# Explanatory Document to Core 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 on electricity balancing

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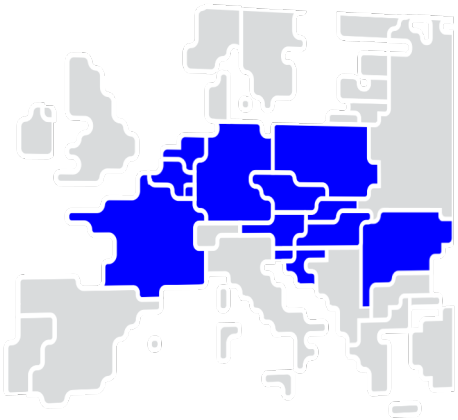

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# DEFINITIONS AND ABBREVIATIONS

## Definitions

| | |
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| **'Co-optimisation method'** | means the methodology to allocate CZC for the exchange of balancing capacity or sharing of reserves that is based on a comparison of the actual market value of CZC for the exchange of balancing capacity or sharing of reserves and the actual market value of CZC for the exchange of energy. |
| **'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. |
| **'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 |
| **'Day-ahead Market timeframe'** | means the timeframe of the electricity market until the day-ahead market gate closure time, where, for each market time unit, products are traded the day prior to delivery. |
| **'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. |
| **'Intraday Market timeframe'** | means the timeframe of the electricity market after intraday cross zonal gate opening time and before intraday cross zonal gate closure time, where for each market time unit, products are traded prior to the delivery of the traded products. |
| **'Market coupling operator'** | means the role of Matching Orders for all Bidding Zones, taking into account Allocation Constraints and Cross Zonal Capacity and thereby implicitly allocating capacity for the Day Ahead and Intraday timeframes. |
| **'Market time unit'** | means the time unit for the aFRR, the mFRR, and RR balancing capacity bids or the day-ahead market time unit (i.e. the period for which the balancing capacity bid price or the market price is established). |
| **'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. |
| **'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. |
| **'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 |

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| | 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. |
| **'Single Day-Ahead Coupling'** | means the auctioning process where collected orders are matched, and cross zonal capacity is allocated simultaneously for different bidding zones in the day-ahead market. |
| **'Single Intra-Day Coupling'** | means the auctioning process where collected orders are matched, and cross zonal capacity is allocated simultaneously for different bidding zones in the intraday market. |
| **'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. |

## 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 |
| **CACM** | Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management |
| **CB** | critical branch |
| **CCR** | capacity calculation region |
| **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 |
| **MCP** | market clearing price |
| **MC** | market coupling |
| **MP** | marginal price |

| | |
|---|---|
| **MTU** | market time unit |
| **MW** | megawatt |
| **MWh** | megawatt hour |
| **NEMO** | nominated electricity market operator |
| **NRA** | national regulatory authority |
| **NTC** | net transfer capacity |
| **PX** | power exchange |
| **RR** | replacement reserve |
| **SDAC** | single day-ahead coupling |
| **SIDC** | single intraday coupling |
| **SOGL** | guideline on electricity transmission system operation |
| **TSO** | transmission system operator |
| **XBID** | the cross-border intraday initiative |

# 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 Core 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 process for 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 zonal 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 different geographical location of the balancing capacity from the dimensioning results for each area, to increase efficiency, competition and cost savings, however, the total amount of procured balancing capacity within the two areas is not reduced.
- **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 not always use their maximum procured capacity simultaneously, TSOs can share their reserves, 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 and use balancing capacity in an efficient, economic and market-based manner;
- improve competition 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).

The aforementioned methods differ in the time period, in which the allocation process is conducted, the timeframe of procurement of balancing capacity as well as in the available data for the allocation. This explanatory document focuses exclusively on the market-based method.

## 1.3 Competition on cross zonal capacity between day-ahead and balancing capacity market

The CZC between two bidding zones is an example of a scarce resource which has to be allocated in an economically efficient way. The CZC allocated to the SDAC decreases the available CZC for balancing capacity (BC) and vice versa. In other words, allocation of CZC to one market increases its welfare but decreases the welfare of the second one and vice versa. The DA and BC markets therefore bilaterally compete for the available CZC for the timeframe of D-1. By establishing a method for allocating CZC, the equal treatment of both markets shall be ensured.

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

Energy supply and demand bids, together with balancing capacity bids, therefore compete for the available CZC for day D.

The classical economic concept to optimally allocate CZC to different purposes (also called the optimal capacity split problem) is to express the marginal economic surplus for an increment of CZC used for each purpose, and then find the capacity split where 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~~Figure 1~~ below.

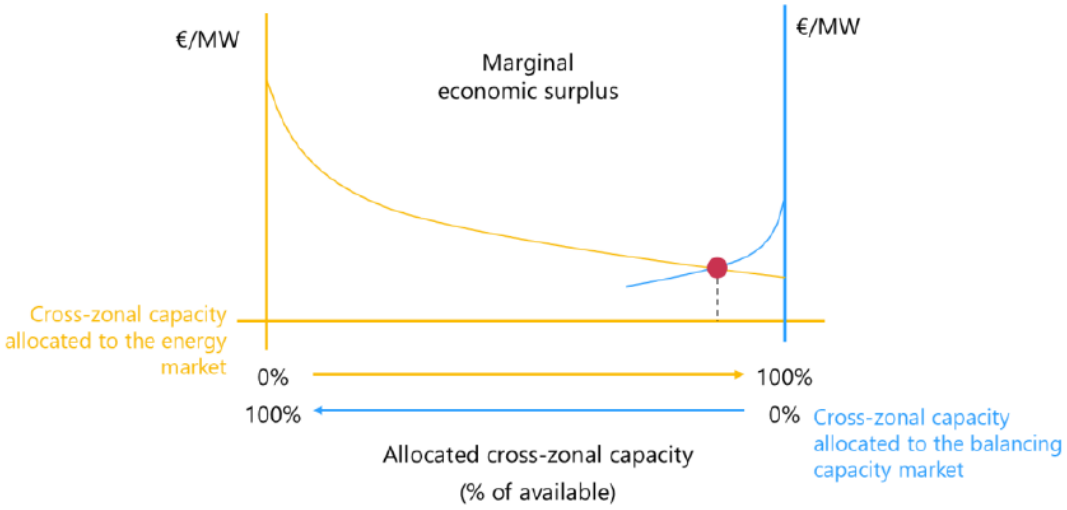



**FIGURE 1:** PRINCIPLE OF OPTIMAL CAPACITY ALLOCATION TO DIFFERENT PURPOSES

CZCA over all borders, all hours and all allocation purposes gives maximum market welfare if and only if it is not possible (i.e. without violating constraints) to reduce the difference in marginal economic surplus between allocation purposes for any hour on any border any further, while the summed effect of resulting increases of the difference in marginal economic surplus on any other border, hour and allocation purpose is lower. This is called a Pareto optimum.

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

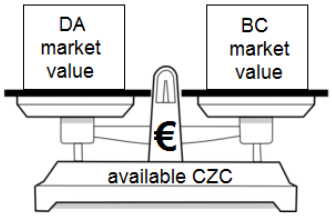



**FIGURE 2:** HOW TO ALLOCATE AVAILABLE CROSS ZONAL CAPACITY

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

# 2 EBGL REQUIREMENTS FOR MARKET-BASED ALLOCATION PROCESS METHODOLOGY

Article 41 of the EBGL enables all TSOs within the CCR Core 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 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;*

i.e. 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.*

i.e. 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 organise and to ensure the availability of reserve capacity resulting from the dimensioning by relying on BSPs that are connected to an area operated by a different contracted TSO within a synchronous area or between two synchronous areas.

Two or more TSOs exchanging or mutually willing to exchange balancing capacity shall 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 Articles 157, 158, 160, and 161 of SOGL.

All TSOs participating in the same exchange of FCR, FRR or RR shall specify an exchange agreement as defined by Article 126 of SOGL.

Exchange of reserves may lead to a different geographical location of the balancing capacity 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~~Figure 5~~ illustrates the exchange of 200 MW of balancing capacity from Area B to Area A.

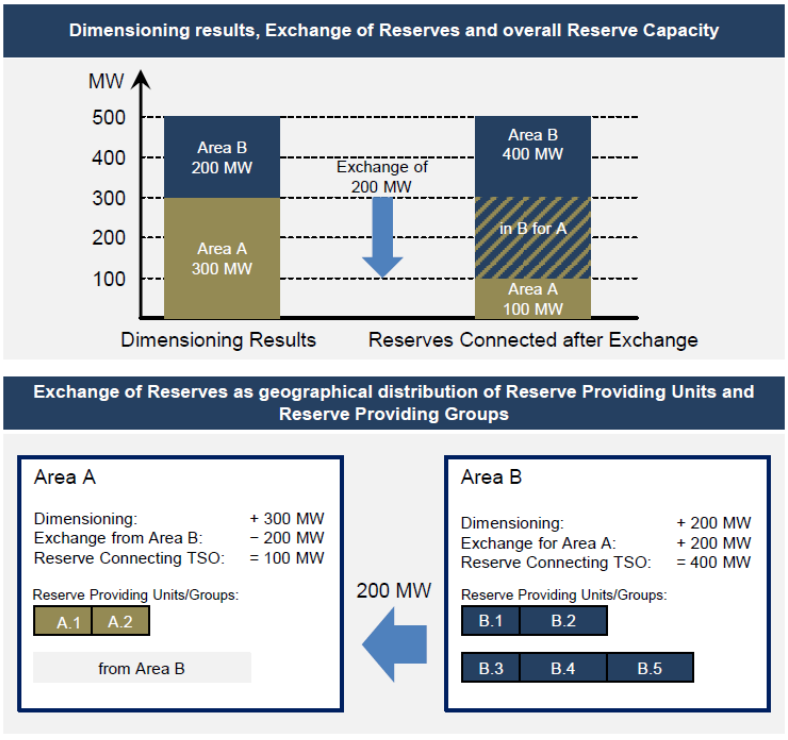



**FIGURE 3:** EXCHANGE OF RESERVES – ILLUSTRATIVE EXAMPLE. SOURCE: LFCR SUPPORTING DOCUMENT 2013

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 are now located within Area B, whereas Area A still ensures in addition 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

The sharing of reserves agreement allows two or more TSOs to organise and to ensure the availability of balancing capacity that is required by dimensioning rules by relying on the same reserves inside a synchronous area and between two synchronous areas.

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 Article 125 of SOGL.

In contrast to the exchange of reserves, which 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. The 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~~Figure 6~~ illustrates the sharing of 100 MW of balancing capacity between two areas with a possible reallocation of a 100 MW of reserves from Area A to Area B.

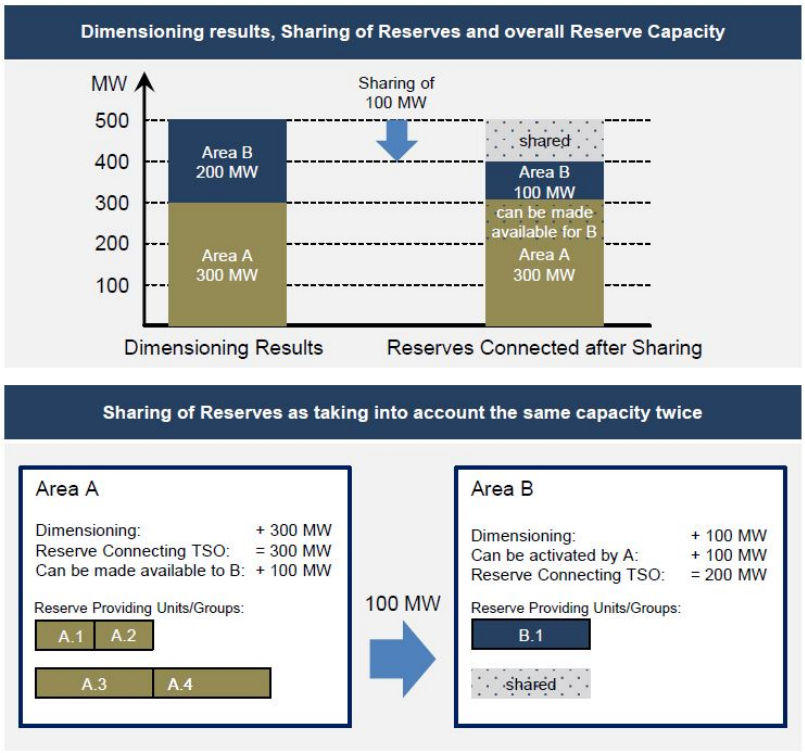



**FIGURE 4:** SHARING OF RESERVES – SIMPLE EXAMPLE. SOURCE: LFCR SUPPORTING DOCUMENT 2013

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 TSOs of area A and area B have to ensure the availability of respectively 300 MW and 200 MW.

However, assuming that in some cases it might be very unlikely that both TSOs need to activate the full amount of reserve capacity at the same time, the TSOs of area A and area B can 'share' part of their

reserve capacity. In practice this means that the TSOs of area B can make use of e.g. 100 MW of the reserve capacity of the TSOs 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 TSOs of area A now make 100 MW of their own reserve capacity also available to the TSOs 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 a 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 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.

The economic concept to optimally allocate CZC to different purposes (also called the optimal capacity split problem) is to express the marginal market value for an increment of CZC used for each purpose (market) and then find the capacity split where the marginal values are equal (or the difference in marginal value is minimal if the lines do not cross).

The maximisation of welfare is achieved by allocating CZC on all borders, for all hours and for all allocation purposes such that the Pareto optimum is reached. I.e.

(a) it is not possible (i.e. without violating constraints) to reduce the difference in marginal market values between allocation purposes for any hour on any border, while at the same time

(b) the difference in marginal market values increases on any other border in any other hour and for any allocation purpose.

However, this concept assumes that the welfare optimization problem must be convex. This assumption may not hold for balancing capacity markets, and the consequences of applying this method is further described in chapter 4.2.5.

## 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 Methodology as submitted by Core TSOs as well as in this accompagnying Explanatory Document, the forecasted market value of CZC for the exchange of energy between bidding zones is defined as the additional welfare surplus expected from SDAC resulting from the additional CZC allocated for the energy market. It is calculated sum of producer surplus, consumer surplus and congestion income.

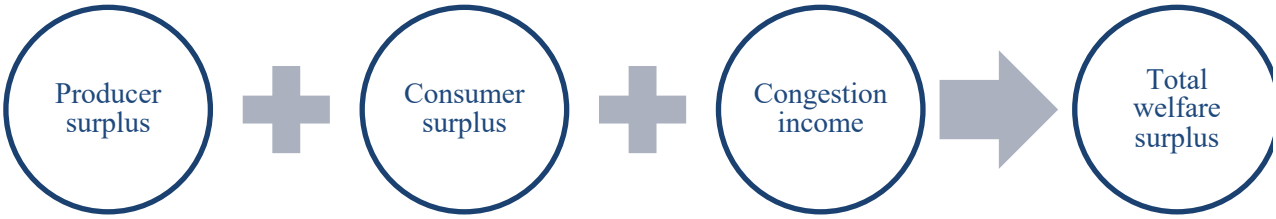



**FIGURE 5:** MARKET VALUE OF CZC IS DEFINED AS THE TOTAL WELFARE SURPLUS

Note that:

- the market value is determined based on the surplus in welfare (relative change) 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~~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.

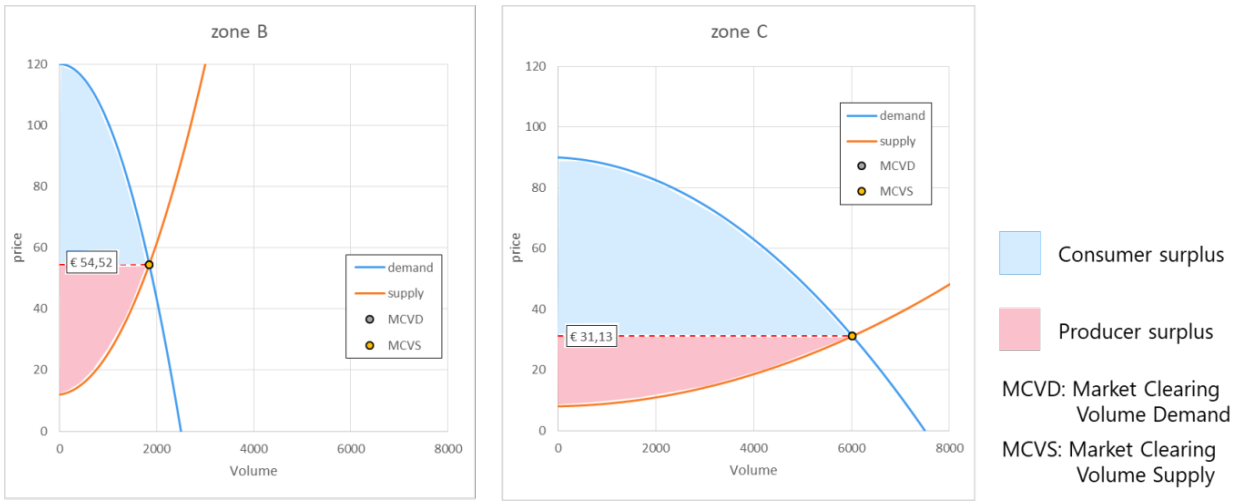



**FIGURE 6:** WELFARE IN TWO ENERGY MARKETS CLEARED IN ISOLATION

### 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~~Figure 5~~ 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 of zone B and C would cancel out and the total congestion rent would disappear.

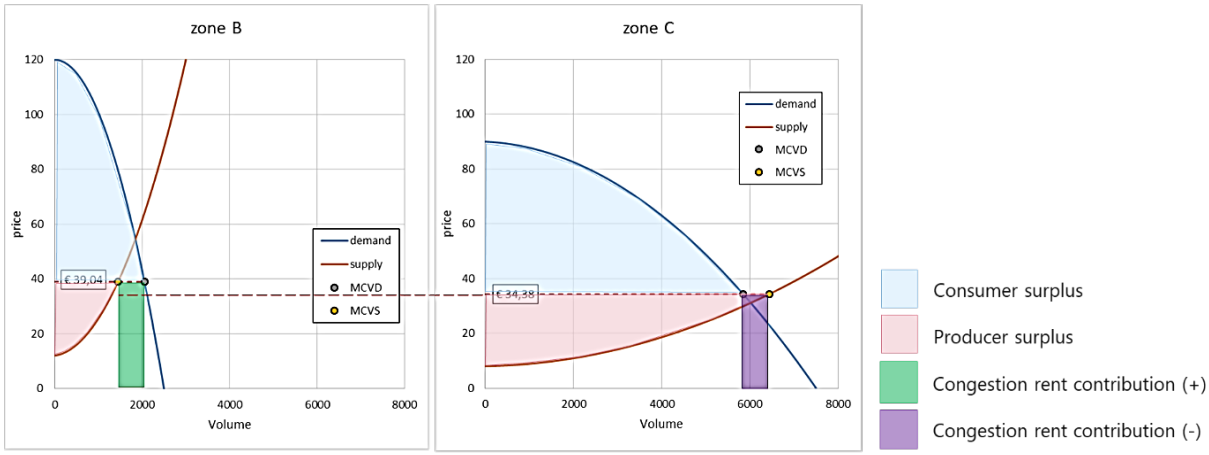



**FIGURE 7:** WELFARE IN COUPLED ENERGY MARKETS WITH CONGESTION

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.

$$\sum_{all\ markets\ m} \{Consumer\ surplus_m + Producer\ surplus_m - Market\ Net\ Position_m\ * Market\ Clearing\ Price_m\}$$

**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 with 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 Methodology as submitted by Core TSOs as well as in this accompagnying 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. It 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. This function is part of the market-based method and is described in more detail in Section **Error! Reference source not found.**5. 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; whereas for pay-as-bid pricing this does not explicitly exist.

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

Figure 8~~Figure 11~~ 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 would be coupled.

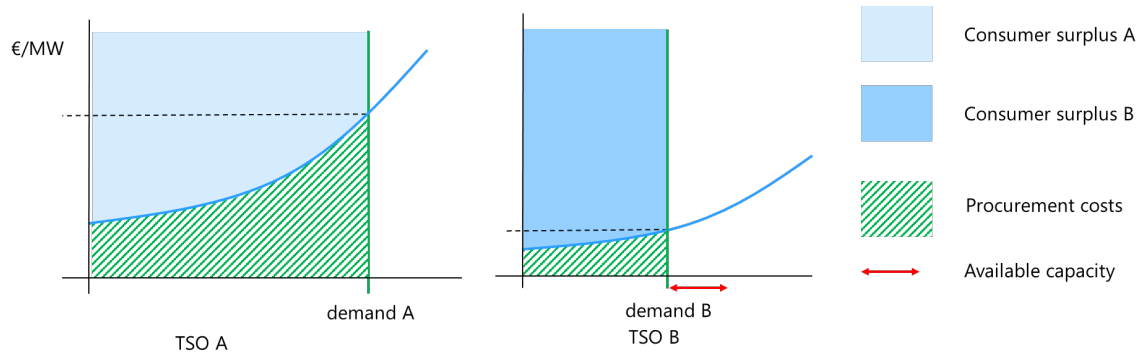



**FIGURE 8:** WELFARE IN ISOLATED MARKETS WITH PAY-AS-BID PRICING

### 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 8~~Figure 8~~ 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 8~~Figure 8~~ 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.

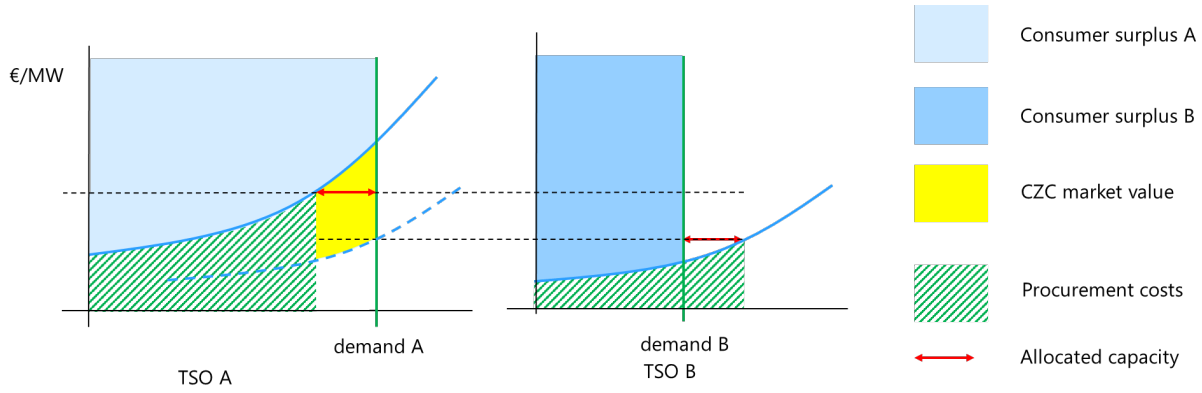



**FIGURE 9:** WELFARE IN COUPLED BALANCING MARKETS WITH PAY-AS-BID PRICING

### 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~~Figure 10~~ below.

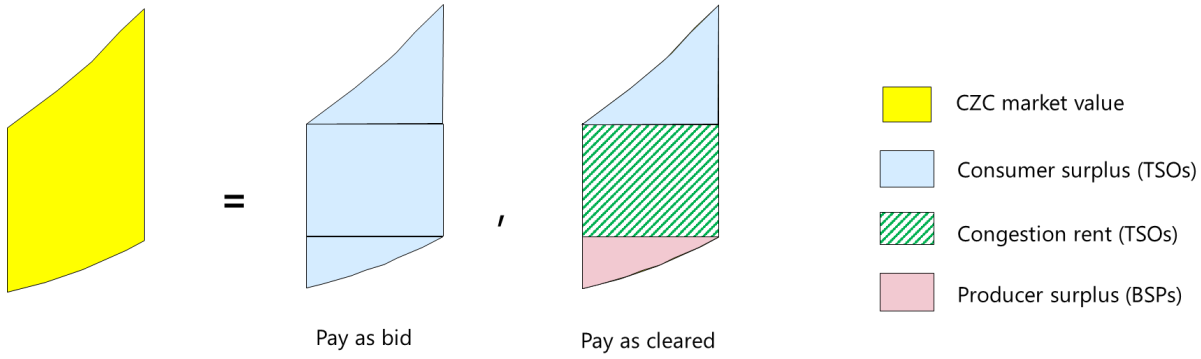



**FIGURE 10:** DIFFERENCE IN THE DISTRIBUTION OF WELFARE SURPLUS DEPENDING ON THE PRICING SCHEME

### 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.

This dependency between the two markets makes it difficult to apply the market coupling principles presented in 3.1.1. For this to be true, there must be no externalities, and no transaction costs, and perfect information has to be 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, e.g. the decision wether a power plant is offline or online is discrete (either 0 or 1). Although such decisions can often be translated in linear problems, such a simplified consideration always come at costs of accuracy. Balancing capacity bids that reflect fundamental costs (e.g. fixed 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 these 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 integer programming. Efficiency of the allocation will be the highest if the energy and balancing capacity market were integrated into one single auction, where the economic surplus is maximised over all matched energy market bids and balancing capacity market bids subject to system constraints. However, this will increase the complexity and processing time.

The combinatorial difficulties can be overcome by restricting reserve bids to a simple format (price, volume). This would render a "merit order" of bids, but the bids would not reflect underlying costs, and the auction would not deliver welfare optimization. Furthermore, this will reduce the efficiency of the CZC allocation and increase the procurement cost of balancing capacity, since the BSP must include a higher risk in their pricing or abstain to participate in the market, which will reduce the liquidity.

### 4.3 Value of Single Intraday Coupling

As mentioned above, article 39(2) of the EBGL states that for the calculation of the actual market value of CZC for the exchange of energy, expected bids of market participants in the intraday market shall be taken into account where relevant and possible.

However, the incorporation of the intraday market would introduce uncertainty of forecasting of intraday trading. In addition, it may be assumed that day-ahead schedules and energy bids of market participants already contain the expectations of the market environment for the respective day, and that the intraday market is used for minor adjustments to these schedules. This also means, that the volume on the intraday market is smaller than on the day-ahead energy market. Compared to the additional uncertainty introduced by forecasting the bids, the intraday market cannot be incorporated in a meaningful way.

### 4.4 Value of Balancing Energy

Allocation of CZC for balancing capacity also allows for the subsequent exchange of balancing energy, including the respective welfare effects. With the market-based approach, the allocation of CZC for balancing capacity shall be based on its actual market value from balancing capacity. In order to derive the contribution of the exchange of balancing energy to the market value, the energy bids would also have to be forecasted including the probability of activation.

Note, however, that in contrast to the intraday market, the relative contribution of balancing energy to the market value of CZC for the balancing market may be equal or even larger than the contribution of balancing capacity. This is also exacerbated by the possibility of a dual use of CZC from one market area to the other: for example, positive balancing energy exchanged from area A to area B and negative balancing energy exchanged from area B to area A have the same energy flow direction, in this case from area A to area B.

## 5 MARKET-BASED APPROACH

### 5.1 Process overview

The market-based methodology consists of five steps: the forecast of market value of CZC for the exchange of energy (1), the bid submission of balancing capacity (2), the optimisation of CZC allocation (3) and of balancing capacity procurement (4), and the publication of the results of the process (5).

### 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 period(s) with the option to include adjustment factors. The forecasting can consist of 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 by application 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 period means a day or days which is/are used to define the forecasted value of CZC. Reference period(s) shall be the latest relevant day(s), for which the used market indicator(s) are available for each bidding zone. (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 BCC of the CCR Core 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). The efficiency of the forecasting from each balancing capacity cooperation will be made public and appropriate measures will be taken to improve the efficiency of the forecasting.

### 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 BCC 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.

In addition to the inputs of BSP bids and TSO demand of balancing capacity for the CZCA optimisation, also the standard limitations and further limitations on the maximum allocation of CZC for the exchange of balancing capacity or sharing of reserves are input of the optimisation. Reasoning for further limitations to reduce the allocation of CZC to balancing capacity are among others: SOGL limitations (Articles 157 and 160) for minimum core part of local procurement (i.e. maximum allowed reduction of (local) balancing capacity procurement per LFC Block), market abusement, protection of SDAC, scarce CZC due to maintenance or outage of network elements, and further limitations for possible step wise implementation of allocation of CZC to balancing capacity.

### 5.1.3 Step 3: CZCA optimisation

The third step awards the CZC either to the exchange of energy or to the exchange of balancing capacity or sharing of reserves.

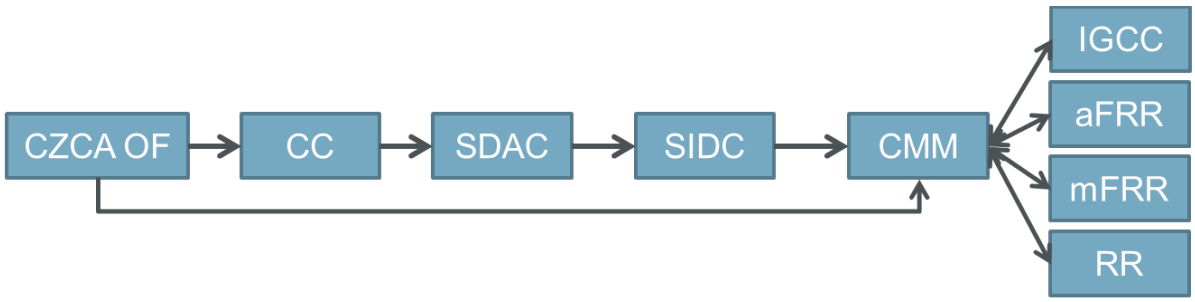
TSOs of the balancing capacity cooperation shall perform the CZCA optimisation function after the TSO-BSP gate closure of standard balancing capacity bids and determine the allocation of CZC for the exchange of balancing capacity or sharing of reserves. The allocated CZC and the price of the CZC have to be determined per standard product and per direction.

### 5.1.4 Step 4: Balancing capacity procurement optimisation

As a result of the CZCA optimisation, the quantity of CZC allocated for the exchange of balancing capacity or sharing of reserves becomes determined for each border and the TSOs shall perform the balancing capacity procurement optimisation function.

TSOs of the BCC shall establish the CMOL of balancing capacity bids using a procurement optimisation function, respecting the allocated CZC for the exchange of balancing capacity or sharing of reserves. The procurement optimisation function minimises the overall balancing capacity procurement costs pursuant to article 58(3) of the EBGL.

The information on the values of allocated CZC in [MW] per border, per product, per direction and per TSO are send to the relevant capacity management functions that communicate with the balancing energy platforms. A simplified overview of the CZC communication directions of the process of market-based allocation including step 3 and step 4 is depicted in the figure below.




Legend: OF = optimisation function; CC = capacity calculation; CMM = capacity management module

**FIGURE 11: SCHEMATIC DEPICTION OF COMMUNICATION FLOWS OF (ALLOCATED) CZC**

The communication paths of the volume of CZC available for the market process are as follows. The CZC allocation optimisation function (CZCA OF) determines the amount of CZC available for balancing capacity and provides this information as input to the capacity calculation (CC). Consequently, the SDAC receives information on the available CZC entirely for the SDAC. Furthermore, the allocated CZC is communicated via the capacity management module (CMM) supporting the balancing energy platforms. The remaining communication between SDAC and SIDC remains the same.

### 5.1.5 Step 5: 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 Core 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

The market-based function maximises the sum of the total welfare of the energy market and of the balancing capacity market.

Regarding the energy market it contains:
- producer surplus;
- consumer surplus;
- congestion income.

Regarding the balancing capacity market it contains:
- buyer surplus (TSO demand);
- seller surplus (BSP bids);
- congestion income.

The forecasted market value of CZC for the exchange of energy is based on reference days where the SDAC spot price difference per bidding zone border is the estimation of the forecasted market value. The components mentioned above (seller surplus, buyer surplus, and congestion income) can then be calculated ex-post in the optimisation.

The actual market value for the exchange of balancing capacity or sharing of reserves is described in Section 4.2 and can be derived directly based on
- actual bids of standard balancing capacity submitted to the procurement optimisation function of the balancing capacity cooperation,
- the balancing capacity demand of each TSO of the balancing capacity cooperation,
- the domain of total available CZC.

The minimum requirements for the CZC allocation optimisation process that will be further specified by each BCC are the following:
- Objective: maximize economic welfare of SDAC and balancing capacity cooperation
- Inputs:
    - Balancing capacity demand;
    - Balancing capacity offers;
    - Sharing of reserve volume;
    - Price difference between bidding zone borders.
    - CZC allocation limitations
- 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
    - 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 73 of the CACM.

For each bidding zone border 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 bidding zone border consists of several interconnectors (owned by different TSOs) with different sharing keys, the net border balancing capacity congestion income shall be assigned first to the respective interconnectors on that bidding zone border 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 bidding zone border. 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 made available by TSOs and published in a common document via ENTSO-E on its web page for information purposes only.

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

## 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 of the BCC 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.

Additional costs of the procurement of balancing capacity relate to additional (local) procurement of balancing capacity by means of a second auction, in order to respect reserve compliancy, based on the dimensioning process.

[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.

# 6 PUBLIC CONSULTATION

To fulfil the EBGL requirements, this methodology is subject to consultation in accordance with article 10(4) of the EBGL. More importantly, this methodology wants to get the input from the stakeholders and market participants on this important feature for the future European balancing capacity market.

The last phase entailed the assessment of all the stakeholder comments collected in the events referred above. After the agreement was reached by all TSOs of the CCR Core, a new version of this methodology has been drafted and is submitted for approval to the Core NRAs on 18 December 2019, together with this explanatory document and a public consultation report answering the feedback from the market participants.