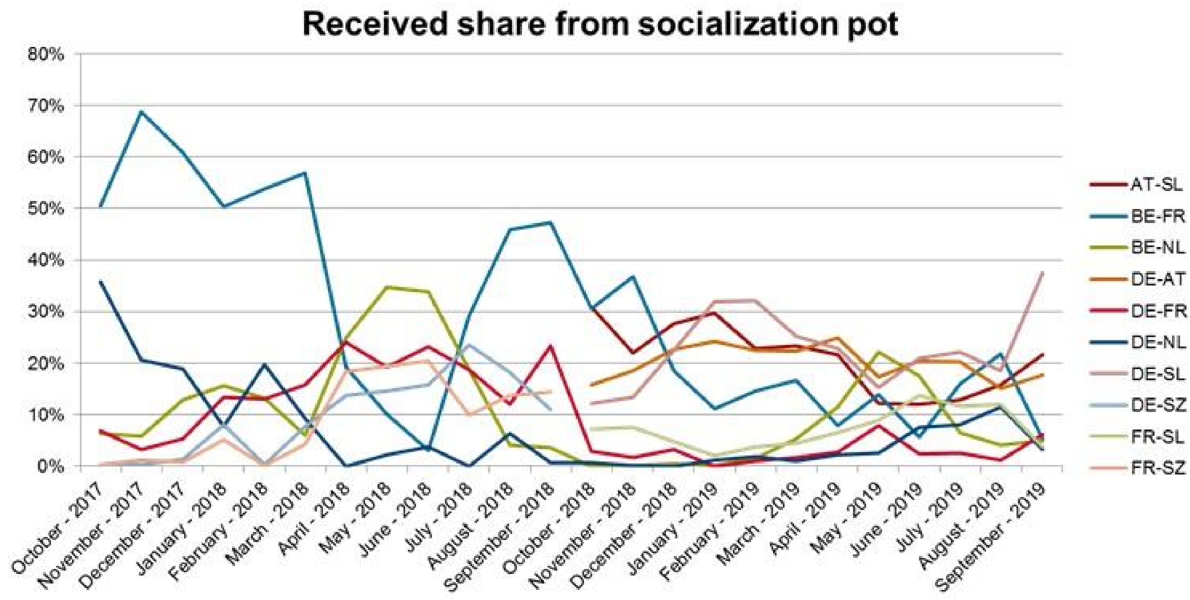
i. Amounts socialized per hub

The figure below indicates the monthly totals paid and received due to the socialization principle for each hub. The concept of the external pot is visible in the SZ hub (until September 2018) and the SL hub (as of October 2018). A negative amount indicates the payment of money to socialization, and a positive amount indicates the money received from socialization (the monthly sum of positive and negative amounts over all hubs has to be equal).



j. Share of total received amounts from socialization pot

The figure below indicates the total amount received per border, divided by the total amount socialized for the region. It is therefore an indicator for the distribution of money from the socialization pot. A higher percentage indicates a higher share received from socialization.



4. Analysis

k. Analysis of fundamental market data

The evaluation of congested hours during a period of twelve months shows that the number of hours with price full convergence increased by ca. 10 percentage points after the introduction of the bidding zone border between Germany/Luxembourg and Austria. Apart from changes in general market conditions, a possible reason for this increase can be seen in the transition of trades between Germany and Austria which were formerly considered as internal trades, but which are now considered as cross-zonal transactions. This change in status means that margins that previously have been taken as granted for internal trades are now available for all trades within the CWE region. This additional control variable adds new options for welfare optimal allocation of cross-zonal capacities, and finally helps to increase the number of hours with full price convergence.

As can be expected, the distribution of hours with full price convergence still shows the same seasonal pattern, with higher shares in spring and summer, and lower shares of hours with full price convergence in autumn and winter. Moreover, also the total monthly market welfare shows more or less the same seasonal patterns before and after the introduction of the bidding zone border between Germany/Luxembourg and Austria. Total market welfare 12 months after the split has increased with about 3,8% (31,3 Billion EUR) compared to the same period before the split of the joint German/Austrian/Luxembourgian bidding zone. Compared to the observed months before the split the social welfare of France and Belgium was reduced whereas in the German, Dutch and for the new Austrian bidding zone higher total welfare numbers were registered.

Total congestion income, as one of the components of total social welfare, shows more or less the same seasonal pattern before and after the introduction of the additional bidding zone border; however the turn from higher to lower congestion income periods occurred one month after the split.

Congestion incomes in the same calendar months were higher before the split than after, except for October, January and August. As the number of congested hours has decreased, there are less hours generating congestion income.

Regarding the volume of allocated LTTRs in the CWE region, it must be noted that the total amount of allocated LTTRs almost doubled with the introduction of the bidding zone border between Germany/Luxembourg and Austria. This is a direct consequence of the significantly high amount of 4.9 GW of LTTRs that are offered in yearly and monthly auctions for the additional bidding zone border.

l. Analysis of the Slack Zone approach

The relative shares of the internal and the external pot of congestion income have slightly shifted towards the internal pot in winter period and towards external pot in summer period. In consequence the external pot receives a smaller share of congestion income during winter period. For bidding zones with an open border, the congestion income allocation methodology assigns remuneration costs both to their internal borders and their borders with the Slack Zone (hereafter: external borders). In line with the increased amount of LTTRs, the remuneration costs have increased both for the internal and external borders.

For the borders with the Slack Zone, the share of the congestion income needed to cover for LTTR remuneration costs roughly doubled after the split (from about 10% to about 20%), whereas for the internal pot it is only increased by about 30% on average in winter period and remained similar in summer period. This increase in the share of remuneration costs of external borders is in strong contrast to the decreasing share of congestion income that is allocated to these external borders. Consequently, it appears that the share of remuneration costs of LTTRs that is allocated to these external borders has increased substantially (as now not only a part of the remuneration costs on the German-French border is partly allocated to an external flow, but also a part of remuneration cost on the German-Austrian bidding zone border with its substantial LTTR volume) while the income that is allocated to these borders did not increase with the same ratio (especially since the financial volume of the slack zone is minimized in line with the design of the CWE congestion income allocation). This finally raises the need for socialization of remuneration costs.

m. Analysis of distributional effects and the socialization principle

In general, the share of congestion income that is used for socialization was higher in each calendar month after the split compared to the same calendar month one year earlier. The relative amount needed for socialization increased from about 6% of the gross congestion income before the split to about 18% of the gross congestion income after the split.

Some borders consistently reach or lack sufficient congestion income from the day ahead market coupling to cover remuneration costs for LTTRs on their borders. This is valid for the most of the year for the new bidding zone border between Germany/Luxembourg and Austria and the border between Germany and the Slack Zone and during winter period for the borders between Belgium and France and between Austria and the Slack Zone. It can be noted that both the new bidding zone border and the border between Austria and the Slack Zone have been added as mostly net receivers from the socialization pot.

Furthermore, it must be noted that the contribution to the socialization principle is not equally distributed over the different hubs. The separated Austrian hub appears to be a clear net receiver from the socialization principle. The hub of the Belgian bidding zone used to be a clear net receiver before the introduction of the fifth bidding zone border, but changed to a net payer to the socialization pot during the first two months after split and more or less balanced position afterwards The joint German/Austrian/Luxembourgian bidding zone was to some extend a limited net receiver before the split of this bidding zone. After the go-live of the market separation, payments of the now separate hub of the German/Luxembourgian bidding zone to and from the socialization pot are more or less balanced. The French hub generally used to be a net receiver before the split and for the first two months of the new market setup; since then it is a net payer to the socialization pot. The Dutch hub had a more or less neutral position before October 2018; since then it is a substantial net payer to the socialization principle especially for the first six months after the split, whereas in the remaining months it was almost balanced again. Additionally, it should be noted that the Slack Zone (formerly the external flow) changed from being a net payer to being a net receiver with the amendment of the methodology.

Regarding the shift of remuneration costs of LTTRs from internal borders towards the external pot, three factors causing this were identified. First, the uneven distribution of LTTRs among borders need to be considered. The amount of 4.9 GW that is reserved for LTTRs on the bidding zone border between Germany/Luxembourg and Austria must be considered as a high value compared to other bidding zone borders, as it has resulted in a doubling of the total volumes of LTTRs in the CWE region. Secondly, the grid topology of the CWE region and the location of the Austrian hub within the CWE region causes relatively high external flows dedicated to the Austrian hub, especially when compared against the remaining borders of the CWE region. Finally, different distribution methods for the allocation of congestion income towards the Slack Zone (based on a price differences times the external flow) and the allocation of LTTR remuneration costs towards the Slack Zone (proportional to the External Flows) lead to an imbalanced distribution of the financial burden. The significance of this imbalance has increased and is now even more pronounced due to the volume of LTTRs on the bidding zone border between Germany/Luxembourg and Austria. Consequently, the (basically virtual) external borders now need to receive money from the socialization as a result of design choice: the remuneration costs assigned to external borders have increased, but the CI assigned to external borders did not increase proportionally.

5. Conclusion

Despite the difficulties of multiple factors influencing the market results and therefore the CID results, this report shows in the four initial months after the split an imbalance in the distribution of socialisation costs. In this period, large sums were needed to socialise costs on the bidding zone border between Germany and Austria. Considering the relaxation in the eight following months, a transitory process following the introduction of a new border to the CWE region might explain those variances occurring in the first phase after the split. The risk of cost imbalances for bidding zones depending on the general CWE market situation remains. In particular unfavourable or stressed market conditions, such as those in autumn 2018 could lead to similar cost imbalances to reoccur.

The methodology itself succeeded in minimizing the amount of congestion income allocated to the Slack zone. However, the method for allocation of LTR remuneration costs to external borders was not changed, which contributed to a higher need to socialise these costs.

The impact of the methodology changes due to the German Austrian bidding zone split, stresses the need for proper assessment of CID methodology changes before further structural changes like ALEGrO and Core are implemented in the future.

With the transition to Core, a CID methodology will be introduced, which addresses some of the now existing risks, like the cost imbalances for bidding zones due to the socialisation of remuneration costs, which will persist in CWE in the meantime.

In summary CIA WG concluded, that despite the unforeseen effects on socialization for some months following the split, CIA WG does not identify a justification for changing the expiring methodology, which is currently applied in CWE. None the less, this change could be a request from NRAs based on the results presented in this report.