Explanatory Document for Greece Italy TSOs' methodologies for a market-based allocation process of cross zonal capacity for the exchange of balancing capacity or sharing of reserves and for an allocation process of cross zonal capacity for the exchange of balancing capacity or sharing of reserves based on economic efficiency analysis in accordance with Article 41 and 42 of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing

18th December 2019

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Definitions and Abbreviations

Definitions

'Cross zonal capacity'	means the capability of the interconnected system to accommodate energy transfer between bidding zones. This cross zonal capacity can be used by market participants in the energy market or by TSOs for the exchange of balancing capacity or sharing of reserves.
'Cross zonal capacity allocation optimization function'	means the role to operate 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
'Balancing capacity procurement optimization function'	means the role to operate the algorithm applied for the optimization of the procurement of balancing capacity within balancing capacity cooperation in which balancing capacity is exchanged.
'Balancing capacity cooperation'	means two or more TSOs that apply the exchange of balancing capacity or sharing of reserves in a geographical area divided into two or more bidding zones.
'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.
'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.
'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.
'Exchange of balancing capacity'	means the process of procuring balancing capacity by a TSO in a different responsibility area or scheduling area when appropriate than the one in which the procured balancing service Provider is connected.
'Sharing of reserves'	means a mechanism in which more than one TSO takes the same balancing capacity, being FRR or RR, into account to fulfil their respective reserve requirements resulting from their reserve dimensioning processes.
'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).
'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 dependent on energy product.
'Co-optimization 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.
'Allocation of cross zonal capacity'	means CZC that is allocated for exchange of balancing capacity or sharing of reserves and thus withdrawn from energy markets.
'Use of cross zonal capacity'	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'	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
CO	co-optimization
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 guideline
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 the same timeframe in which the balancing capacity procurement is organized. To yield the largest benefit through a CZCA in a market-based environment, the EBGL introduces three capacity allocation methods:

- Article 40 - Co-optimized 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 Greece Italy CCR TSOs proposals 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 EBGL and for a **methodology for an allocation process of cross zonal capacity for the exchange of balancing capacity or sharing of reserves based on economic efficiency analysis** (hereafter referred to as 'EE CZCA') for the exchange of balancing capacity or sharing of reserves, being developed in accordance with Article 42 of EBGL.

The aim of this explanatory document is to provide additional information with regard to the MB CZCA and EE 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 optimization (cost benefit analysis) are provided;
- **Chapter 5** introduces a comprehensive description of the market-based allocation process;
- **Chapter 6** introduces a comprehensive description of the inverted market-based allocation process;
- **Chapter 7** introduces a comprehensive description of the economic efficiency allocation process;
- **Chapter 8** provides a high-level description of the sharing of congestion income of cross zonal capacity;
- **Chapter 9** provides background information regarding firmness regime of cross zonal capacity;
- **Chapter 10** is dedicated to the Public Consultation about the MB CZCA methodology and the EE 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 harmonization in both technical requirements and market rules. To provide this level of harmonization, the EBGL sets out certain requirements for the developments of harmonized 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 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 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 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 border exchange of balancing capacity or sharing of reserves. Such an allocation may:

- 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-optimized 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-optimization (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).

Aforementioned methods differ in the time period, in which the allocation process is conducted 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 decrease the available CZC for the 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 directly compete for the available CZC in the given timeframe. 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 day D together with the contracting of balancing capacity. Forecasted energy supply and demand bids, together with firm balancing capacity bids, therefore compete for the available CZC for day D, as calculated and published by the TSOs at the latest one hour before the SDAC gate closure time.

The **inverted market-based** allocation process implies CZCA for the balancing capacity market at D-1 for the 24 hours of the next day together, with and at the same time as the allocation of cross zonal capacity to the SDAC. Firm energy supply and demand bids, together with forecasted standard balancing capacity bids, therefore compete at the same time for the available CZC for the next day, as calculated and published by the TSOs before the GCT of the SDAC.

The **economic efficiency** allocation process implies CZCA for the balancing capacity market before W-1. Forecasted energy supply and demand bids, together with forecasted standard balancing capacity bids, therefore compete at the same time for the available CZC for the next day, as calculated and published by the TSOs before the GCT of the SDAC.

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 below.

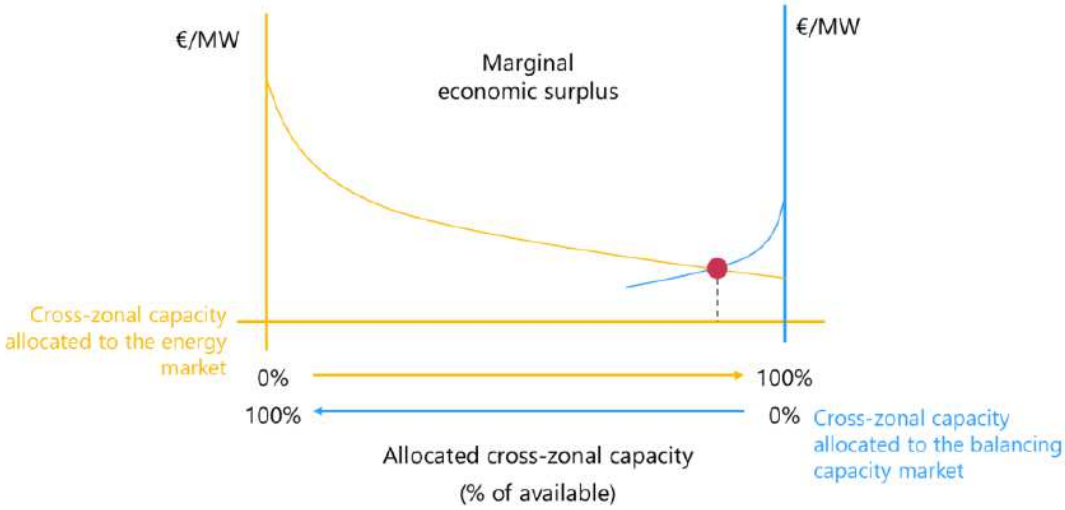

FIGURE 1: PRINCIPLE OF OPTIMAL CAPACITY ALLOCATION TO DIFFERENT PURPOSES

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 maximize the sum of welfare of the balancing capacity market and the SDAC.

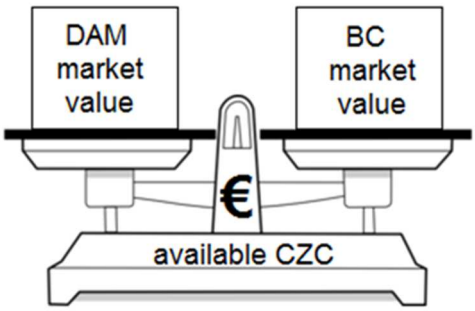

FIGURE 2: HOW TO ALLOCATE AVAILABLE CROSS ZONAL CAPACITY

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

2 EBGL requirements for market-based allocation process methodology

Article 41 of the EBGL requires Greece Italy 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 Greece Italy 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 positive or negative (revenue or cost). It can appear 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;

(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 actual market value of cross-zonal capacity for the exchange of energy;

Actual bids, which represent the actual market value, are used for all products. This means that:

- the gate closure time is the same for balancing capacity and energy markets;
- TSOs (balancing) and NEMOs (trading energy) have the same timeslot to send data to the market coupling operator.

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 only for the exchange of balancing capacity or sharing of reserves and the associated exchange of balancing energy.

2.2 Economic efficiency proposal: Article 42 of the EBGL

Article 42(1) of the EBGL states the requirements to develop "*a methodology for the allocation of cross-zonal capacity based on an economic efficiency analysis".*

Besides the obligation to develop a proposal, Article 42 of the EBGL defines boundary conditions and specific requirements for this methodology.

In the words of the EBGL, such a methodology shall apply for the exchange of balancing capacity or sharing of reserves with a contracting period of more than one day and where the contracting is done more than one week in advance of the provision of the balancing capacity.

The methodology shall include:

a) the rules and principles for allocating cross-zonal capacity based on an economic efficiency analysis;

b) a detailed description of how to determine the forecasted market value of cross-zonal capacity for the exchange of balancing capacity or sharing of reserves, and an assessment of the market value of cross-zonal capacity for the exchange of energy;

c) a detailed description of the pricing method, firmness regime and the sharing of congestion income for the cross-zonal capacity that has been allocated based on an economic efficiency analysis;

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 positive or negative (revenue or cost). It can appear 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 EE CZCA Proposal contains the principles for sharing the congestion income.

Article 42(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 EE CZCA Proposal is applied ensure equal treatment between balancing capacity bids and energy bids.

(d) the maximum volume of allocated cross-zonal capacity for the exchange of balancing capacity or sharing of reserves pursuant to paragraph 2;

Article 42(2) states that the allocation of cross-zonal capacity based on an economic efficiency analysis shall be limited to 5% of the available capacity for the exchange of energy of the previous relevant calendar year between the respective bidding zones or, in case of new interconnectors, 10% of the total installed technical capacity of those new interconnectors. This volume limitation may not apply for bidding zone borders connected through DC interconnectors until the co-optimized or market-based allocation processes are harmonized at Union level pursuant to Article 38(3).

Moreover, it is stated in Article 42(6) of the EBGL that CZC allocated for the exchange of balancing capacity or sharing of reserves via the EE allocation process shall be yearly reassessed and released if it is no longer beneficial.

3 Background information

3.1 Single day-ahead coupling (SDAC)

3.1.1 Market coupling principles

In day-ahead market coupling, the CZC is implicitly (that means capacity and energy) allocated between bidding zones through the choice of energy bids. Indeed, the social welfare is maximized by selecting the cheapest bids from different bidding zones to the extent of the CZC between them. Below the main steps, the coupling principles and timeline of SDAC are presented.

Day-ahead market based on explicit auctions (that means capacity only) are not considered here because this methodology is out of target solution of CACM.

3.1.2 Timelines

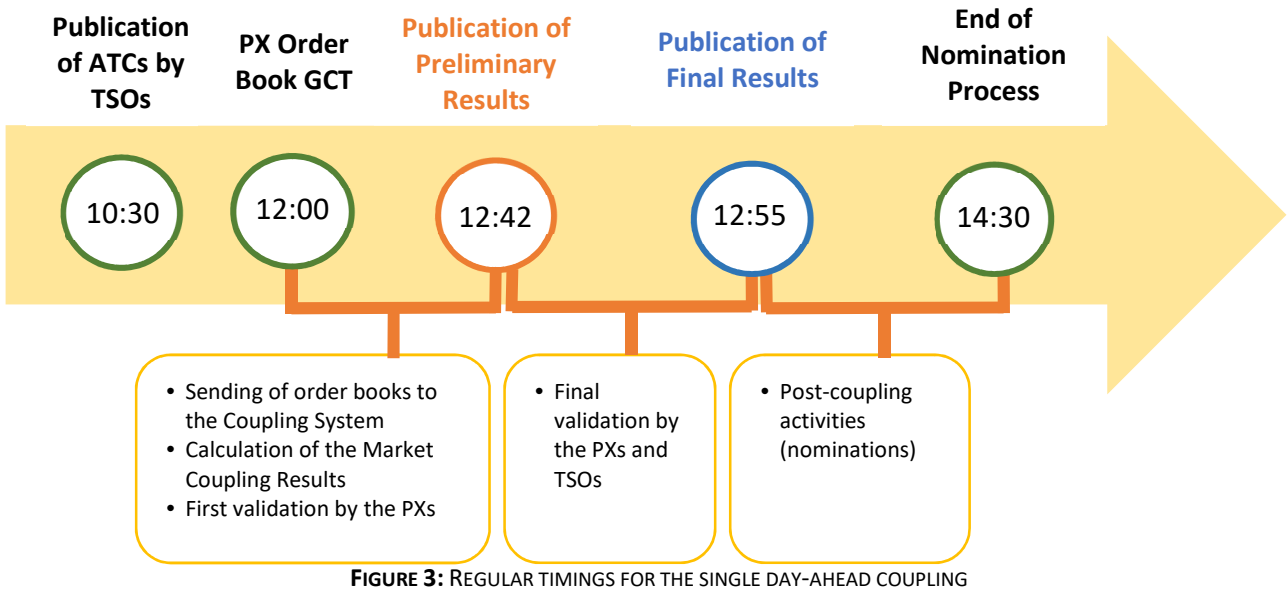

FIGURE 3: REGULAR TIMINGS FOR THE SINGLE DAY-AHEAD COUPLING

1. Until 10.30, TSOs assess the available CZC (Flow Based or ATC) and publish them.
2. The market participants communicate their buy/sell orders from the following day to PX, until market gate closure time (CACM harmonization target is 12:00) for all the coupled market.
3. The MC clearing algorithm calculates the prices, the volumes and the net positions.
4. The results for coupled markets are published, the preliminary publication is for information
5. The final results are published until 12:55 in regular case. In case of problems, the publication of final results could be delayed until 13:50 latest.

in case of technical problems there is the possibility to implement additional actions to get results for the day-ahead process like partial decoupling or full decoupling resulting in a fall back solution based on explicit capacity shadow auctions.

3.2 Single intraday coupling (SIDC)

SIDC brings the whole European intraday continuous market together, with an implicit CZC allocation across Europe. The structure of the SIDC platform allows the share of order books between different PXs (SOB) while choosing the minimal path for the commercial transaction. The platform is using ATC nonetheless in the future, FB could be used as calculation method.

Considering the timings of SIDC, two options are in place:

For the first one the gate closure time for the hour for trading is always 60 minutes before the beginning of a full hour. Only until that time, this hour and subsequent ¼ hours could be traded. In fact, this is resulting in different pre-trading duration for the ¼ blocks of each traded hour.

3.3 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

3.3.1 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.

3.3.2 Exchange of balancing capacity

The exchange of reserves allows TSOs to organize 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 harmonized 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 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 4 illustrates the exchange of 200 MW of balancing capacity from Area B to Area A.

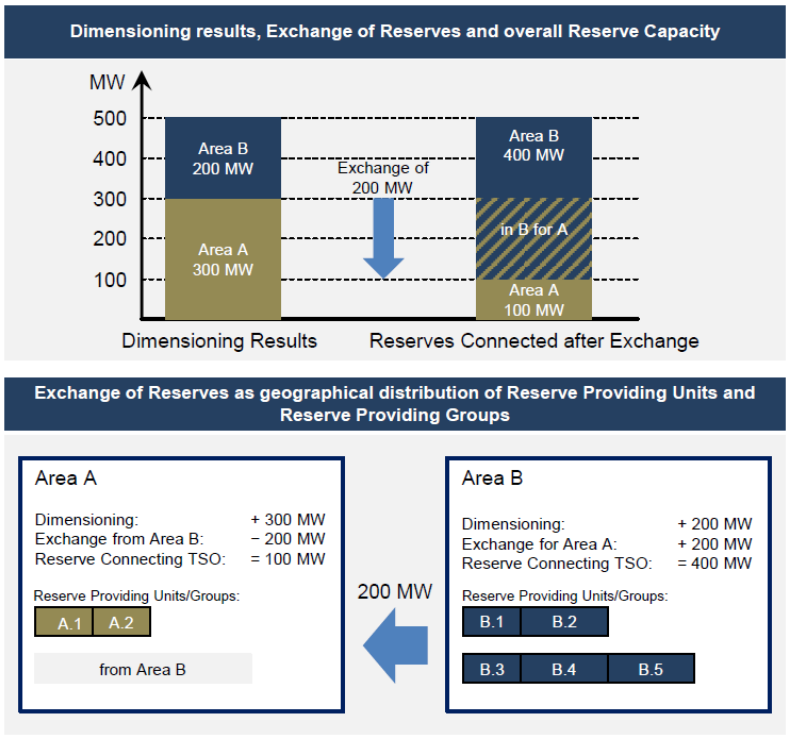

FIGURE 4: EXCHANGE OF RESERVES – ILLUSTRATIVE EXAMPLE. SOURCE: LFCR SUPPORTING DOCUMENT 2013

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.

3.3.3 Sharing of reserves

The sharing of reserves agreement allows two or more TSOs to organize 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 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. 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 5 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.

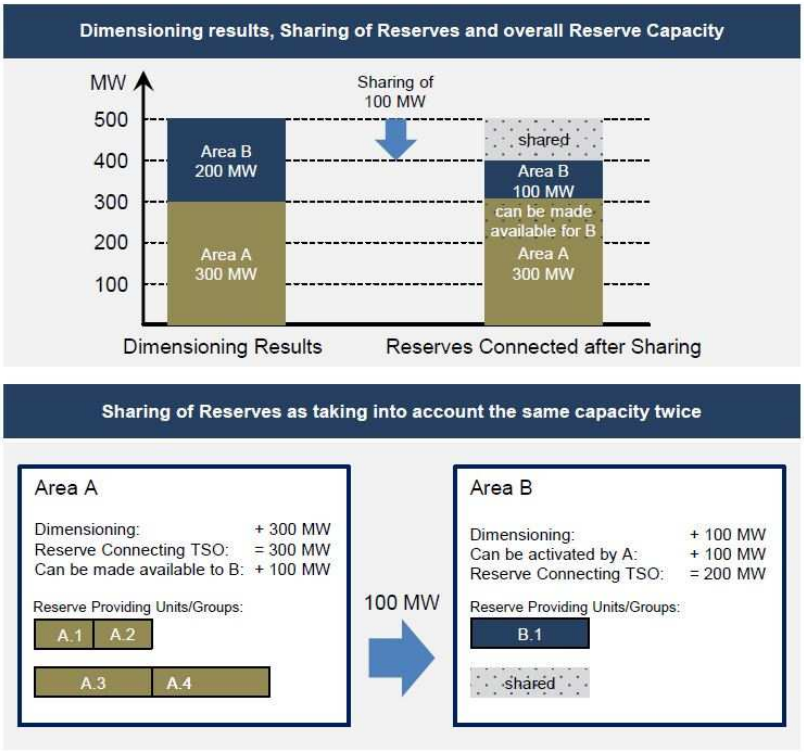

FIGURE 5: SHARING OF RESERVES – SIMPLE EXAMPLE. SOURCE: LFCR SUPPORTING DOCUMENT 2013

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 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.

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 active power reserves in the synchronous area, with an impact on the geographical distribution as an additional implicit effect. The sharing agreement defines priority rights to the shared reserves in the situation where both TSOs have a simultaneous need.

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 reduction of 100 MW of reserve capacity in the total system).

4 Market value of cross zonal capacity

The decision 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 actual market value of cross-zonal capacity for the exchange of energy, according to Article 40(2) of the EBGL.

Article 39 (2-4) of the EBGL further specifies how the actual market value shall be derived: with regard to the exchange of energy the bids of market participants in the day-ahead markets shall be used, also taking into account bids in the intraday market where relevant and possible; and balancing capacity bids submitted to the capacity procurement function pursuant to Article 33 (3) of the EBGL shall be used with regard to the exchange of balancing capacity. 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 consumer surplus for the balancing capacity market. The actual 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 maximization of welfare is achieved by allocating CZC on all borders, 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 Actual Market Value of cross zonal capacity for the Exchange of Energy

4.1.1 The market value of cross zonal capacity

In the MB and EE CZCA Proposals as well as in this Explanatory Document, the market value of CZC for the exchange of energy between all bidding zones of the SDAC is defined as the additional welfare surplus of the SDAC resulting from the additional CZC allocated for the energy market and is calculated based on the sum of producer surplus, consumer surplus and congestion income.

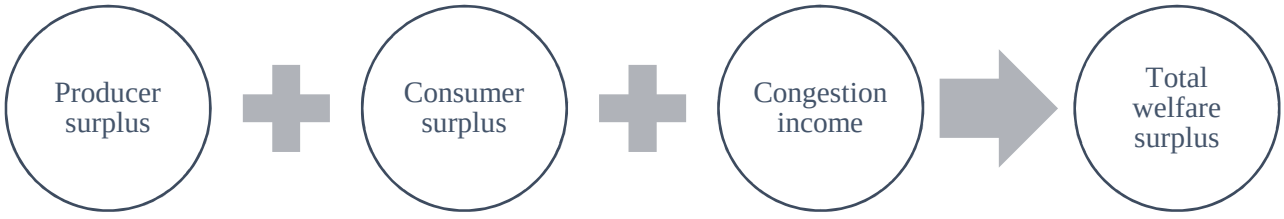

FIGURE 6 : MARKET VALUE OF CZC IS DEFINED AS THE TOTAL WELFARE SURPLUS

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 since the final allocation of CZC is based on co-optimization; 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 allocated via co-optimization.

4.1.2 *Isolated energy markets cleared independently*

Figure 7 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.

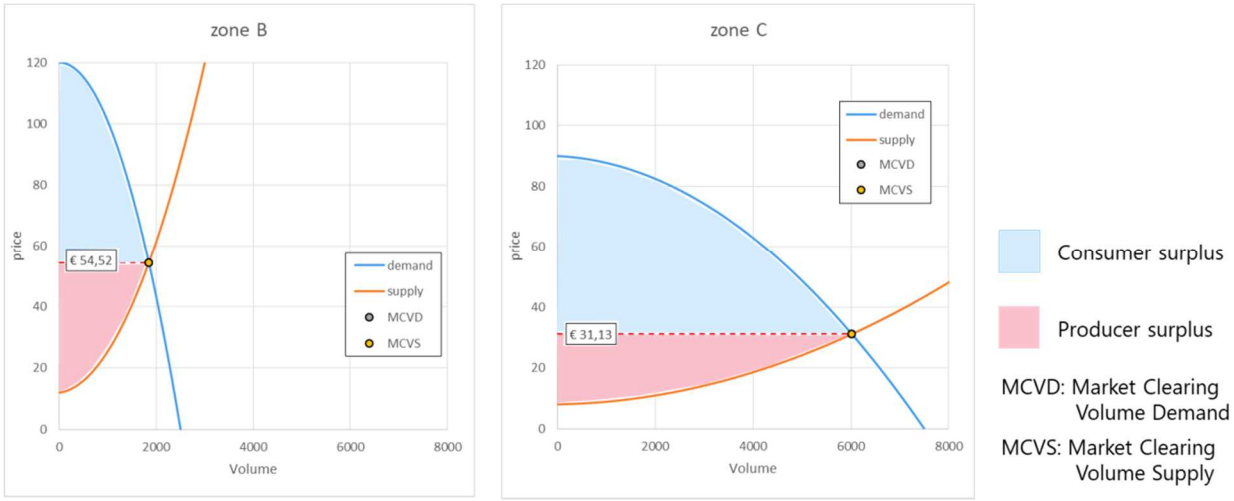

FIGURE 7: WELFARE IN TWO ENERGY MARKETS CLEARED IN ISOLATION

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 8 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.

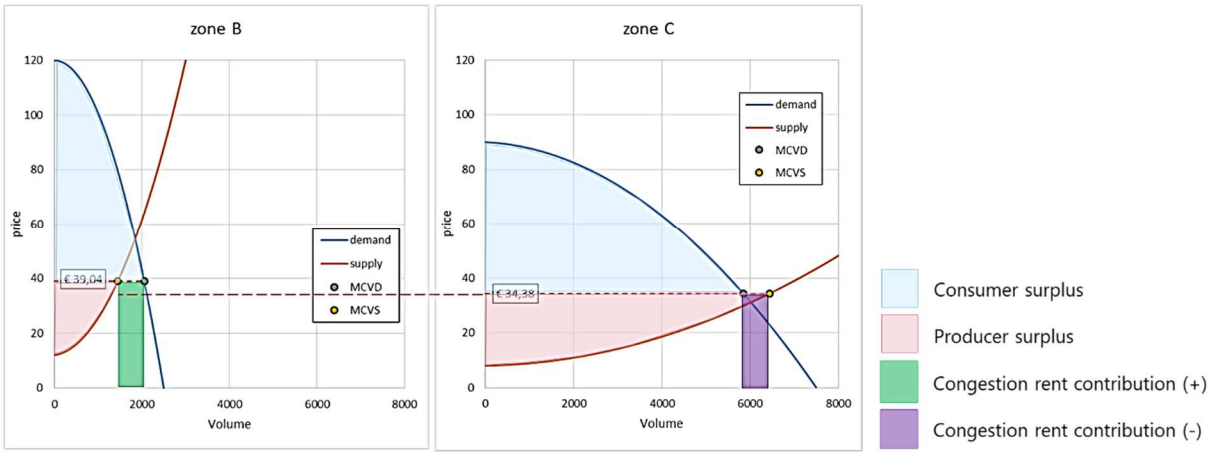

FIGURE 8: WELFARE IN COUPLED ENERGY MARKETS WITH CONGESTION

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 co-optimization 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 co-optimization 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 and EE CZCA Proposals 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 again calculated based on consumer surplus, and when marginal pricing is used as to clear the market also on producer surplus as well as on congestion income. This means that the market value does not represent the absolute value of the balancing capacity market and CZCA.

The underlying data are upward and downward balancing capacity bids (actual or forecasted) which have been submitted and accepted by the capacity procurement optimization function pursuant to Article 33(3) of the EBGL.. In general, upward and downward balancing capacity bids are optimized 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 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 only difference is that the total welfare is the same, but the distribution is different: there is producer surplus for marginal pricing; for pay-as-bid pricing this would also be part of consumer surplus. Also, with pay-as-bid pricing, all welfare gains are attributed to TSOs (as consumer surplus), whereas marginal pricing allows producers to also profit from the value of CZC.

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

Figure 9 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.

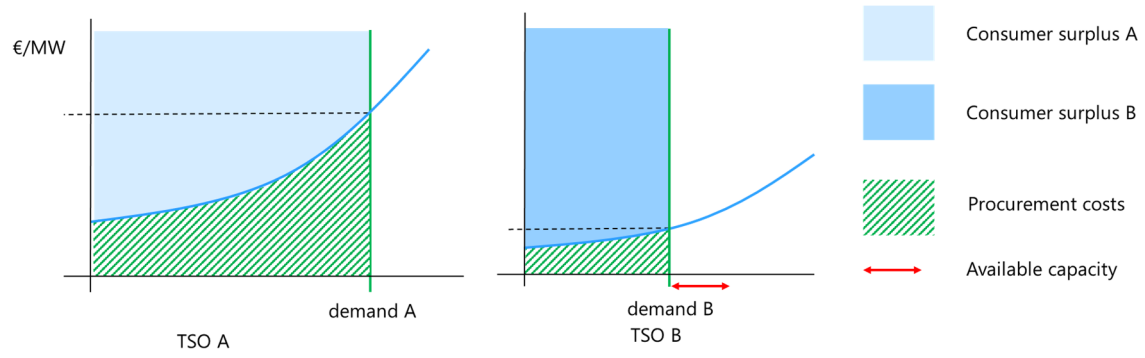

FIGURE 9: WELFARE IN ISOLATED MARKETS WITH PAY-AS-BID PRICING

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 10 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 10 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.

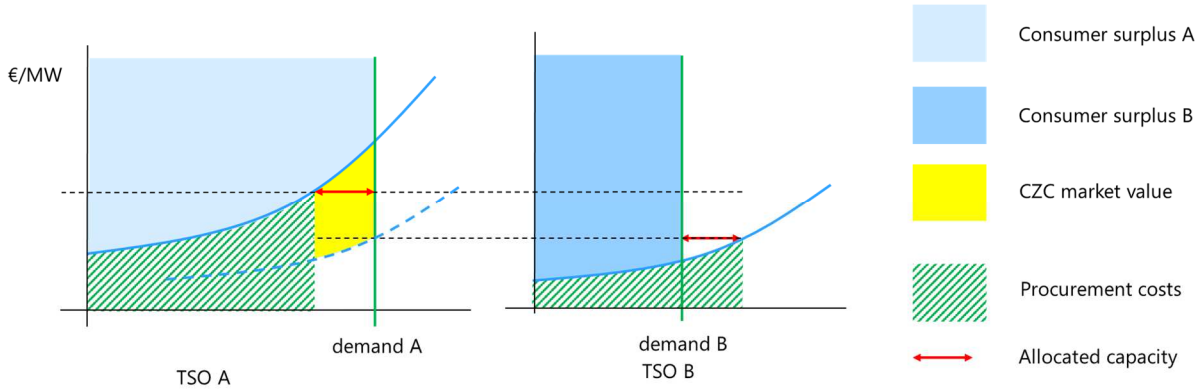

FIGURE 10: WELFARE IN COUPLED BALANCING MARKETS WITH PAY-AS-BID PRICING

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 11 below.

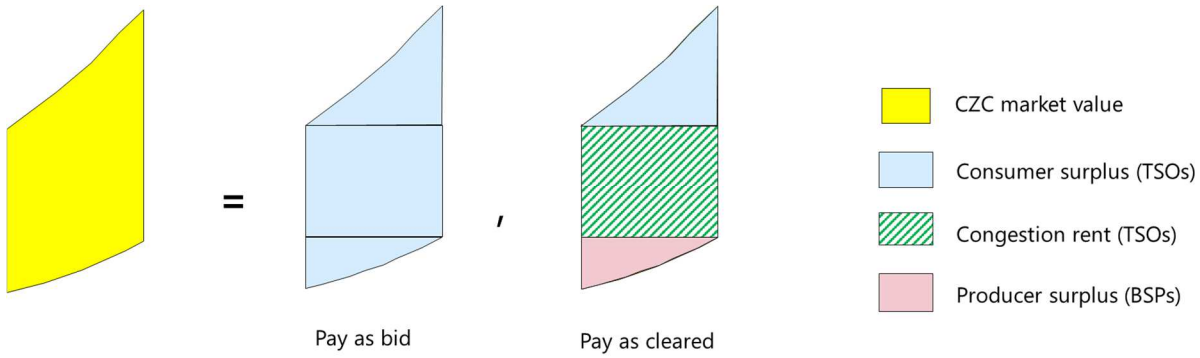

FIGURE 11: DIFFERENCE IN THE DISTRIBUTION OF WELFARE SURPLUS DEPENDING ON THE PRICING SCHEME

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 presented in 3.1.1. 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 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 maximizing 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 maximized 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. This will on the other hand reduce the efficiency of the CZCA allocation and the 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 difficult 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. Depending on whether the market based or the inverted market-based approach is used, the allocation of CZC for balancing capacity must be based on its actual or the forecasted market value, respectively. In order to derive the contribution of the exchange of balancing energy to the market value, the energy bids also need to be forecast. 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 5 steps: the forecast of market value, the bid submission, the optimization of CZC allocation and of balancing capacity procurement 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 market value of CZC for the exchange of energy shall be forecasted based on submitted SDAC bids of 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).

During the basic forecast process, each TSO 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) may e.g. be the latest relevant day(s), where 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 (but not limited to):

- 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 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 nominated 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 organized 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 of a cooperation.

5.1.3 Step 3: CZCA Optimization

CZC allocation award the cross zonal capacity 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 optimization function after the TSO-BSP GCT of standard balancing capacity bids and determine the allocation of CZC for the exchange of balancing capacity or sharing of reserves. This has to be determined per standard product and per direction.

5.1.4 Step 4: Balancing capacity procurement optimization

As a result of the CZCA optimization, the quantity of cross zonal capacity 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 optimization function.

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

5.1.5 Step 5: Publication

TSOs shall inform all affected parties of the process results, including all TSOs in the Greece Italy CCR.

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 Greece Italy CCR 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 mark the allocated CZC for the exchange of balancing capacity or sharing of reserves as already allocated CZC for the CZC calculation process.

5.2 Description of Optimization Setup

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

Regarding the energy market it shall contain:

- producer surplus
- consumer surplus, and
- congestion income

Regarding the balancing capacity market it shall contain:

- consumer surplus (TSO demand), and if applicable
- producer surplus (BSP bids), and if applicable
- congestion income.

The forecasted market value of CZC for the exchange of energy is based on reference days as described in Section 5.1.1.: these reference days may be used to forecast e.g. the SDAC spot price differences or directly the SDAC bids or bid functions. The components mentioned above (producer surplus, consumer surplus, and congestion income) can then be calculated ex-post in the optimization.

The actual market value of CZC for the exchange of balancing capacity or sharing of reserves is described in Section 4.2 and can be derived based on

- actual bids of standard balancing capacity submitted to the procurement optimization function of the balancing capacity cooperation
- the balancing capacity demand of each TSO of the balancing capacity cooperation
- the domain of total available CZC.

If the TSOs of the balancing capacity cooperation decide to also take into account the expected value of CZC regarding the cross-border activation of balancing energy, they may follow the same approach and derive this expected value based on:

- forecasted bids of balancing energy submitted to the activation optimization function
- the probability of activating balancing energy (varying TSO demand)

A minimum example for the conceptual description is the following:

- Objective: maximize economic welfare in the SDAC region and the balancing capacity cooperation
- Inputs:
    - Balancing capacity demand
    - Balancing capacity offers
    - Energy demand bids
    - Energy supply bids
- Outputs:
    - Matched balancing capacity orders
    - Matched energy demand and supply bids
    - Clearing prices for balancing capacity and energy
    - 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 of a balancing capacity cooperation
    - the sum of allocated CZC to the balancing capacity market may not exceed the total available CZC

6 Inverted market-based approach

6.1 Process overview

The inverted market-based methodology consists of 5 steps: forecast of market value of CZC for the exchange of balancing capacity or sharing of reserves, the bid submission, matching bids in the Single Day-Ahead Coupling, balancing capacity procurement optimization and the publication of the results of the process.

6.1.1 Step 1: Forecast of market value of CZC for the exchange of balancing capacity or sharing of reserves

The market value of CZC for the exchange of balancing capacity or sharing of reserves between bidding zones shall be forecasted based on submitted standard upward and downward balancing capacity bids of 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).

During the basic forecast process, each TSO may take into account any market indicator based on the submitted standard BC bids, or the submitted standard BC 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) may e.g. be the latest relevant day(s), where 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 (but not limited to):

- 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 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 balancing capacity or sharing of reserves (both the basic and the improved forecast need to be transparent).

The TSOs of the balancing capacity cooperation convert the standard BC bids in supply and demand orders to make them compatible for the SDAC.

The results of the bid preparation step are the so-called balancing capacity import/export curve and, based on these, a curve for the CZC to be allocated to the balancing capacity market of the bidding zone is generated.

The latter is the required input for the optimization step.

6.1.2 Step 2: Bid submission

With the same GCT as the SDAC DAM bids are submitted by market parties to the NEMOs.

6.1.3 Step 3: Matching bids in the Single Day-Ahead Coupling

The SDAC is performed and takes into account all energy and forecasted standard balancing capacity bids. The optimization function maximizes the welfare of both markets combined. The amount of CZC for the exchange of balancing capacity or sharing of reserves is determined and communicated to the TSOs of the balancing capacity cooperation. Bids of the DAM are matched, prices are determined, and the result becomes firm.

6.1.4 Step 4: Balancing capacity procurement optimization

As a result of the Step 3, the quantity of cross zonal capacity 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 optimization function.

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

6.1.5 Step 5: Publication

TSOs shall inform all affected parties of the process results, including all TSOs in the Greece Italy CCR.

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 Greece Italy implementing this inverted market-based 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 mark the allocated CZC for the exchange of balancing capacity or sharing of reserves as already allocated CZC for the CZC calculation process.

6.2 Description of Optimization Setup

The inverted market-based function maximizes the total welfare of the energy market and of the balancing capacity market.

Regarding the energy market it contains:

- producer surplus
- consumer surplus, and
- congestion income

Regarding the balancing capacity market it contains:

- consumer surplus (TSO demand), and if applicable
- producer surplus (BSP bids), and if applicable
- congestion income.

Since the calculation of the market value of CZC for the exchange of energy is already developed and implemented in the SDAC, only the calculation of the forecasted market value of CZC for the exchange of balancing capacity or sharing of reserves is further elaborated.

The forecasted market value of CZC for the exchange of balancing capacity or sharing of reserves is based on reference day(s) as described in Section 6.1.1 and can be based on:

- forecasted bids of standard balancing capacity that are submitted to the procurement optimization function of the balancing capacity cooperation
- the forecasted balancing capacity demand of each TSO of the balancing capacity cooperation
- the domain of total available CZC.
-

If the TSOs of the balancing capacity cooperation decide to also take into account the expected value of CZC regarding the cross-border activation of balancing energy, they may follow the same approach and derive this expected value based on:

- forecasted bids of balancing energy submitted to the activation optimization function
- the probability of activating balancing energy (varying TSO demand)

A minimum example for the conceptual description is the following:

- Objective: maximize economic welfare in the SDAC region and the balancing capacity cooperation
- Inputs:
    - Balancing capacity demand
    - Balancing capacity offers
    - Energy demand bids
    - Energy supply bids
- Outputs:
    - Matched balancing capacity orders
    - Matched energy demand and supply bids
    - Clearing prices for balancing capacity and energy
    - 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 of a balancing capacity cooperation
    - the sum of allocated CZC to the balancing capacity market may not exceed the total available CZC

7 Economic efficiency approach

7.1 Process overview

The economic efficiency methodology consists of 5 steps: the forecast of standard balancing capacity bids value, the bid submission, the optimization of CZC allocation and of balancing capacity procurement and the publication of the results of the process.

7.1.1 Step 1: Forecast of market value of CZC for the exchange of balancing capacity or sharing of reserves

The market value of CZC for the exchange of balancing capacity or sharing of reserves between bidding zones shall be forecasted based on submitted standard upward and downward balancing capacity bids of 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).

During the basic forecast process, each TSO may take into account any market indicator based on the submitted standard BC bids, or the submitted standard BC 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) may e.g. be the latest relevant day(s), where 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 (but not limited to):

- 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 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 balancing capacity or sharing of reserves (both the basic and the improved forecast need to be transparent).

The TSOs of the balancing capacity cooperation convert the standard BC bids in supply and demand orders to make them compatible for the SDAC.

The results of the bid preparation step are the so-called balancing capacity import/export curve and, based on these, a curve for the CZC to be allocated to the balancing capacity market of the bidding zone is generated.

The latter is the required input for the optimization step.

7.1.2 Step 2: Forecast of market value of CZC for the exchange of energy

The market value of CZC for the exchange of energy shall be forecasted based on submitted SDAC bids of 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).

During the basic forecast process, each TSO 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. (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 (but not limited to):

- 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 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).

7.1.3 Step 3: CZCA Optimization

CZC allocation award the cross zonal capacity 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 optimization and determine the allocation of CZC for the exchange of balancing capacity or sharing of reserves. This has to be determined per standard product and per direction.

7.1.4 Step 4: Balancing capacity procurement optimization

As a result of the CZCA optimization, the quantity of cross zonal capacity 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 optimization function.

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

7.1.5 Step 5: Publication

TSOs shall inform all affected parties of the process results, including all TSOs in the Greece Italy CCR.

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 the Greece Italy CCR implementing this EE 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 mark the allocated CZC for the exchange of balancing capacity or sharing of reserves as already allocated CZC for the CZC calculation process.

7.2 Description of Optimization Setup

The economic efficiency function maximizes the total welfare of the energy market and of the balancing capacity market.

Regarding the energy market it contains:

- producer surplus
- consumer surplus, and
- congestion income

Regarding the balancing capacity market it contains:

- consumer surplus (TSO demand), and if applicable
- producer surplus (BSP bids), and if applicable
- congestion income.
-

The forecasted market value of CZC for the exchange of energy is based on reference day(s) as described in Section 7.1.2. These reference day(s) may be used to forecast e.g. the SDAC spot price differences or directly the SDAC bids or bid functions. The components mentioned above (producer surplus, consumer surplus, and congestion income) can then be calculated ex-post in the optimization.

The forecasted market value of CZC for the exchange of balancing capacity or sharing of reserves is based on reference day(s) as described in Section 7.1.1 and can be based on:

- forecasted bids of standard balancing capacity that are submitted to the procurement optimization function of the balancing capacity cooperation
- the forecasted balancing capacity demand of each TSO of the balancing capacity cooperation
- the domain of total available CZC.

If the TSOs of the balancing capacity cooperation decide to also take into account the expected value of CZC regarding the cross-border activation of balancing energy, they may follow the same approach and derive this expected value based on:

- forecasted bids of balancing energy submitted to the activation optimization function
- the probability of activating balancing energy (varying TSO demand)

A minimum example for the conceptual description is the following:

- Objective: maximize economic welfare in the SDAC region and the balancing capacity cooperation
- Inputs:
    - Balancing capacity demand
    - Balancing capacity offers
    - Energy demand bids
    - Energy supply bids
- Outputs:
    - Matched balancing capacity orders
    - Matched energy demand and supply bids
    - Clearing prices for balancing capacity and energy
    - 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 of a balancing capacity cooperation
    - the sum of allocated CZC to the balancing capacity market may not exceed the total available CZC

8 Sharing of congestion income of cross zonal capacity

The sharing of congestion income distribution will follow what is established by the Congestion income distribution methodology document, written in accordance with Article 73 of the Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a Guideline on Capacity Allocation and Congestion Management.

For each balancing capacity 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 involve, but are not limited to, different ownership shares or different investment costs. The percentages for these specific cases are included in Annex 1 of the CID-CACM.

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.

9 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 optimization function pursuant to Article 33(3) of the EBGL. The details for the costs of ensuring firmness in case of curtailment of firm CZC will be defined once two or more TSOs of the Greece Italy Capacity Calculation Region will establish a balancing capacity cooperation.

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.

The Greece Italy TSOs may set a commonly agreed cost compensation cap.

10 Public Consultation

To fulfil the EBGL requirements, the MB and EE Proposals are subject to consultation in accordance with Article 10(4) of the EBGL. More importantly, the input from the stakeholders and market participants on this important feature is essential for the future European balancing capacity market.

The last phase will entail the assessment of all the stakeholder comments collected in the Public Consultation. After an agreement is reached by the Greece Italy TSOs, a new version of the MB and EE Proposals will be drafted and submitted for approval to the relevant NRAs on 18 December 2019.