Explanatory Document to the Hansa CCR TSOs' methodology for a market-based allocation process of cross zonal capacity for the exchange of balancing capacity or sharing of reserves in accordance with Article 41 of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline

20 September 2019

For public consultation

DISCLAIMER

This document is released on behalf of the *Hansa* transmission system operators ("TSOs") only for the purposes of the public consultation on the proposal for a methodology for a market-based allocation process of cross zonal capacity for the exchange of balancing capacity or sharing of reserves ("MB CZCA") in accordance with Article 41 of Commission Regulation (EU) 2017/2195 establishing a guideline on electricity balancing. This version of the MB CZCA does not in any case represent a firm, binding or definitive *Hansa* TSOs' position on the content.

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Definitions and Abbreviations

Definitions

'Cross zonal capacity allocation optimisation function'	means the algorithm applied for the allocation of CZC to the balancing capacity market within a balancing capacity cooperation in which balancing capacity is exchanged with the objective function to maximize the sum of welfare of the balancing capacity market and the SDAC market
'Contracting of balancing capacity'	means a process at a certain point in time where balancing service providers' bids in a balancing capacity auction are selected after the gate closure time and the balancing service providers are informed about their selected bids.
'Procurement of balancing capacity'	means a range of processes during a certain time period and ranges from creating a balancing capacity auction until the selection of balancing capacity bids at the gate closure time (the Contracting of balancing capacity), and informing the balancing service providers about their selected bids.
'Balancing market time unit'	means the longer of the imbalance settlement periods within a single balancing capacity cooperation, except for where at least one of the two imbalance settlement periods are longer than 15 minutes, in which case the balancing market time unit means 15 minutes, starting right after 00:00 CET. The balancing market time units shall be consecutive and not overlapping.
'Duration of application'	means the contracting period where CZC is allocated that has been made by a TSO for exchange of balancing capacity or sharing of reserves. It is related to the duration of the reserve, and sometimes dependant on energy product.
'Use of cross zonal capacity for the exchange of balancing capacity or sharing of reserves'	means allocated CZC used for the exchange of balancing capacity or sharing of reserves, either for exchange of balancing capacity in terms of dimensioning/compliancy or for physical use of CZC for actual transfer of balancing energy.
'Release of cross zonal capacity for the exchange of balancing capacity or sharing of reserves'	means CZC allocated for the exchange of balancing capacity or sharing of

reserves that is no longer needed, shall be released as soon as possible and returned in the subsequent capacity allocation timeframes. CZC allocated for the exchange of balancing capacity or sharing of reserves that has not used for the associated exchange of balancing energy, shall be released for the exchange of balancing energy with shorter activation times or for operating the imbalance netting process.

'**Market value of cross zonal capacity for the exchange of energy** means the welfare surplus of the SDAC and is the sum of the producer surplus, consumer surplus and congestion income. The market value of CZC for the exchange of balancing capacity or sharing of reserves is defined as the welfare surplus of the balancing capacity market and is the sum of consumer surplus and if applicable producer surplus and congestion income.

Abbreviations

The list of abbreviations used in this document:

AC	alternating current
aFRR	frequency restoration reserves with automatic activation
ATC	Available Transfer Capacity
BC	balancing capacity
BEC	Bilateral Exchange Computation
BRP	balancing responsible party
BSP	balancing service provider
BTU	balancing market time unit
CACM	Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management
CB	critical branch
CMOL	common merit order list
CZC	cross zonal capacity
CZCA	cross zonal capacity allocation
D	day
D2CF	two-days ahead congestion forecast
DAM	day-ahead market
DC	direct current
EBGL	electricity balancing guide line
ECC	European Commodity Clearing
ENTSO-E	European Network of Transmission System Operators for Electricity
EU	European Union
FB	Flow-Based
FBCE	Flow-Based Central Environment
FCR	frequency containment reserves
FRR	frequency restoration reserves
GSK	generation shift key
H	hour
JAO	Joint Allocation Office
LFC	load-frequency control

LFCR	load-frequency control and reserves
LT	long-term
mFRR	frequency restoration reserves with manual activation

1 Introduction

The Commission Regulation (EU) 2017/2015 establishing a guideline on electricity balancing (hereafter referred to as the 'EBGL') proposes the application of cross-zonal capacity allocation (hereafter referred to as 'CZCA) for the balancing process to improve competition by means of cross zonal balancing exchanges. This implies that TSOs may allocate cross-zonal capacity (hereafter referred to as 'CZC') available from the single day-ahead coupling (hereafter referred to as 'SDAC'). To yield the largest benefit through a CZCA in a market-based environment, the EBGL introduces three capacity allocation methods:

- Article 40 - Co-optimised allocation process
- Article 41 - Market-based allocation process
- Article 42 - Allocation process based on economic efficiency analysis

This document gives background information and rationale for the CCR Hansa proposal for a **methodology for a market-based allocation process of cross zonal capacity** (hereafter referred to as 'MB CZCA') for the exchange of balancing capacity or sharing of reserves, being developed in accordance with Article 41 of the EBGL.

The aim of this explanatory document is to provide additional information with regard to the MB CZCA for the exchange of balancing capacity and sharing of reserves.

For higher legibility the document is structured as follows:

- **Chapter 1** and **2** give a general presentation of the EBGL requirement and the market-based allocation process methodology;
- **Chapter 3** provides background information regarding day-ahead and intraday market coupling, and balancing capacity markets;
- **Chapter 4** covers the assessment of the market value of CZC. The principles of the required CZCA optimisation (cost benefit analysis) are provided;
- **Chapter 5** introduces a comprehensive description of the market-based allocation process. The mathematical description and firmness regimes are emphasized;
- **Chapter 6** is dedicated to the public consultation about this MB CZCA methodology.

1.1 EBGL and the scope of the CZCA Proposal

The EBGL established an EU-wide set of technical, operational and market rules to govern the functioning of electricity balancing markets.

The main purpose of this guideline is the integration of balancing markets to enhance the efficiency of the European balancing processes. The integration should be done in a way that avoids undue market distortion. In other words, it is important to focus on establishing a level playing field. This requires a certain level of harmonisation in both technical requirements and market rules. To provide this level of harmonisation,

the EBGL sets out certain requirements for the developments of harmonised methodologies for the allocation of cross zonal capacity for balancing purposes.

1.2 TSOs may allocate cross zonal capacity

TSOs procure ahead of real-time balancing capacity from frequency restoration reserves (FRR) and/or replacement reserves (RR). These reserves are the system's insurance to make sure that in real-time TSOs can activate at least a minimum amount of balancing energy bids to cope with imbalances in the system.

Cross border cooperation for the procurement of balancing capacity for FRR and/or RR could be implemented by two different schemes:

- **Exchange of balancing capacity** which refers to the provision of balancing capacity to a TSO in a different scheduling area than the one in which the procured balancing service provider is connected. Exchange of balancing capacity between balancing areas may lead to a geographical location of the balancing capacity that differs from the dimensioning results for each area.
- **Sharing of reserves** which refers to a mechanism in which more than one TSO takes the same reserve capacity, being FRR or RR, into account to fulfil their respective reserve requirements resulting from their reserve dimensioning processes. Since TSOs most often do not use their maximum procured capacity simultaneously, TSOs can share some of their reserves, and thereby reduce the total amount of procured balancing capacity within the two areas and save procurement costs.

Article 38 of the EBGL allows two or more TSOs to allocate a part of the CZC for the cross zonal exchange of balancing capacity or sharing of reserves. Such an allocation can:

- enable TSOs to procure balancing capacity in an efficient and market-based manner;
- improve competition and liquidity for balancing capacity markets;
- improve competition between different markets;
- facilitate regional procurement of balancing capacity

To yield the largest benefit through a CZCA in a market-based environment, the EBGL introduces three capacity allocation methods:

- Co-optimised allocation process, pursuant to Article 40;
- Market-based allocation process, pursuant to Article 41;
- Allocation process based on economic efficiency analysis, pursuant to Article 42

All TSOs shall provide a common proposal for an allocation method based on co-optimisation (Art. 40) and each CCR may provide a common proposal for a) market-based allocation (Art. 41) and b) allocation based on economic efficiency analysis (Art. 42).

This explanatory document focuses exclusively on the market-based method.

1.3 Optimised allocation of cross zonal capacity between day-ahead and balancing capacity market

CZC between two bidding zones can be allocated to different time frames and is thus a scarce resource which has to be allocated in an economically efficient way. The CZC allocated to the SDAC decreases the available CZC for the balancing capacity (BC) and vice versa. In other words, allocation of CZC to one market increases the welfare resulting from that market but decreases the welfare resulting from the other and vice versa.

The market based allocation process implies allocation of CZCA for the balancing capacity market between W-1 and D-1 for the 24 hours of day D together with the contracting of balancing capacity.

Day-ahead energy supply and demand bids, together with balancing capacity bids, therefore compete for the available CZC for day D.

The classic economic approach to (Pareto) optimally allocating CZC to different purposes (also called the optimal capacity split problem) is to set the capacity split such that the marginal value for each purpose is equal (or the difference in marginal value is minimal if the lines do not cross). This principle is shown in Figure 1 below. Given the scope of the MB CZCA, this capacity split achieves the maximum overall welfare.

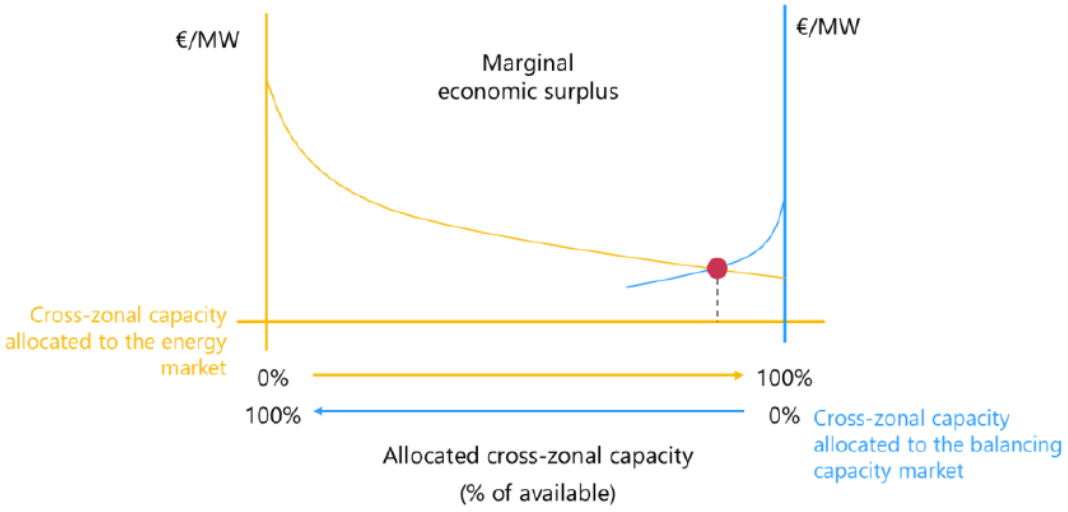

Figure 1: Principle of optimal capacity allocation to different purposes

The objective of the procurement optimisation function is to maximise the sum of welfare of the balancing capacity market and the SDAC.

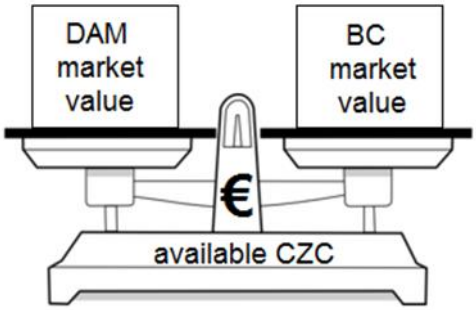

Figure 2: How to allocate available cross zonal capacity

As a result, CZC may incrementally be allocated for the exchange of balancing capacity or sharing of reserves as long as the incremental market value for the exchange of balancing capacity exceeds the incremental market value for the SDAC.

2 EBGL requirements for market-based allocation process methodology

Article 41 of the EBGL enables all Hansa TSOs to develop a proposal for a methodology for a market-based allocation process of CZC for the exchange of balancing capacity or sharing of reserves. This section provides a summary of the EBGL requirements for the MB CZCA.

2.1 Market-based proposal: Article 41 of the EBGL

Article 41(1) of the EBGL states the requirements to develop "*a methodology for a market-based allocation process of cross-zonal capacity for the exchange of balancing capacity or sharing of reserves.*"

Besides the obligation to develop a proposal, Article 41 of the EBGL defines boundary conditions and specific requirements for this methodology.

In the words of the EBGL, such a methodology shall:

a) *apply for the exchange of balancing capacity or sharing of reserves with a contracting period of not more than one day and where the contracting is done not more than one week in advance of the provision of the balancing capacity;*

b) *include the notification process for the use of the market-based allocation process;*

c) *include a detailed description of how to determine the actual market value of cross-zonal capacity for the exchange of balancing capacity or sharing of reserves, and the forecasted market value of cross-zonal capacity for exchanges of energy and the forecasted market value of cross-zonal capacity for the exchange of balancing capacity or sharing of reserves;*

d) *include a detailed description of the pricing method, the firmness regime and the sharing of congestion income for the cross-zonal capacity that has been allocated to bids for the exchange of balancing capacity or sharing of reserves via the market-based allocation process;*

Pricing methods are, for example, pay-as-bid and pay-as-cleared. It is required to describe in detail when the CZC is considered to be firmly allocated to the matched bids for the exchange of balancing capacity or sharing of reserves, in other words, to identify the time interval during which this CZC is not available for any other allocation processes.

In general, the congestion income is part of the total economic welfare and its value can be change due to allocation of CZC for the exchange of balancing capacity or sharing of reserves. It appears whenever there is a price difference between bidding zones and it can also take into account the cost of using CZC (in case a third party owns transmission rights). The congestion income on a border, if any, must be shared between the TSOs who share that border: it is required that the MB CZCA Proposal contains the principles for sharing the congestion income.

Article 41(4) of the EBGL requires that the definitions of the pricing method of CZC, the firmness regime of CZC, and the sharing of congestion income from CZC for which the MB CZCA Proposal is applied ensure equal treatment between balancing capacity bids and energy bids.

> *(e) include the process to define the maximum volume of allocated cross-zonal capacity for the exchange of balancing capacity or sharing of reserves pursuant to paragraph 2;*

Article 41 poses no a priori limitation for the market-based allocation of CZC for exchange of balancing capacity or sharing of reserves, but limits can arise from technical or economic reasons.

> *(f) be based on a comparison of the actual market value of cross-zonal capacity for the exchange of balancing capacity or sharing of reserves and the forecasted market value of cross-zonal capacity for the exchange of energy;*

Moreover, it is stated in Article 41(5) of the EBGL that CZC allocated for the exchange of balancing capacity or sharing of reserves via the market-based allocation process shall be used exclusively for the exchange of balancing capacity or sharing of reserves and the associated exchange of balancing energy, otherwise it shall be released.

2.2 Principles from Articles 38 and 39 of the EBGL

Article 38 of the EBGL – General requirements

The methodology for the MB CZCA is based on general requirements set out in Article 38 of the EBGL.

Article 38(1) of the EBGL states that two or more TSOs are allowed to allocate parts of CZC for the use of balancing, based on three different allocation methodologies, market-based being one of them. Any contract between two or more TSOs for CZCA for the exchange of balancing capacity or sharing of reserves already in place before the EBGL entered into force may remain valid until the contract expires.

Article 38(2) of the EBGL lists information that any CZCA proposal needs to specify regarding its scope of application: bidding zone borders, market timeframe, duration, and methodology.

Article 38(3) of the EBGL stipulates that, where relevant, all TSOs shall develop a proposal to harmonise the different proposals for each of the three allocation methodologies by 5 years after the EBGL entered into force.

Article 38(4) of the EBGL mentions that CZC which is allocated to the exchange of balancing capacity or sharing of reserves can only be used for the standard products of mFRR, aFRR and RR for both AC and DC interconnections. On DC interconnectors, CZC may also be allocated for operating and exchanging FCR. The reliability margin of AC interconnectors shall be used for operating and exchanging FCR and shall not be used for the exchange of balancing capacity or sharing of reserves.

Article 38(5) of the EBGL forbids the CZCA for balancing purposes when capacity calculation is not performed according to capacity calculation methodologies developed pursuant to Commission Regulation (EU) 2015/1222 and pursuant to

Commission Regulation (EU) 2016/1719. However, the TSOs believe this requirement shall not prevent TSOs to establish early market based integrated balancing capacity markets and applying allocation of cross-zonal capacity.

Article 38(8) of the EBGL requires that:

- on a regular basis it is assessed whether the allocated CZC is needed for the purpose of balancing;
- when CZC is no longer needed for the purpose of balancing, it shall be released as soon as possible and returned in the subsequent capacity allocation timeframes, where it shall no longer appear as already allocated CZC in the calculations of CZC.

According to Article 38(9) of the EBGL, allocated CZC shall be released when it has not been used for the associated exchange of balancing energy, meaning that the RR, mFRR and aFRR quantities affecting CZC have not been activated in their relevant timeframes. Releasing CZC means that it becomes available for the exchange of balancing energy with shorter activation times (e.g. allocated CZC for aFRR, when released, is available for imbalance netting).

Article 39 of the EBGL – Calculation of the market value of cross zonal capacity

Article 39 of the EBGL defines the principles for the calculation of the market value of CZC. The relevant parts for the MB CZCA methodology are described in the following and in more detail in Section 4.

Article 39(1) of the EBGL states that for MB CZCA the market value of CZC is determined based on actual or forecasted market values of CZC.

Article 39(3) of the EBGL says that the actual market value of CZC for the exchange of balancing capacity shall be calculated based on balancing capacity bids submitted to the capacity procurement optimisation function.

Article 39(4) of the EBGL says that the actual market value of CZC for sharing of reserves shall be calculated based on the avoided costs of procuring balancing capacity.

2.3 Other relevant information from the EBGL

Article 33 of the EBGL – Exchange of balancing capacity

According to Article 33(2) of the EBGL, *"except in cases where the TSO-BSP model is applied pursuant to Article 35, the exchange of balancing capacity shall always be performed based on a TSO-TSO model whereby two or more TSOs establish a method for the common procurement of balancing capacity taking into account the available cross-zonal capacity and the operational limits defined in Chapters 1 and 2 of Part IV Title VIII of Regulation (EU) 2017/1485."*

Article 33(3) of the EBGL states that, apart from the exceptions in Articles 26 and 27 of the EBGL, *"all TSOs exchanging balancing capacity shall submit all balancing capacity bids from standard products to the capacity procurement optimisation function"*, without modifying or withholding any balancing capacity bids which shall be included in the procurement process.

Article 33(4) of the EBGL requires that all TSOs exchanging balancing capacity ensure the (secure) availability of CZC, either by a probabilistic approach (described in Article 33(6) of the EBGL) or by the CZCA methodologies pursuant to Articles 38 to 42 of the EBGL.

Article 36 of the EBGL – Use of cross zonal capacity

According to Article 36(2) of the EBGL, *"two or more TSOs exchanging balancing capacity may use cross-zonal capacity for the exchange of balancing energy when cross-zonal capacity is:*

a) available pursuant to Article 33(6);

i.e. it is calculated with the probabilistic approach,

b) released pursuant to paragraphs 8 and 9 of Article 38;

meaning that CZC was allocated according to one of the methodologies in Articles 40, 41 and 42 of the EBGL and then either not used for the associated exchange of balancing energy or deemed too high in a re-evaluation,

c) allocated pursuant to Articles 40, 41 and 42.

meaning that CZC was allocated according to one of the methodologies in Articles 40, 41 and 42 of the EBGL and can therefore be used for the associated exchange of balancing energy.

3 Balancing capacity market

According to Article 32 of the EBGL, all TSOs of an LFC block shall regularly and at least once a year review and define the reserve capacity requirements for the LFC block or scheduling areas of the LFC block pursuant to dimensioning rules given by SOGL. Reserve capacity can be provided by:

a) procurement of balancing capacity within control area and exchange of balancing capacity with neighbouring TSOs;

b) sharing of reserves;

c) the volume of non-contracted balancing energy bids which are expected to be available both within their control area and within the European platforms taking into account the available CZC

3.1 Balancing capacity auctioning

Each TSO procuring balancing capacity shall define the rules for the procurement of balancing capacity. The rules for the procurement of balancing capacity shall comply with the following principles, according to the Article 32(2) of the EBGL:

a) the procurement method shall be market-based for at least the frequency restoration reserves and the replacement reserves;

b) the procurement process shall be performed on a short-term basis to the extent possible and where economically efficient;

c) the contracted volume of balancing capacity may be divided into several contracting periods.

d) the procurement of upward and downward balancing capacity for at least the frequency restoration reserves and the replacement reserves shall be carried out separately.

3.2 Exchange of balancing capacity

The exchange of reserves allows TSOs to rely on BSPs that are connected to an area operated by a different TSO.

Two or more TSOs may develop a proposal for the establishment of common and harmonised rules and processes for the exchange and procurement of balancing capacity while respecting the requirements set by EBGL for procurement for balancing capacity.

Except in cases where the TSO-BSP model is applied, the exchange of balancing capacity shall always be performed based on a TSO-TSO model whereby two or more TSOs establish a method for the common procurement of balancing capacity taking into account the available CZC and the operational limits defined by SOGL.

All TSOs participating in the same exchange of FCR, FRR or RR shall specify an exchange agreement as defined by SOGL.

Exchange of reserves may lead to a geographical location of the balancing capacity that differs from the dimensioning results for each area, however, the total amount of balancing capacity within the two areas is still equivalent to the total amount without the exchange of reserves.

Figure 3 illustrates the exchange of 200 MW of balancing capacity from Area B to Area A.

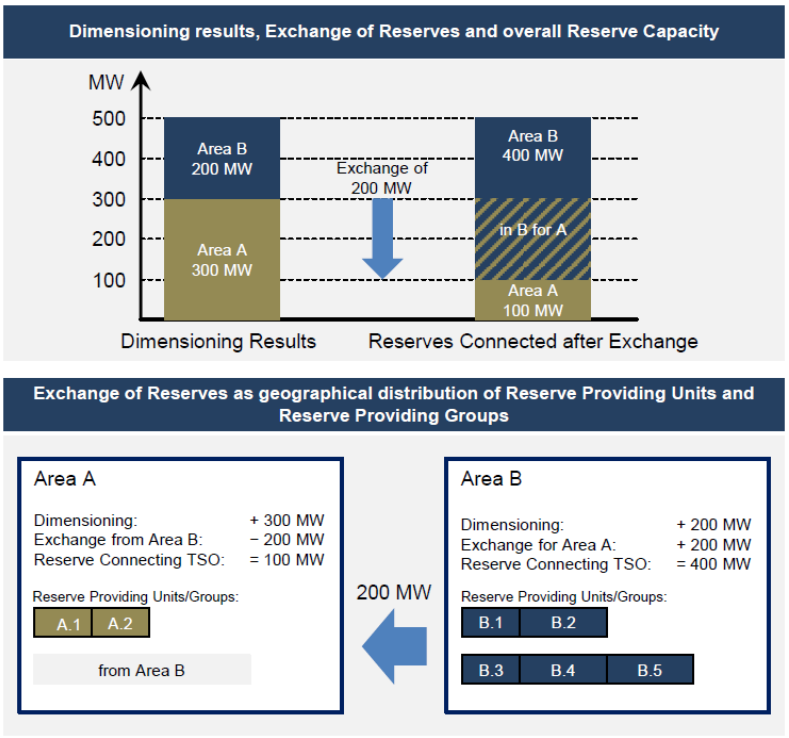

Figure 3: exchange of reserves – illustrative example. Source: LFCR supporting document 2013

Suppose that the dimensioning rules result in the need of 300 MW for Area A and 200 MW for Area B. Without the exchange of reserves, the respective reserve capacity has to be provided by reserve providing units or reserve providing groups connected to the Area which means that 300 MW have to be connected in Area A and 200 MW in Area B.

As a result of the exchange of reserves of 200 MW from Area B to Area A, 200 MW of reserve capacity needed for Area A will now be located within Area B, whereas Area A still ensures the availability of the full amount of its own reserve capacity.

Although the geographical location of the reserve capacity is different from the dimensioning results for each area, the total amount of reserve capacity within Area A and B is still 500 MW which is equivalent to the total amount without the exchange.

3.3 Sharing of reserves

A sharing of reserves agreement allows two or more TSOs to rely on the same reserves.

The roles and responsibilities of the reserve connecting TSO, the reserve receiving TSO and the affected TSO for the exchange of reserves between synchronous areas, shall be described in the synchronous area operational agreement and a sharing agreement as defined by SOGL.

In contrast to the exchange of reserves, that only changes the geographical distribution of reserve capacity, the sharing of reserves changes the total amount of procured balancing capacity by involved TSOs, with an impact on the geographical distribution as an additional implicit effect. A sharing of reserves agreement defines priority rights to the shared reserves in the situation where either two or more TSOs have a simultaneous need.

Figure 4 illustrates the sharing of 100 MW of balancing capacity between two areas with a possible relocation of a 100 MW of reserves from Area A to Area B.

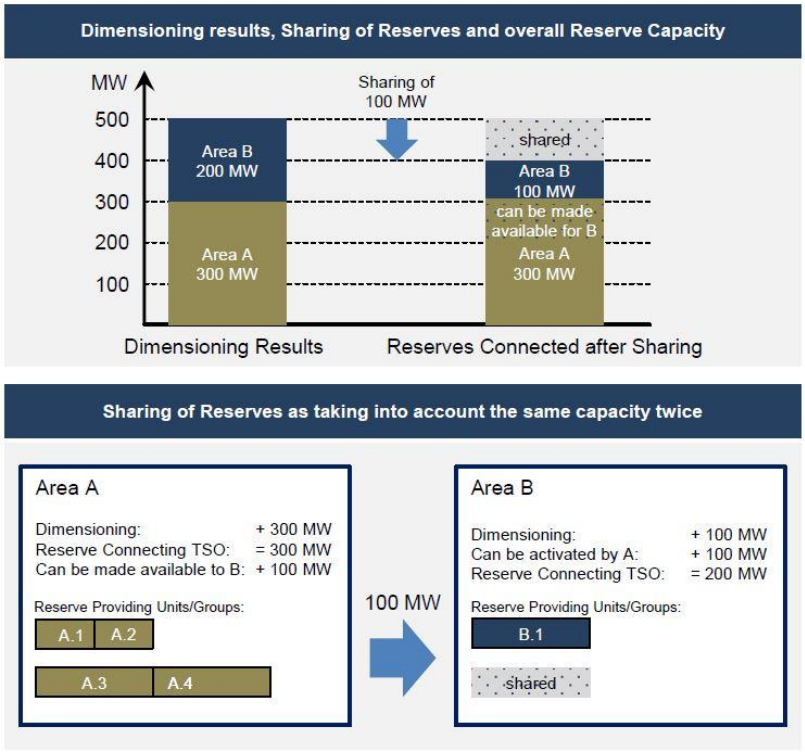

Figure 4: Sharing of Reserves – simple example. Source: LFCR supporting document 2013

Suppose that the dimensioning rules for area A and area B result in the need of 300 MW for area A and 200 MW for area B. Without the sharing of reserves, the TSO of area A and area B have to ensure the availability of respectively 300 MW and 200 MW.

However, assuming that is very unlikely that both TSOs need to activate the full amount of reserve capacity at the same time, the TSO of area A and area B can 'share' a part of their reserve capacity. In practice this means that the TSO of area B can make use of e.g. 100 MW of the reserve capacity of the TSO in area A.

As a result, the TSOs of area A and area B now need to ensure the availability of 300 MW and 100 MW. The TSO of area A now makes 100 MW of his own reserve capacity available to the TSO of area B. The total amount of the reserve capacity within the system is now 400 MW, whereas it was 500 MW without the sharing agreement (leading in this example to reduction of 100 MW of reserve capacity in the total system).

4 Market value of cross zonal capacity

The decision within the MB CZCA to optimally allocate CZC to either the day-ahead energy market or the balancing capacity market shall be based on a comparison of the actual market value of cross-zonal capacity for the exchange of balancing capacity or sharing of reserves and the forecasted market value of cross-zonal capacity for the exchange of energy, according to Article 41(3) of the EBGL.

Article 39 (3-4) of the EBGL further specifies how the actual market value shall be derived: balancing capacity bids submitted to the capacity procurement function pursuant to Article 33 (3) of the EBGL shall be used. When CZC is used for the sharing of reserves, the market value shall be based on the avoided costs of procuring balancing capacity in order to calculate the buyer surplus for the balancing capacity market. The forecasted market value of CZC for the exchange of energy between bidding zones and for the exchange of balancing capacity are calculated per MTU.

4.1 Forecasted Market Value of cross zonal capacity for the Exchange of Energy

4.1.1 The market value of cross zonal capacity

In the MB CZCA Proposal as well as in this Explanatory Document, the forecasted market value of CZC for the day-ahead exchange of energy between bidding zones is defined as the welfare increase expected from the SDAC resulting from an incremental increase in CZC allocated to the energy market.

The market value is calculated based on price differences to calculate the sum of producer surplus, consumer surplus and congestion income.

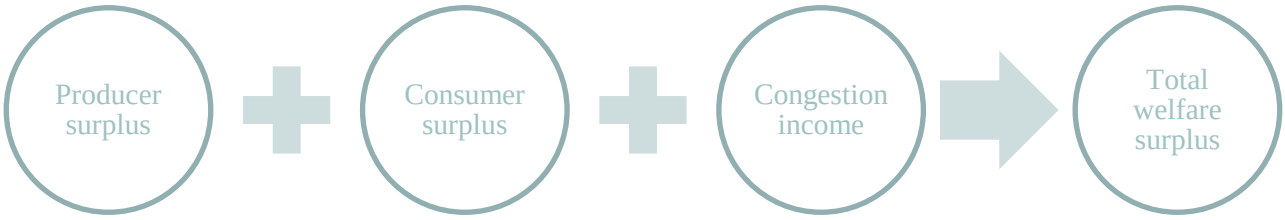

Figure 5 : Market value of CZC is defined as the total welfare surplus

Note that:

- the important measure for the market value is the surplus in welfare of additional CZC, not the absolute values of welfare.
- only the implicit allocation of CZC (flow-based or ATC-based) is relevant for the calculation; any explicit allocation of CZC which may take place e.g. monthly or yearly only affects and determines the upper limit of CZC that may be used in the market-based allocation.

4.1.2 Isolated energy markets cleared independently

Figure 6 shows the base case of isolated energy markets which are cleared independently, i.e. no CZC is allocated or used for the exchange of energy and the market clearing prices (will) differ. In this example, the market clearing price in zone C is lower than in zone B. The consumer and producer surpluses are highlighted in blue and red, respectively, and the total sum of the areas represents the total welfare.

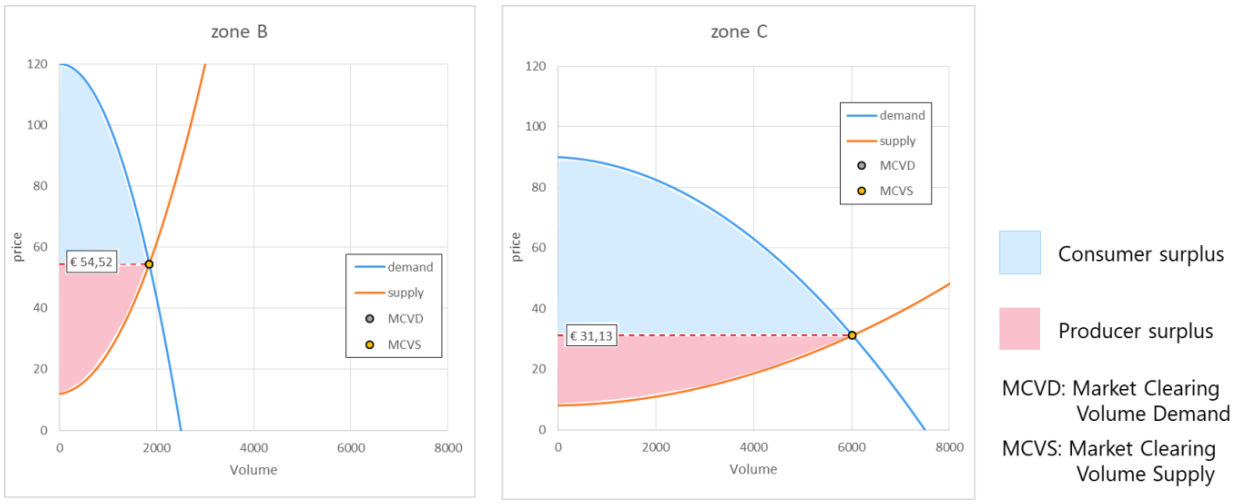

Figure 6: Welfare in two energy markets cleared in isolation

4.1.3 Coupled energy markets with congestion

When CZC is allocated and may be used for the exchange of energy, market participants may trade across the border. If the amount of available CZC is large enough, this may even lead to full price convergence between the two bidding zones. Once prices have converged, any additional CZC would then have a value of 0. Figure 7 depicts a situation where the allocated CZC only allows for a partial price convergence: the market clearing price in zone C remains higher than in zone B. In addition to consumer and producer surpluses, the remaining price difference creates a positive congestion rent which is also part of total welfare (the green area between the red dotted lines in the zone B). With full price convergence, the congestion rent distributions would cancel out and disappear.

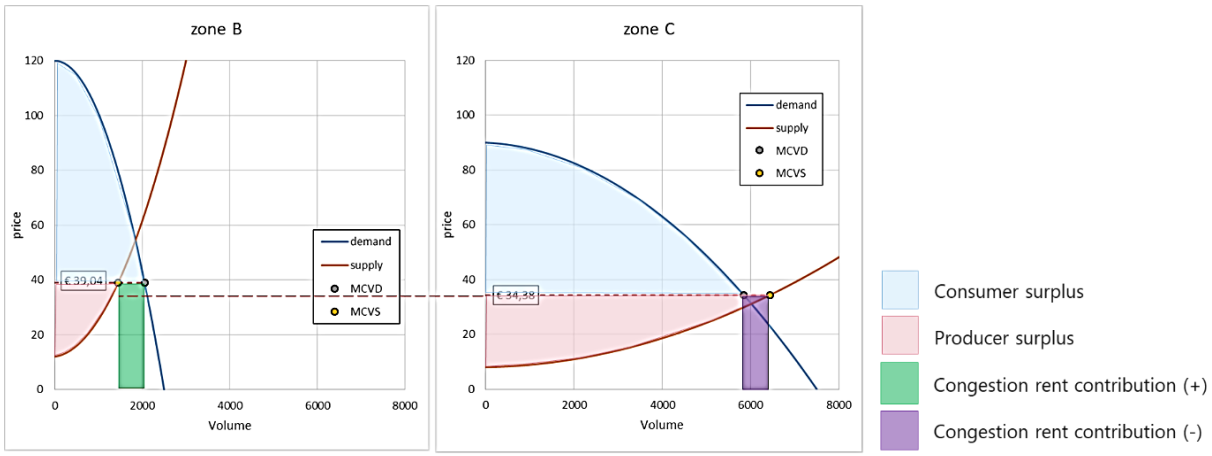

Figure 7: welfare in coupled energy markets with congestion

The same logic may be applied to multiple markets and bidding zones; it is thus possible to calculate the value of CZC for each border for which the market-based allocation applies. The general calculation of welfare is shown in the equation below and consists of the sum of consumer surplus, producer surplus and congestion rent over all markets. The congestion rent for a market or bidding zone is calculated based on the market clearing price and the market net position, where the market net position equals the sum of exchanges in both directions (positive for export, negative for import) on all borders with other markets. The market net position also equals the difference in supply and demand volumes cleared.

$$\sum_{all\ markets} \{Consumer\ surplus + Producer\ surplus - Market\ Net\ Position\ * Market\ Clearing\ Price\}$$

Equation 1: Calculation of the economic surplus when supply and demand are matched to an equilibrium clearing Point

The market value of CZC may now be calculated as the difference between total welfare when CZC is allocated for the exchange of energy and the situation of isolated markets. The optimal allocation of CZC using the market-based allocation method is determined by comparing the marginal market value of an additional MW of CZC for the exchange of energy and then compared to the marginal market value of the same additional MW of CZC for the exchange of balancing capacity for each border.

4.2 Actual Market Value of cross zonal capacity for the Exchange of Balancing Capacity or Sharing of Reserves

In the MB CZCA Proposal as well as in this Explanatory Document, the market value of CZC for the exchange of balancing capacity or sharing of reserves is defined as the additional total welfare surplus in the balancing market resulting from the additional CZC allocated for the balancing capacity market, and is calculated based on buyer surplus (TSO), and when marginal pricing is used as to clear the market also on seller surplus (balancing service provider) as well as on congestion income.

The underlying data are upward and downward balancing capacity bids which have been submitted by the capacity procurement optimisation function pursuant to

Article 33(3) of the EBGL. In general, upward and downward balancing capacity bids are optimised independently, i.e. the demands etc. are not netted ex-ante. Note, that sharing of reserves is modelled as a reduction of consumer (TSO) demand by the shared amounts, before the markets are coupled. The additional market value of sharing of reserves is therefore based on the avoided costs of procuring according to Article 39(4) of the EBGL and assigned as the consumer surplus.

4.2.1 The market value calculation concept is independent of the pricing method for balancing capacity

The calculation of the market value is based on the maximization of welfare. Hence it is independent of the pricing method for balancing capacity, i.e. pay-as-bid or marginal pricing. The difference is that there is producer surplus for marginal pricing; for pay-as-bid pricing this is not explicitly part.

4.2.2 Isolated markets for balancing capacity with pay-as-bid pricing

Figure 8 depicts the base case of two isolated markets for balancing capacity with pay-as-bid pricing. In this example, it is assumed that the supply curves for balancing capacity are monotonously non-decreasing in both markets and the demand for balancing capacity in both areas is fixed and perfectly inelastic. It should be noted this is a simplification, as the balancing capacity market includes non-convexities as start-up and shut-down costs along with minimum output requirements (which state that if a plant is running, it must produce at least a certain amount). This is further elaborated in 4.2.5.

In this example, the price for the last accepted bid for TSO A is higher than the respective price for TSO B. The red arrow indicates available CZC for the exchange of balancing capacity or sharing of reserves, if the markets were coupled.

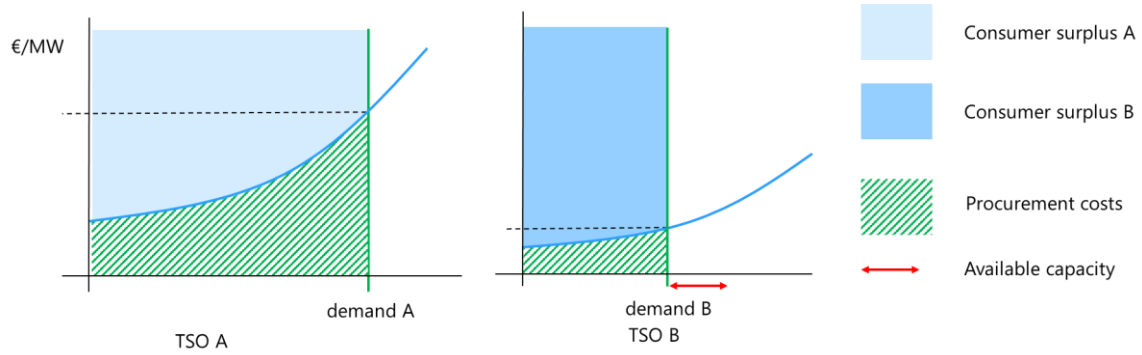

Figure 8: Welfare in isolated markets with pay-as-bid pricing

4.2.3 Coupled balancing markets with pay-as-bid pricing

When the two markets are coupled and CZC is allocated, TSO A will be able to procure part of its balancing capacity in the area of TSO B. As a result, the price of the last accepted bid of TSO A will decrease and that of TSO B will increase. Figure 9 shows the situation where available CZC is not enough to reach full price convergence; consumer surplus for TSO A will decrease, whereas consumer surplus

for TSO B will increase. A part of the procurement costs of TSO A in the isolated situation is now used to procure cheaper balancing capacity in market B. As is shown on the left hand side of Figure 9 the difference in welfare is the area (yellow) below the supply curve of area A, above the shifted supply curve of area B (dashed blue line) and between the supply clearing volume in the coupled situation and the original demand A. This is the market value of the allocated CZC in this particular situation. To derive the marginal market value these results must be compared to incremental changes of CZC, i.e. for each additional MW of CZC allocated to the balancing capacity market.

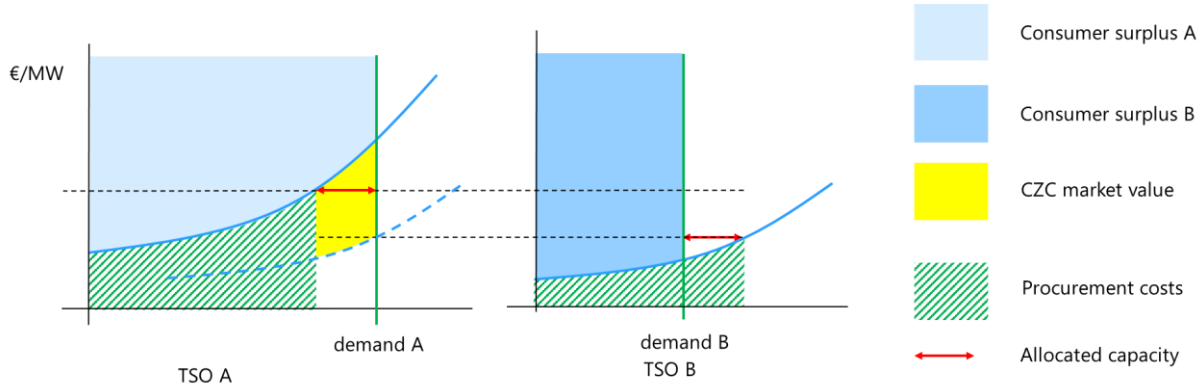

Figure 9: Welfare in coupled balancing markets with pay-as-bid pricing

4.2.4 Difference in the distribution of welfare surplus depending on the pricing scheme

The market value of CZC does not depend on the pricing scheme. With pay-as-bid pricing all of the market value represents consumer surplus. When the market is cleared with marginal pricing, this value also consists of producer surplus and congestion rent; the sum, however, remains the same. This difference in distribution is summarized in Figure 10 below.

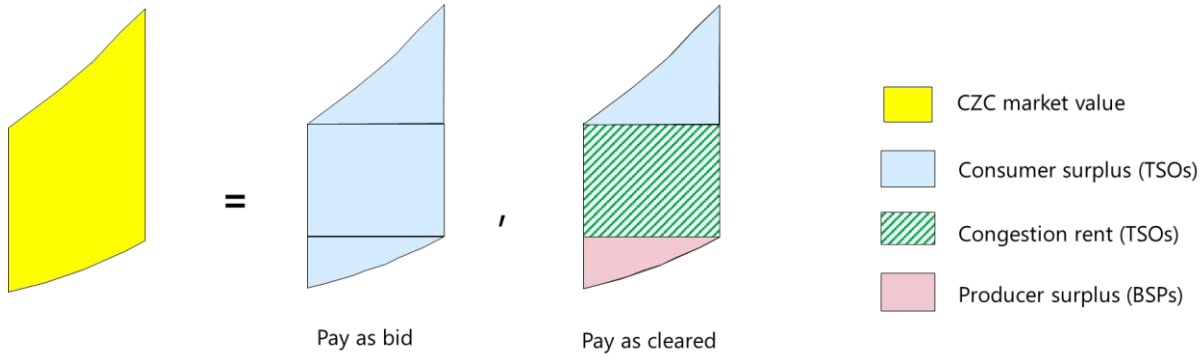

Figure 10: Difference in the distribution of welfare surplus depending on the pricing scheme

4.2.5 Non-convexities in balancing capacity markets

The balancing capacity market is directly linked to the energy market, i.e. the BSPs' expectation of the market clearing in the energy market will be reflected in their bidding behaviour for balancing capacity. The alternative costs for provision of

reserves instead of energy are lowest for the market participants that are almost indifferent to deliver energy, i.e. their marginal costs are near the spot price. For reserves to be offered, some market participants can lower their energy output, and others can start energy production at a moderate economic loss. The former has a variable cost and the latter have a fixed cost.

This dependency between the two markets makes it difficult to apply the market coupling principles as described above. For this to be true, there must be no externalities, and no transaction costs, and perfect information is assumed. Additionally, the welfare optimization problem must be convex. This includes the absence of discrete variables. Discrete variables mean combinatorial problems that are hard to solve. Balancing capacity bids that reflect fundamental costs cannot be organized as a monotonously increasing "merit order list".

Non-convexities include start-up and shut-down costs along with minimum output requirements (which state that if a plant is running, it must produce at least a certain amount). Due to this combinatorial problem, there does not exist a "market clearing price" in spinning reserve markets that clears a balancing capacity market efficiently, nor a "marginal price". The market price conveys little or no information on which reserve offers were accepted.

The non-convex effects in the balancing capacity market can be tackled through discrete variables (block bids and combinatorial constraints), and by maximising the welfare by using mixed integer programming. Efficiency of the allocation will be the highest if the procurement of balancing capacity and cross zonal capacity allocation market is integrated into one single auction, where the economic surplus is maximised subject to system constraints.

5 Market-based approach

5.1 Process overview

The market-based methodology consists of 4 steps: the forecast of market value of CZC for the exchange of energy, the bid submission of balancing capacity, the balancing capacity procurement and CZC allocation, and the publication of the results of the process.

5.1.1 Step 1: Forecast of market value of CZC for the exchange of energy

The forecasted market value of CZC for the exchange of energy shall be forecasted based on price differences per border from SDAC for pre-selected reference day(s) with the option to include adjustment factors. The forecasting can have two steps:

- the basic forecast where the value of the used market indicator is determined, and
- the optional step of the improved forecast where the result of the basic forecast is modified with the use of the adjustment factor(s).

According to Article 41 of the EBGL, during the basic forecast process, the entity responsible for forecasting may take into account any market indicator (e.g. market clearing prices for each bidding zone) based on the submitted SDAC bids, or the submitted SDAC bids themselves. The TSOs of the balancing capacity cooperation shall define which market indicator(s) are used.

Reference day means a day which is used to define the forecasted value of CZC. Reference day(s) shall be the latest relevant day(s), where the used market indicator(s) are available for each bidding zone based on actual market outcome. (E.g. if the subject day is a bank holiday, TSOs may use the average value of a market indicator for the latest bank holiday and the latest weekend day.)

An adjustment factor can be any of the following:

- a fixed added value to the result of the basic forecast
- a fixed value by which the result of the basic forecast is multiplied
- parameters in a transparent methodology that uses the result of the basic forecast and other transparent data.

If the adjustment factors are used, they shall be used in a transparent way to incorporate improved forecasting and not to give preference to the exchange of balancing capacity or sharing of reserves on the expense of CZC allocated to the exchange of energy.

The TSOs of the balancing capacity cooperation shall use a transparent methodology to forecast the market value of CZC for the exchange of energy (both the basic and the improved forecast need to be transparent).

5.1.2 Step 2: Bid submission

BSPs submit standard upward and standard downward balancing capacity bids to their balancing capacity market operators.

The TSO-BSP GCT of standard balancing capacity bids shall be the same for each BSP within each balancing capacity cooperation (per standard product and per direction) and shall be organised in between week-ahead and before sending the final results of the capacity calculation for CZC of the SDAC to NEMOs.

TSOs of a balancing capacity cooperation have the option to allow BSPs to submit linked bids and/or block bids but the same rules have to apply to all BSPs within a balancing capacity cooperation.

5.1.3 Step 3: Balancing capacity procurement optimization and CZCA optimisation

When optimising the balancing capacity procurement, the TSOs of each balancing capacity cooperation shall select the balancing capacity bids. This process shall include the forecasted value of CZC for day-ahead exchange of energy as a cost associated with a balancing capacity bid requiring CZCA for exchange of balancing capacity or sharing of reserves.

CZC shall be allocated to the exchange of balancing capacity and sharing of reserves based on the accepted balancing capacity bids.

5.1.4 Step 4: Publication

TSOs shall inform all affected parties of the process results.

BSPs shall be notified about their selected standard upward balancing capacity bids or downward balancing capacity bids at the same point in time within each balancing capacity cooperation. The notification shall be done before subsequent TSO-BSP GCTs within the balancing capacity cooperation within CCR Hansa implementing this MB CZCA, and at the latest one hour before the GCT of the SDAC. Notification to all market participants of allocated CZC for the exchange of balancing capacity and/or sharing of reserves shall be done at the same point in time as the notification to BSPs mentioned above.

TSOs of the balancing capacity cooperation shall be responsible to update the CZC calculation results for D-1 in order to take into account the allocated volumes for the balancing capacity market, not available for SDAC.

5.2 Description of Optimisation Setup

A minimum example for the conceptual description is the following:

- Objective: maximize economic welfare of SDAC and balancing capacity cooperation
- Inputs:
    - Balancing capacity demand
    - Balancing capacity offers
    - Sharing of reserve volume

  - Forecasted market value for the exchange of energy (including adjustment factors and mark-ups)
- Outputs:
  - Matched balancing capacity orders
  - Clearing prices for balancing capacity
  - Allocated CZC for the exchange of balancing capacity or sharing of reserves
- Constraints:
  - Matched volume of balancing capacity offers must equal balancing capacity demand for each TSO within a balancing capacity cooperation
  - the sum of allocated CZC to the balancing capacity market may not exceed the total available CZC

5.3 Sharing of congestion income of cross zonal capacity

The rules applied for the sharing of congestion income are equal to the ones developed for the balancing energy market and based on the All TSOs' Proposal for a Congestion Income Distribution (CID) methodology in accordance with Article 57 of the Commission Regulation (EU) 2016/1719 of 26 September 2016 establishing a guideline on forward capacity allocation.

For each BZB on which congestion income results from the exchange of balancing capacity or sharing of reserves, in accordance with the calculation of congestion income from the SDAC, the TSOs on each side of the balancing capacity border shall receive their share of net border congestion income based on a 50%-50% sharing key. In specific cases, the concerned TSOs may also use a sharing key different from 50%-50%. Such cases may be due to the different ownership shares, different shares of investments costs, exemption decisions[1] or decisions on cross-border cost allocation[2] by competent NRAs or the Agency.

In case the BZB consists of several interconnectors with different sharing keys, on which are owned by different TSOs, the net border balancing capacity congestion income shall be assigned first to the respective interconnectors on that BZB based on each interconnector's contribution to the allocated capacity. The parameters defining the contribution of each interconnector will be agreed by the TSOs on the BZB. In case specific interconnectors are owned by entities other than TSOs, the reference to TSOs in this article shall be understood as referring to those entities.

Specific sharing keys and parameters shall be published in a common document by ENTSO-E on its web page for information purposes only.

Due to an impact of allocating CZC for the exchange of balancing capacity or sharing of reserves on SDAC CID, certain measures had to be taken. The potential missing money problem could happen as the obligations to remunerate Long-Term Transmission rights are bound to the borders in Day-Ahead timeframe. By providing a specific amount of balancing income to SDAC CID process it will be ensured, that

[1] Exemption decision granted to these entities by relevant competent Authorities in accordance with article 17 of Regulation (EC) 714/2009.

[2] Decisions on cross-border cost allocation granted to these entities by relevant competent Authorities or the Agency in accordance with article 12(4) or 12(6) of Regulation (EC) 347/2013.

the remuneration of Long-Term Transmission rights will not lead into a deficit of revenue and none of the TSOs will be disadvantaged at the expense of CZC allocation for the exchange of balancing capacity or sharing of reserves. The fragile equilibrium of these processes cannot be disturbed, since any withdrawal of money from the algorithm can lead to a deepening of the problem and also to its transfer to all TSOs in the region due to the functioning principle of socialization.

The amount of income that is transferred for the purposes of the SDAC CID processes is equal to the amount of CZC allocated this way multiplied by the resulting Day-Ahead market spread between two relevant hubs. Congestion Income (CI) from balancing should be on average higher than the missing CI from DA market trading as is a result of optimization and the prices for balancing CZC should be higher as well. However, it is not ensured that it is true for 100 % of trading hours. Therefore, a special account will be set up for process coverage, where congestion income generated by CZC allocated for the exchange of balancing capacity or sharing of reserves will be collected for at least one month. Remaining surplus after a one month will be assigned to relevant balancing borders on pro-rata basis according to the congestion income originally generated by the exchange of balancing capacity or sharing of reserves. Sharing of the final balancing congestion income attributed to each TSO shall be then distributed pursuant to the first three paragraphs of this article.

5.4 Firmness regime of cross zonal capacity

Allocated CZC for the exchange of balancing capacity or sharing of reserves shall be firm after the selection of standard upward balancing capacity bids or standard downward balancing capacity bids by the capacity procurement optimisation function pursuant to Article 33(3) of the EBGL.

According to Article 38(9) of the EBGL, when CZC allocated for the exchange of balancing capacity or sharing of reserves has not been used for the associated exchange of balancing energy, it shall be released for the exchange of balancing energy for all TSOs on the balancing energy platform with shorter timeframes.

The costs of ensuring firmness or in the case of curtailment of firm CZC in the event of force majeure or emergency situations are borne by the relevant TSOs sharing the CZC. These costs include the additional costs from the procurement of balancing capacity due to the non-availability of the balancing capacity given the curtailment of CZC.

6 Public Consultation

To fulfil the EBGL requirements, this proposal is subject to consultation in accordance with Article 10(4) of the EBGL. More importantly, this proposal wants to get the input from the stakeholders and market participants on this important feature for the future European balancing capacity market. As a result, all TSOs of the CCR Hansa hold this open on-line consultation to welcome feedback from stakeholders.

The last phase will entail the assessment of all the stakeholder comments collected in the events referred above. After an agreement is reached by all Hansa TSOs, a new version of this proposal will be drafted and submitted for approval to the Hansa NRAs on 18 December 2019.