Explanatory document to all TSOs' proposal for a methodology for a co-optimised allocation process of cross-zonal capacity for the exchange of balancing capacity or sharing of reserves in accordance with Article 40(1) of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing

18 December 2019

DISCLAIMER

This document is submitted by all transmission system operators (TSOs) to ACER for informative purposes only, accompanying the all TSOs' proposal for a methodology for a co-optimised allocation process of cross-zonal capacity for the exchange of balancing capacity or sharing of reserves in accordance with Article 40(1) of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing.

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Definitions and Abbreviations

Definitions

'Contracting period'	means the period for which balancing capacity is procured by the capacity procurement optimisation function and which may extend over multiple balancing capacity validity periods.
'Balancing capacity validity period'	means the period for which the single standard product for balancing capacity bid (i.e. each submitted capacity volume has one single bid price) is offered and for which the accepted standard product for balancing capacity bid could be activated as standard balancing energy bid where all the characteristics of the standard balancing energy product are respected. The balancing capacity validity period is defined by a start time and an end time.
'Cross-zonal capacity'	means as defined in Article 2(70) of Commission Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity (recast).
'Cross-zonal capacity allocation optimisation function'	means the algorithm that optimises the allocation of CZC between SDAC and balancing capacity markets applied for the allocation of CZC for the exchange of balancing capacity or sharing of reserves.
'Duration of application'	means the period for which balancing capacity cooperation applies the co-optimisation methodology over one or more bidding zone borders to allocate CZC for the exchange of balancing capacity or sharing of reserves according to Article 38(2) of the EB Regulation.
'Exchange of balancing capacity'	means as defined in Article 2(30) of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing.
'Intraday market time-frame'	means as defined in Article 2(37) of Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management.
'Market operator'	means as defined in Article 2(7) of Commission Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity (recast).
'Market coupling operator'	means as defined in Article 2(30) of Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management.
'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.

'Release of cross-zonal capacity'	means CZC allocated for the exchange of balancing capacity or sharing of reserves that are no longer needed and is released as soon as possible and returned in the subsequent capacity allocation timeframes.
'Single day-ahead coupling'	means as defined in Article 2(26) of Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management.
'Single intraday coupling'	means as defined in Article 2(27) of Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management.
'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.
'Use of cross-zonal capacity for the exchange of balancing capacity or sharing of reserves'	means the physical use of CZC with an actual transfer of balancing energy

Abbreviations

The list of abbreviations used in this document:

AC	alternating current
ACER	Agency for the Cooperation of Energy Regulators
aFRR	frequency restoration reserves with automatic activation
ATC	Available Transfer Capacity
BC	balancing capacity
BEC	Bilateral Exchange Computation
BSP	balancing service provider
CA	control area
CACM	Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management
CB	critical branch
CCR	Capacity Coordination Region
CO	co-optimisation
CZC	cross-zonal capacity
CZCA	cross-zonal capacity allocation
D	day
D2CF	two-days ahead congestion forecast
DAM	day-ahead market
DC	direct current
EB Regulation	Commission Regulation (EU) 2017/2195 of 23 November 2017 a establishing a guideline on electricity balancing
ECC	European Commodity Clearing
ENTSO-E	European Network of Transmission System Operators for Electricity
EU	European Union
FB	flow-based
FCR	frequency containment reserves
FRR	frequency restoration reserves
GCT	gate closure time
GSK	generation shift key
H	hour

JAO	Joint Allocation Office
LFC	load-frequency control
LFCR	load-frequency control and reserves
LT	long-term
LTTR	long-term transmission right
mFRR	frequency restoration reserves with manual activation
MC	market coupling
MW	megawatt
NEMO	nominated electricity market operator
NRA	national regulatory authority
NTC	Net Transfer Capacity
PX	power exchange
RCC	regional coordination centre
RR	replacement reserve
SA	synchronous area
SDAC	single day-ahead coupling
SIDC	single intraday coupling
SO Regulation	Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity transmission system operation
TSO	transmission system operator

1 Introduction

The Commission Regulation (EU) 2017/2015 establishing a guideline on electricity balancing (hereafter referred to as the 'EB Regulation') 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 organised. To yield the largest benefit through a CZCA in a market-based environment, the EB Regulation introduces three cross-zonal capacity allocation processes:

- Article 40 to develop a methodology based on the co-optimised allocation process
- Article 41 to develop a methodology based on Market-based allocation process
- Article 42 to develop a methodology based on the allocation process based on economic efficiency analysis

This document gives background information and rationale for the all TSOs' proposal for a **methodology for a co-optimised allocation process of cross-zonal capacity** (hereafter referred to as 'CO CZCA methodology') for the exchange of balancing capacity or sharing of reserves, being developed in accordance with Article 40 of EB Regulation.

This explanatory document aims to provide additional information concerning the CO CZCA methodology 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 EB Regulation requirement and the co-optimisation 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 co-optimised allocation process, where three processes are defining. The mathematical description, implementation impact assessment, sharing of congestion income of cross-zonal capacity and firmness regimes are worded;
- **Chapter 6** is dedicated to stakeholders' involvement in this CO CZCA methodology.

1.1 EB Regulation and the scope of the CZCA Proposal

The EB Regulation 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

EB Regulation 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.

The 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 refer 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 EB Regulation 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 EB Regulation 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).

Methods mentioned above 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 co-optimised 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, the allocation of CZC to one market increases its economic surplus but decreases the economic surplus 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 co-optimisation 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 firm 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.

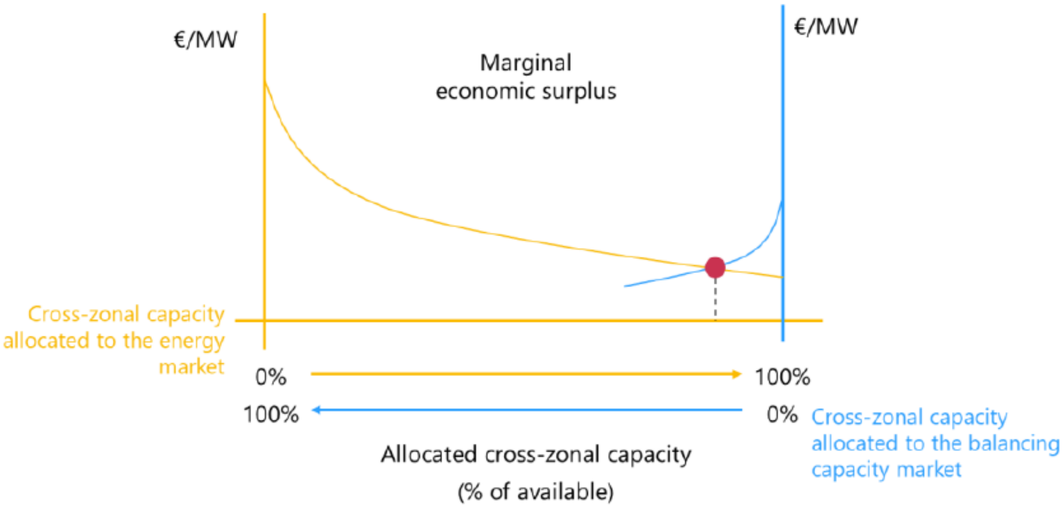


FIGURE 1: PRINCIPLE OF OPTIMAL CAPACITY ALLOCATION TO DIFFERENT PURPOSES

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 co-optimisation function is to maximise the sum of the economic surplus of the balancing capacity market and the SDAC.

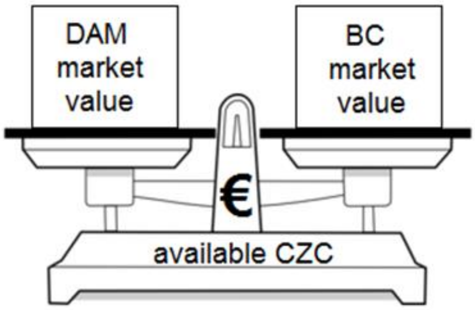


FIGURE 2: HOW TO ALLOCATE AVAILABLE CROSS-ZONAL CAPACITY

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 EB Regulation requirements for co-optimisation allocation process methodology

Article 40 of the EB Regulation requires all TSOs to develop a proposal for a methodology for a co-optimised allocation process of CZC for the exchange of balancing capacity or sharing of reserves. This section provides a summary of the core EB Regulation requirements for the CO CZCA methodology.

2.1 Co-optimisation proposal: Article 40 of the EB Regulation

Article 40(1) of the EB Regulation states the requirement to develop "*a proposal for a methodology for a co-optimised allocation process of cross-zonal capacity for the exchange of balancing capacity or sharing of reserves*."

Besides the obligation to develop a proposal, Article 40 of the EB Regulation defines boundary conditions and specific requirements for this methodology.

In the words of the EB Regulation, 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 day in advance of the provision of the balancing capacity;*

This means that the entire process of CO CZCA methodology takes place within H-24 and H, where H is the time of the provision of the balancing capacity. This means that according to the EB Regulation, co-optimisation allocation is done during the SDAC auction.

> *(b) include the notification process for the use of the co-optimised allocation process;*

> *(c) include a detailed description of how cross-zonal capacity shall be allocated to bids for the exchange of energy and bids for the exchange of balancing capacity or sharing of reserves in a single optimisation process performed for both implicit and explicit auctions;*

In CO CZCA methodology, for the use of the same amount of CZC, within the same market process, there is a direct competition between (at least) two different products: bids for energy and bids for balancing capacity. The inputs of the single optimisation process are both balancing capacity bids and energy bids, submitted per bidding zone. The result is an optimal allocation of the CZC to both products.

> *(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 co-optimised allocation process;*

Pricing methods are, for example, pay-as-bid and pay-as-cleared. The results of the co-optimisation are completely independent of the method for TSO-BSP pricing, which is applied *ex-post* to the selected balancing capacity bids (see Section 4.2).

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 CO CZCA methodology contains the principles for sharing the congestion income.

Article 40(3) of the EB Regulation 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 CO CZCA methodology is applied to 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;*

Article 40 poses no a priori limitation for the co-optimised 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 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 GCT 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 40(4) of the EB Regulation that CZC allocated for the exchange of balancing capacity or sharing of reserves via the co-optimised 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 Principles from Articles 38 and 39 of the EB Regulation

Article 38 of the EB Regulation – General requirements

The methodology for the CO CZCA methodology is based on general requirements set out in Article 38 of the EB Regulation:

Article 38(1) of the EB Regulation states that two or more TSOs are allowed to allocate parts of CZC for the use of balancing, based on three different allocation methodologies, co-optimisation 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 EB Regulation entered into force may remain valid until the contract expires.

Article 38(2) of the EB Regulation lists the 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 EB Regulation 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 EB Regulation entered into force.

Article 38(4) of the EB Regulation 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 EB Regulation forbids the CZCA for balancing purposes when the 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 an early market based integrated balancing capacity markets and applying allocation of cross-zonal capacity.

Article 38(8) of the EB Regulation 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 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 EB Regulation, 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 EB Regulation – Calculation of the market value of cross-zonal capacity

Article 39 of the EB Regulation defines the principles for the calculation of the market value of CZC. The relevant parts for the CO CZCA methodology are described in the following and more detail in Section 4, considering that for this methodology it is mandatory to use actual bids for both the exchange of energy and the exchange of balancing capacity (or sharing of reserves).

Article 39(1) of the EB Regulation states that for the CO CZCA methodology, the market value of CZC is determined based on actual market values of CZC.

Article 39(2) of the EB Regulation says that the actual market value of CZC for the exchange of energy is calculated based on actual bids from the SDAC and its calculation should take into account, where relevant and possible, expected bids from SIDC.

Article 39(3) of the EB Regulation 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 EB Regulation says that the actual market value of CZC for sharing of reserves shall be calculated based on the avoided costs of procuring balancing capacity. This is implicitly taken into account in the CO CZCA methodology because sharing of reserves means that the total demand for balancing capacity of the TSOs in the sharing agreement is lower; therefore the benefit of allocating CZC is the avoided cost of procurement.

2.3 Other relevant information from the EB Regulation

Article 33 of the EB Regulation – Exchange of balancing capacity

According to Article 33(2) of the EB Regulation, *"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 EB Regulation states that, apart from the exceptions in Articles 26 and 27 of the EB Regulation, *"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 EB Regulation 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 EB Regulation) or by the CZCA methodologies pursuant to Articles 38 to 42 of the EB Regulation.

Article 36 of the EB Regulation – Use of cross-zonal capacity

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

> *a) available pursuant to Article 33(6);* i.e. it is calculated with the probabilistic approach,
>
> *b) released pursuant to paragraphs 8 and 9 of Article 38;* meaning that CZC was allocated according to one of the methodologies in Articles 40, 41 and 42 of the EB Regulation and then either not used for the associated exchange of balancing energy or deemed too high in a re-evaluation,
>
> *c) allocated pursuant to Articles 40, 41 and 42.* meaning that CZC was allocated according to one of the methodologies in Articles 40, 41 and 42 of the EB Regulation and can, therefore, be used for the associated exchange of balancing energy.

3 Background information

3.1 Single day-ahead coupling (SDAC)

3.1.1 Market coupling principles

In the day-ahead market (hereafter referred to 'DAM') coupling, the CZC is implicit, that means capacity and energy, allocated between bidding zones through the choice of energy bids. Indeed, the economic surplus is maximised 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.

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

3.1.2 Overview of the functions and steps

Figure 3 illustrates the main functions of the SDAC and is based on the flow-based market coupling process.

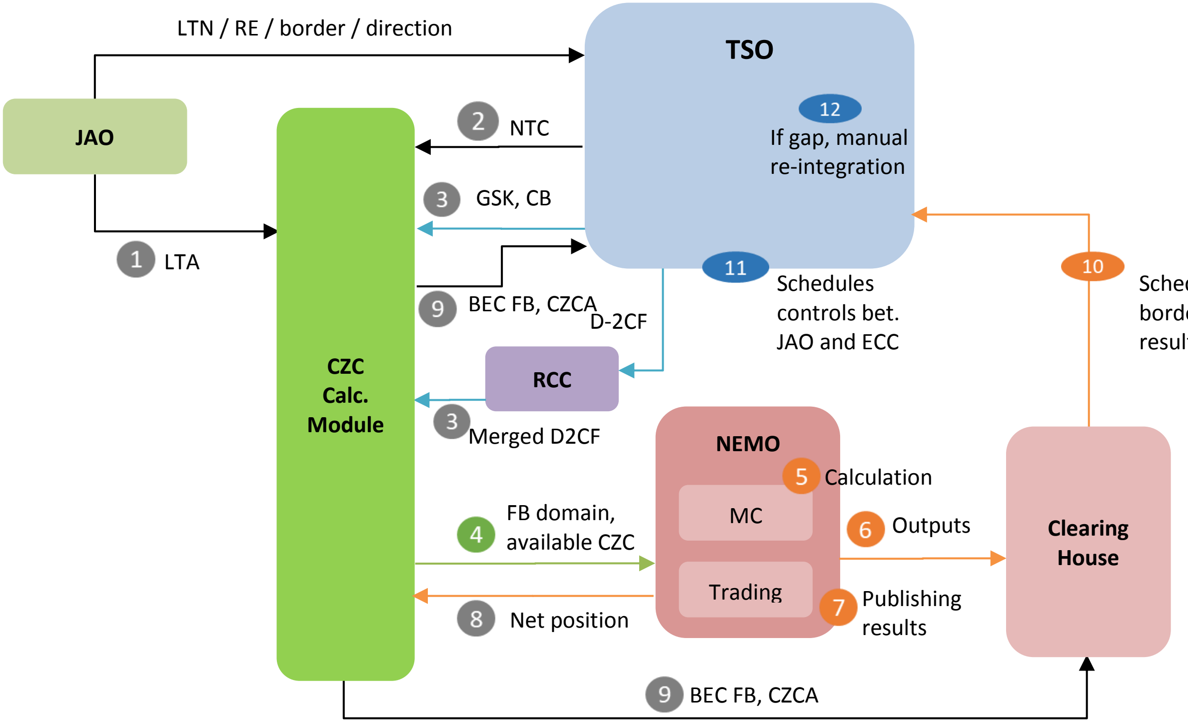


FIGURE 3: MAIN FUNCTIONS OF THE SINGLE DAY-AHEAD COUPLING

The CZC Calculation Module receives the following information to assess the FB domain and the available CZC that will be offered to the day-ahead market coupling:

- JAO transmits the LT allocation from previous auctions (1).
- The TSOs transmit NTCs (2) and FB files: Critical Branches (CB), Generation Shift Key (GSK) (3).
- The RCCs sends back the merged D-2CF (3) for the relevant area.

The CZC Calculation Module informs the NEMO about the FB domain and available CZC (4). The Market Coupling algorithm runs the coupled algorithm (5) and sends the following results to the clearinghouse (6):

final net positions, accepted offers, and (marginal) prices. The NEMO also publishes the results at 12:42 (7). The net positions per hub are sent to the CZC Calculation Module (8) for the Bilateral Exchange Computation (BEC). Once the calculation is finished, the CZC Calculation Module sends the results to TSOs and the clearinghouse (9). The clearinghouse forwards the results and the schedules per border to the TSO (10). The TSO then compares the BEC it received by ECC (11) and by the CZC Calculation Module (9). If they are different, nominations will be rejected, and re-integration will be made at day-ahead schedules, with the other TSO as a counterparty (12). In the case of decoupling, JAO explicitly allocates CZC through shadow auctions.

3.1.3 Timelines

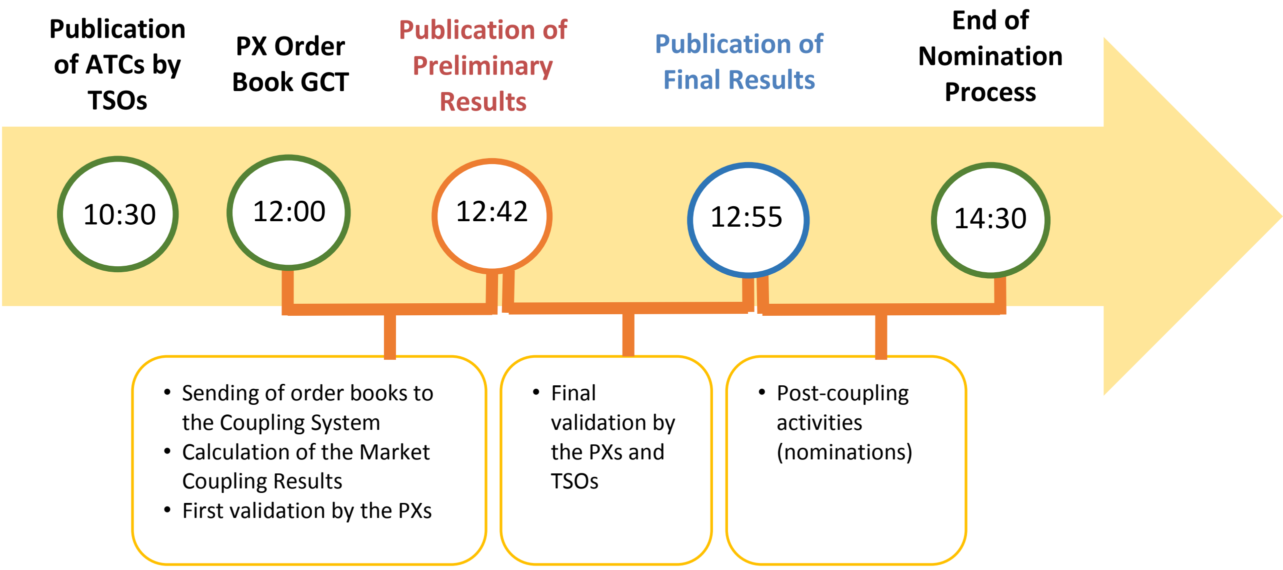


FIGURE 4: REGULAR TIMINGS FOR THE SINGLE DAY-AHEAD COUPLING

1. Until 10.30, TSOs assess the available CZC (based on either Flow-based or ATC-based) and publish them.
2. The market participants communicate their buy/sell orders from the following day to PX, until market GCT 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 a 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 (SOB) between different PXs while choosing the minimal path for the commercial transaction. The platform is using ATC; nonetheless, in the future, FB could be used as the calculation method.

Considering the timings of SIDC, two options are in place: for the first one, the GCT for the hour for trading is always 60 minutes before the beginning of a full hour. Only until that time, this hour and subsequent 15 min could be traded; this is the second. This is resulting in different pre-trading duration for 15 min blocks of each traded hour.

3.3 Balancing capacity market

According to Article 32 of the EB Regulation, 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 the dimensioning rules given by SO Regulation. Reserve capacity can be provided by:

a) procurement of balancing capacity within the control area (CA) 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 Article 32(2) of the EB Regulation:

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.

The application of CZCA co-optimisation results in a BC auction at D-1. However, each balancing capacity cooperation can choose if the auction at D-1 has a contracting period of 24 hours, is smaller or even consists of multiple contracting periods, within 24 hours.

E.g. Peak from 09:00 a.m. to 10:00 a.m. and other at 10:00 to 11:00 p.m.

The validity period of the TSO demand equals the validity period of balancing capacity bids and consequently can be different within a contracting period.

3.3.2 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 EB Regulation 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 SO Regulation.

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

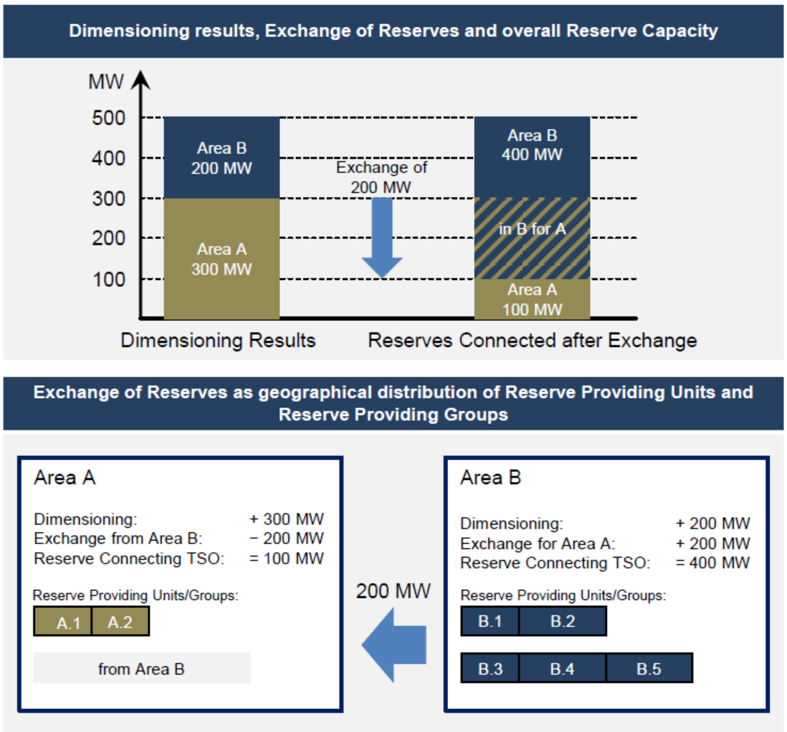


FIGURE 5: EXCHANGE OF RESERVES – ILLUSTRATIVE EXAMPLE. SOURCE: LFCR SUPPORTING DOCUMENT 2013

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 is now located within Area B, whereas Area A still ensures, besides, the availability of the full amount of its 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 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 SO Regulation.

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 the 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 6 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.

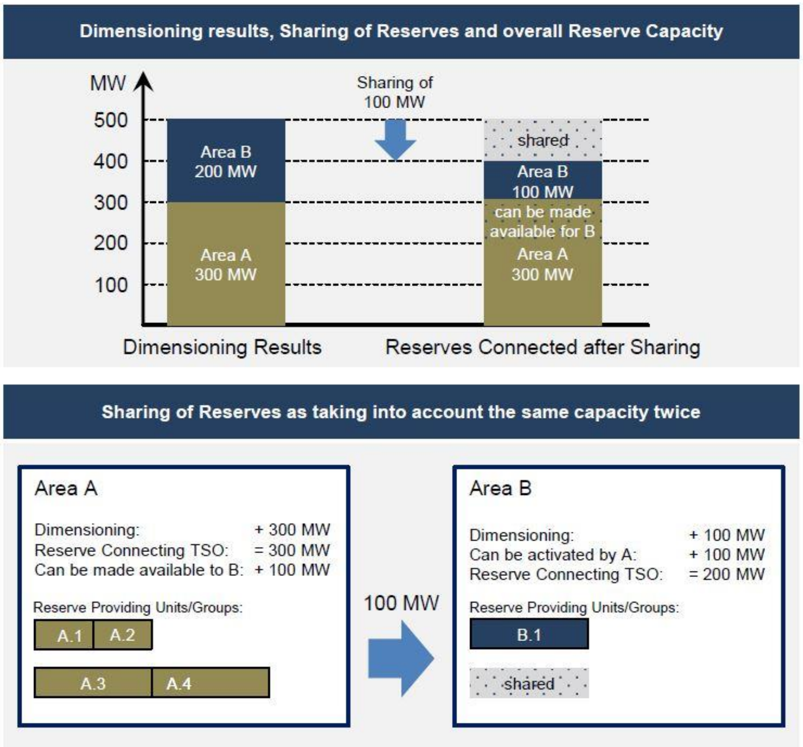


FIGURE 6: SHARING OF RESERVES – SIMPLE EXAMPLE. SOURCE: LFCR SUPPORTING DOCUMENT 2013

Suppose that the dimensioning rules for area A and area B result in 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.

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 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).

3.3.4 Limitations to the CZC allocated to the balancing capacity market

Due to its criticality for system adequacy, and its possible interference with the SDAC processes, allocation of CZC to the balancing capacity market may be subject to additional limitations, beyond the capacity calculation processes that are in place for the allocation of CZC to the energy market.

Relevant NRAs and TSOs within balancing capacity cooperation may decide to limit CZC allocation to the balancing capacity market

a) in case it is necessary to comply with the SOGL limits for local procurement (Articles 167 and 169 and Annexes),

b) as a way to avoid market distortions and safeguard the effective execution of the SDAC,

c) as a measure for market power mitigation, or

d) in case of an already reduced CZC due to planned or unplanned outages, wherein the allocation to the balancing capacity market would excessively constrain the execution of the SDAC.

Such additional limits would then be entered as an input for the CZCA optimisation function and be enforced as an additional constraint to the optimisation itself.

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 EB Regulation.

Articles from 39(2) to 39(4) of the EB Regulation further specifies how the actual market value shall be derived: with regard to the exchange of energy the bids of market participants in the DAM 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 EB Regulation 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 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 day-ahead market time unit.

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 the economic surplus 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 economic surplus optimisation problem must be convex. This assumption may not hold for balancing capacity markets, and the consequences of applying this method are 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 CO CZCA methodology 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 economic surplus (change/incremental) of the SDAC resulting from the additional CZC allocated for the energy market. It is calculated based on the sum of producer surplus, consumer surplus and congestion income, and it is defined per day-ahead market time unit.

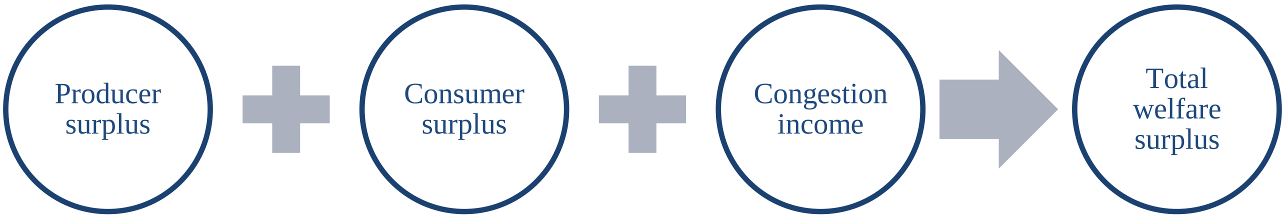


FIGURE 7: MARKET VALUE OF CZC IS DEFINED AS THE TOTAL ECONOMIC SURPLUS

Note that:

- the important measure for the market value is the economic surplus in of additional CZC, not the absolute values of this economic surplus.
- 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-optimisation; 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-optimisation.

4.1.2 Isolated energy markets cleared independently

Figure 8 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 economic surplus.

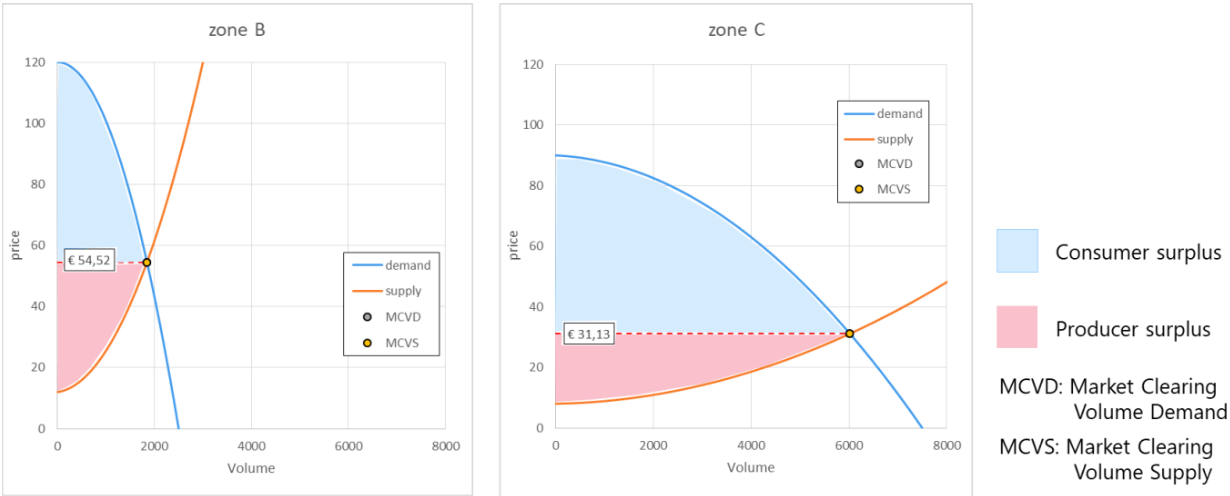


FIGURE 8: ECONOMIC SURPLUS IN TWO ENERGY MARKETS CLEARED IN ISOLATION

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 9 depicts a situation where the allocated CZC only allows for a partial price convergence: the market-clearing price in zone C remains lower than in zone B. In addition to buyer and seller surpluses, the remaining price difference creates a positive congestion rent which is also part of total economic surplus (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.

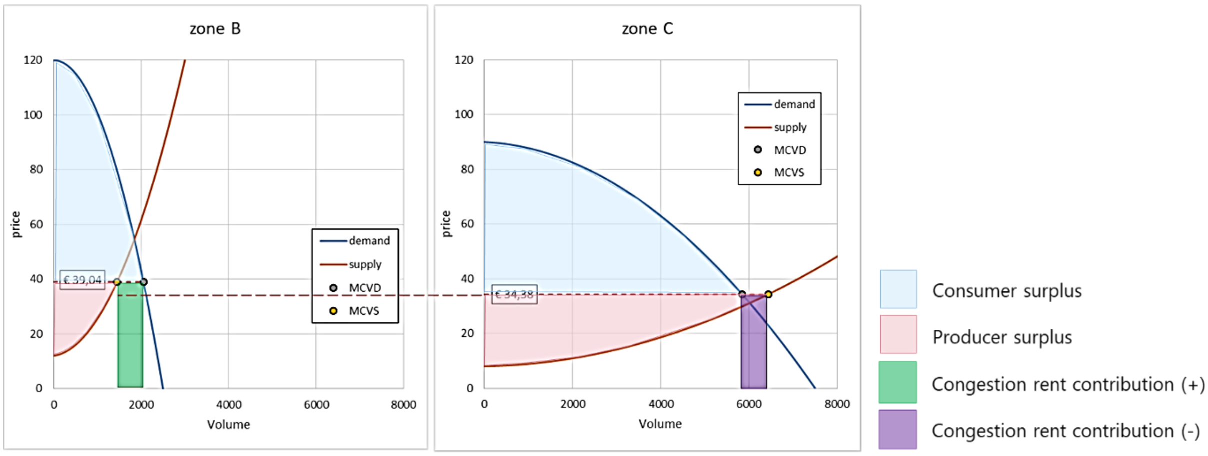


FIGURE 9: ECONOMIC SURPLUS IN COUPLED ENERGY MARKETS WITH CONGESTION

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-optimisation applies. The general calculation of economic surplus is shown in the equation below and consists of the sum of consumer buyer/surplus, producer/seller surplus and congestion rent overall 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.

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

EQUATION: 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 economic surplus when CZC is allocated for the exchange of energy and the situation of isolated markets. The optimal allocation of CZC using the co-optimisation 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 CO CZCA methodology 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 economic 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 which have been submitted and accepted by the capacity procurement optimisation function pursuant to Article 33(3) of the EB Regulation. This function is part of the co-optimisation method and is described in more detail in **Section 5**. In general, upward and downward balancing capacity bids are co-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 EB Regulation 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 maximisation of economic surplus. 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 economic surplus is the same, but the distribution is different: there is seller surplus for marginal pricing; for pay-as-bid pricing, this would also be part of buyer surplus. Also, with pay-as-bid pricing, all economic surplus gains are attributed to TSOs (as buyer surplus), whereas marginal pricing allows the seller to also profit from the value of CZC.

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

Figure 10 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 case the local TSO demand of balancing capacity per bidding zone exceeds the available amount of local submitted balancing capacity bids in the bidding zone, the market value of CZC for the exchange of balancing capacity or sharing of reserves is calculated for the unsatisfied bids based on the local balancing capacity bid price cap.

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.

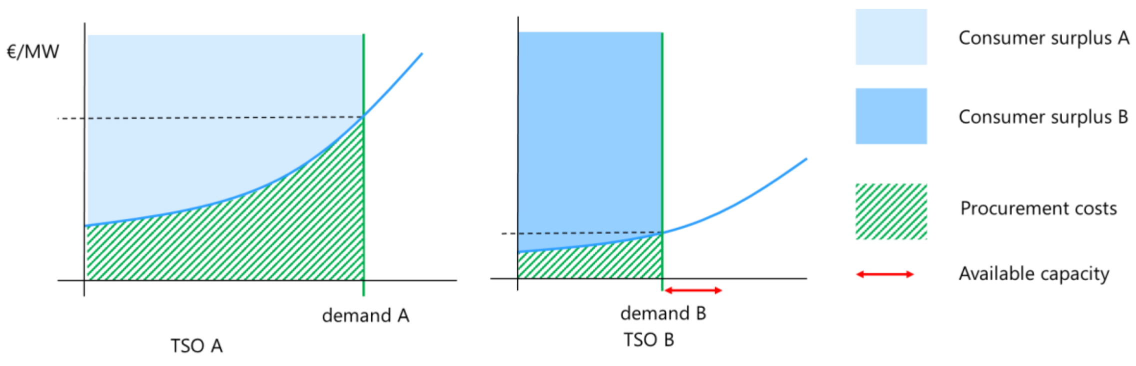


FIGURE 10: ECONOMIC SURPLUS IN ISOLATED MARKETS WITH PAY-AS-BID PRICING

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 11** 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 11** the difference in economic surplus 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.

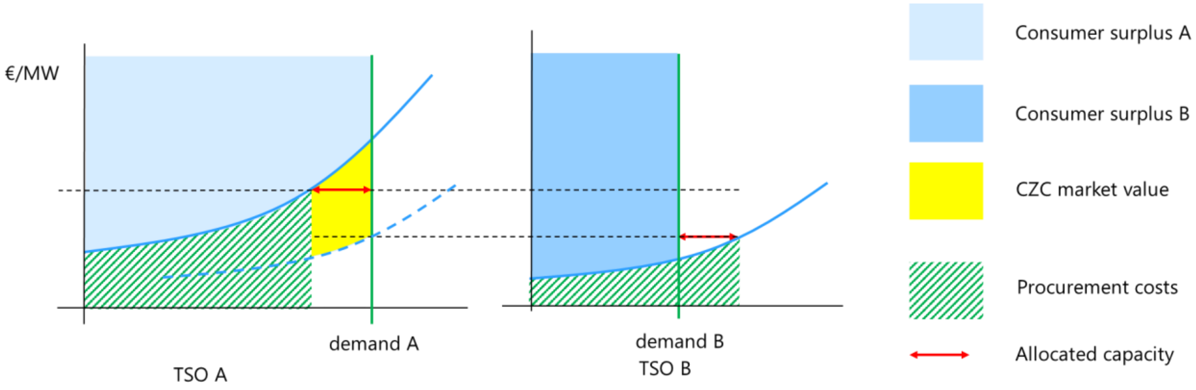
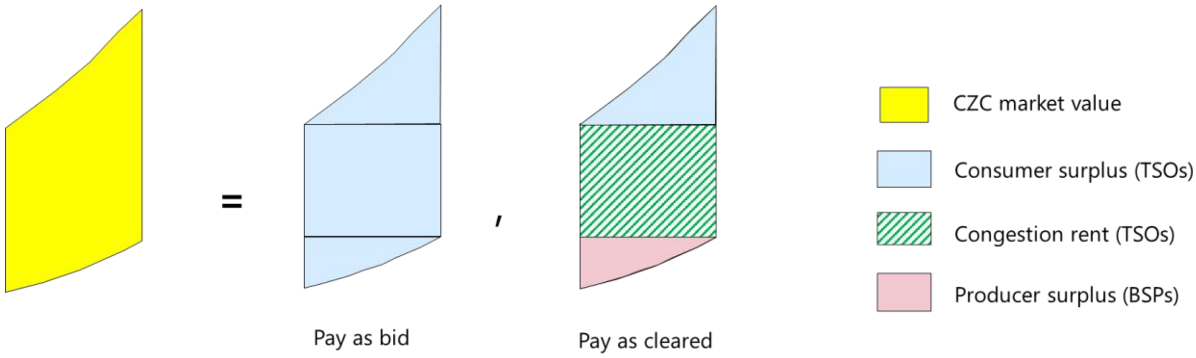


FIGURE 11: ECONOMIC SURPLUS IN COUPLED BALANCING MARKETS WITH PAY-AS-BID PRICING

4.2.4 The difference in the distribution of economic 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 summarised in **Figure 12** below.

FIGURE 12: DIFFERENCE IN THE DISTRIBUTION OF ECONOMIC 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 the 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 has 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 economic surplus optimisation 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 organised as a monotonously increasing "merit order list".

Non-convexities include start-up and shut-down costs along with minimum output requirements (which state that if a plant is running, it must produce at least a certain amount). Due to this combinatorial problem, there does not exist a "market-clearing price" in spinning reserve markets that clear 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 economic surplus integer programming. The efficiency of the allocation would 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 economic surplus optimisation. 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 from participating in the market, which will reduce the liquidity.

4.3 Value of Single Intraday Coupling

As mentioned above, Article 39(2) of the EB Regulation 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, concerning co-optimisation (see **Section 5**), the incorporation of the intraday market would introduce the necessity to forecast the respective bids, whereas the focus on the day-ahead energy market and the balancing capacity market allows for calculating the optimal allocation of CZC based on actual bids only. Using forecasting methods for bids introduces additional uncertainty to the co-optimisation. As the effects cannot be anticipated by market participants, reducing the overall transparency of the method.

Besides, it may be assumed that day-ahead schedules and 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 into co-optimisation 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. Article 39(3) of the EB Regulation demands that the actual market value of CZC for balancing capacity is calculated. This is again taken into account in co-optimisation by using only actual bids. In order to derive the contribution of the exchange of balancing energy to the market value, the energy bids would need to be forecast which introduces uncertainty. Hence, balancing energy is not taken into account for co-optimisation.

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 Co-optimisation

5.1 Criteria for a functional co-optimisation process

Subject to the requirements set by the EB Regulation, different options for the co-optimisation process have been evaluated and based on specified criteria and requirements. The **table** below presents the evaluation criteria chosen for the co-optimisation process. The proposed co-optimisation process is described in paragraph 5.2.

Criterion	Requirement
TSO's ability to develop and specify the allocation method and the procurement of balancing capacity	TSOs are able to request changes to the allocation method and make their own decisions on the procurement for balancing capacity, (e.g. related to ownership of the platform, control on change requests, IPR on the algorithm, in-house knowledge of the solution).
Technical feasibility	An operational method should be known/available/demonstrated for calculating the results for an optimal allocation of CZC between two different markets.
The efficiency of the allocation	The allocation overall coupled energy and balancing capacity markets should provide a maximum economic surplus.
Impact on TSO business processes	Required changes to the TSO business process should be minimal
Impact on NEMOs business processes	Required changes to the NEMO business processes should be avoided and otherwise only be minimal.
TSOs' operational independence from third parties	TSOs can independently operate the capacity procurement optimisation function.
Impact on the overall processing time	The total processing time from bidding gate closure to the publication of the results should be within the current time window available for the SDAC and respecting the current timings of all other processes.
Governance	The impact on the existing contractual framework between TSOs and NEMOs should be avoided and otherwise only be minimal.
Impacts on EUPHEMIA	Changes required on EUPHEMIA and NEMOs' trading systems should be avoided and otherwise only be minimal.

TABLE: EVALUATION CRITERIA FOR THE CO-OPTIMISATION PROCESS

5.2 Process overview

Based on the evaluated criteria of paragraph 5.1, TSOs have developed three processes for the co-optimisation methodology consisting of 5 fundamental process steps, which are schematically depicted in **Figure 13** to **Figure 15** . The distinction of the three processes is subject to the level of linking between balancing capacity and day-ahead market bids. Different degrees to enable linkage of the bids are shown below:

I. No linking

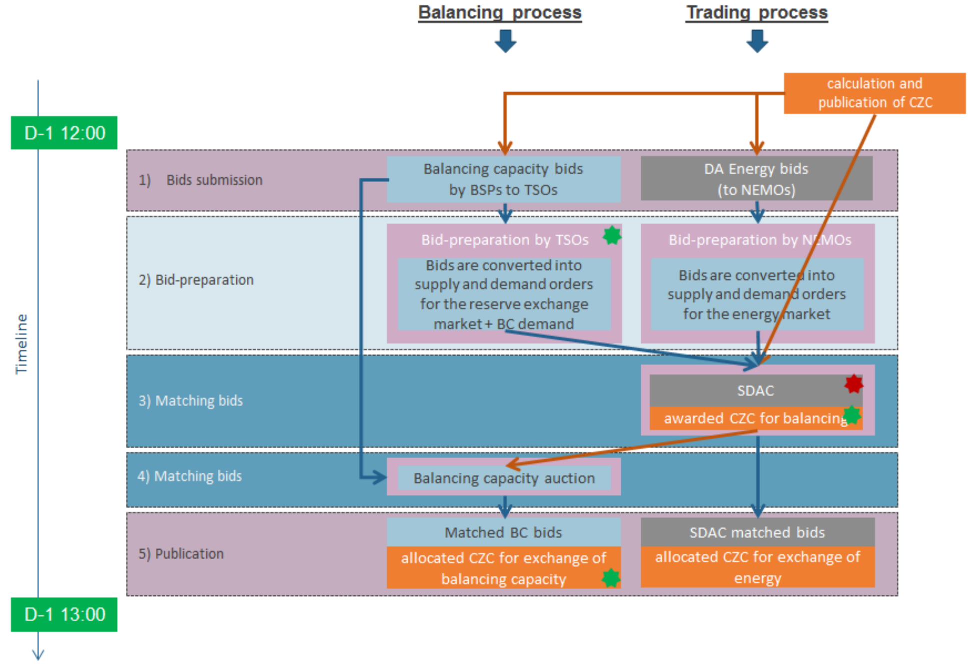


FIGURE 13: CO-OPTIMISATION PROCESS (NOT ENABLING LINKING OF THE BIDS)

II. Partially linking

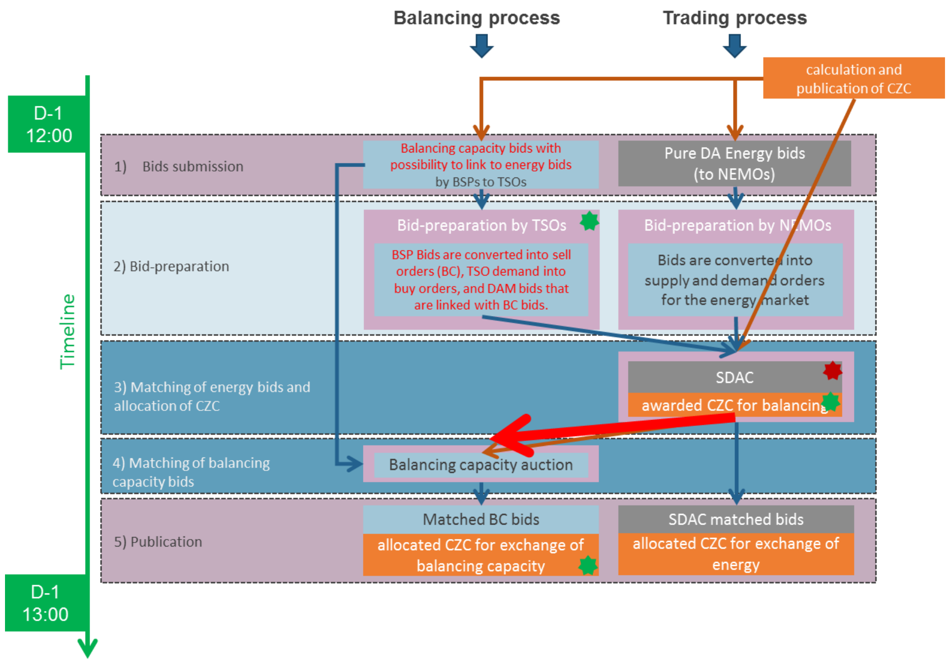


FIGURE 14: CO-OPTIMISATION PROCESS (PARTIALLY ENABLED THE C LINKING OF THE BIDS)

III. Fully linking

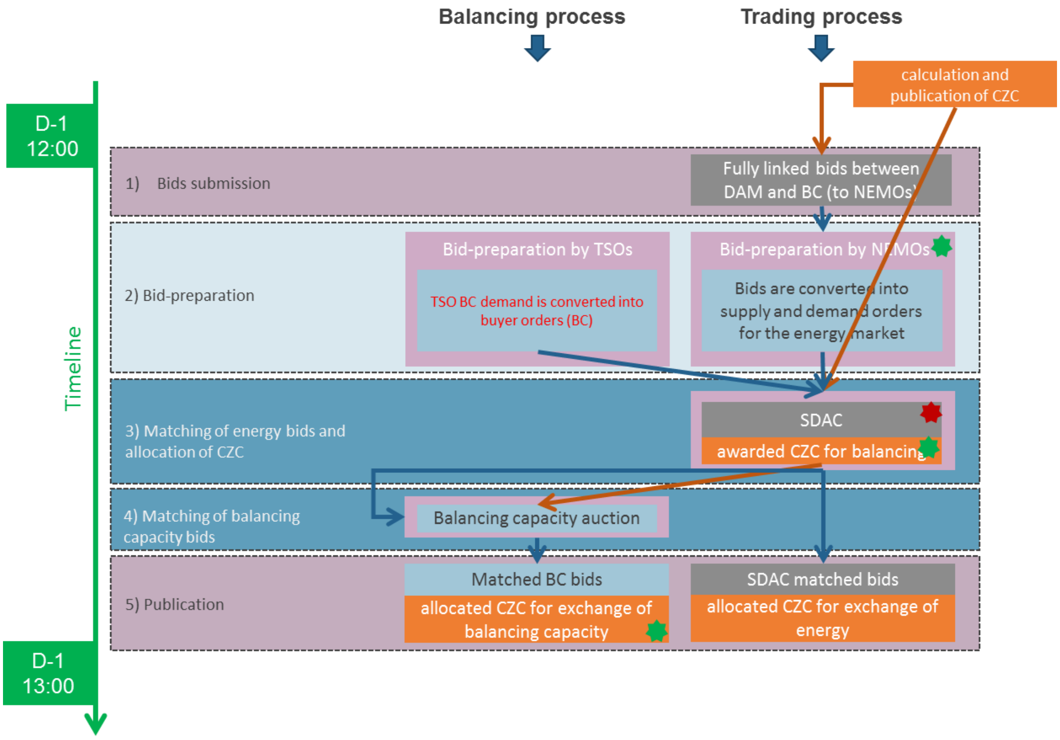


FIGURE 15: CO-OPTIMISATION PROCESS (FULLY ENABLED THE USE OF THE LINKING OF THE BIDS)

Before the first step of the co-optimisation process, CZC available for the day-ahead market timeframe is calculated and published for market participants to prepare their bidding strategies for the SDAC, and for the cross-zonal market for balancing capacity based on a TSO-TSO model.

5.2.1 Step 1: Bid submission

With the same Gate Closure Time as the Single Day-Ahead Coupling (SDAC):

- Respective market parties submit the upward and/or downward balancing capacity bids, either to the connecting TSOs when linking is not allowed or only partially allowed, or to the NEMOs when fully linked bids are allowed;
- Market parties submit DAM bids to the NEMOs.

5.2.2 Step 2:Bid preparation

The bid preparation is also known as pre-coupling. During this process at SDAC, NEMOs transform the bids received from market parties into supply and demand order books. For the balancing capacity market, it means, that the respective market operator(s) of the balancing capacity cooperation (BCC) convert the balancing capacity bids into seller order books and that TSOs convert balancing capacity demand into buyer order books. Consequently, the orders of the balancing capacity market are made compatible with the SDAC optimisation function. Besides, if partial or full linking of bids is allowed, information about which bids are linked is added to the individual bids.

The results of the bid preparation step are so-called balancing capacity import/export curves 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 co-optimisation. Note, that the linear curves shown in **Figure 16** represent approximations used for illustration and that the curves in the final process may deviate (see also Sections 4.1 and 4.2).

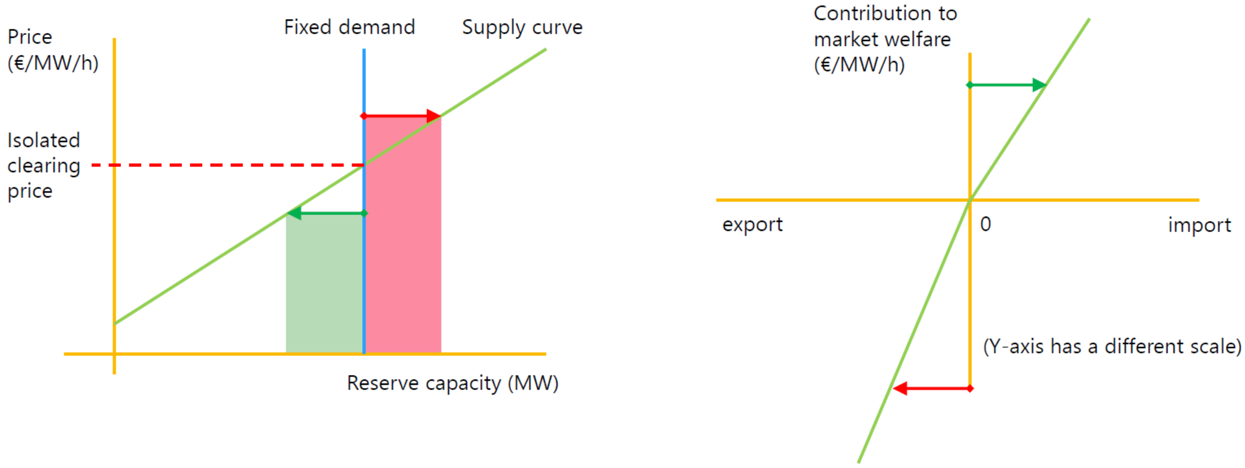


FIGURE 16: TRANSLATION OF BALANCING CAPACITY BIDS FOR THE CZCA

5.2.3 Step 3: Determination of allocation of CZC and clearing the Single Day-Ahead Market

In this step, the SDAC is performed, and at the same time, the CZC is allocated between the day-ahead market and the balancing capacity market. The input data of the SDAC are:

a. network capacities and constraints;

b. the balancing capacity bids and offers (if allowed including information about links to DAM bids and offers);

c. potential sharing of reserves volumes per product;

d. additional constraints and limitations related to the procurement of balancing capacity;

e. the trading bids and offers (when full linking of bids is allowed including information about links to balancing capacity bids and offers);

The MCO processes all input data to perform SDAC and allocate CZC between day-ahead and balancing capacity markets, to maximise the total economic surplus of both markets. Accordingly. the output data of the SDAC are:

a. clearing prices of the day-ahead market;

b. matched trades;

c. scheduled exchanges:

d. the net position of bidding areas;

e. allocated volumes of CZC for the exchange of balancing capacity per bidding zone border;

f. allocated volumes for sharing of reserves per bidding zone border

g. bids of the DAM are matched, prices are determined, and the result becomes firm.

5.2.4 Step 4: Clearing the balancing capacity market

Allocated CZC for the balancing capacity cooperation is used by the TSOs to clear the balancing capacity market (i.e., matching upward and/or downward balancing capacity bids with the balancing capacity demand and maximise the economic surplus overall matched balancing capacity bids).

This step is performed by the capacity procurement optimisation function pursuant to Article 33(3) of the EB Regulation. The output data of the balancing capacity market are:

a. clearing prices of balancing capacity market;
b. settled balancing capacity bids
c. matched balancing capacity demand
d. sharing of reserves volumes
e. the firmness of allocated volumes of CZC for the exchange of balancing capacity per bidding zone border
f. the firmness of allocated volumes for sharing of reserves per bidding zone border

5.2.5 Step 5: Publication

Finally, the market outcome for energy trading is published (matched bids and prices). And TSOs publish the market outcome of BC (matched bids and prices if applicable).

5.3 Mathematical description

The co-optimisation function maximises the total economic surplus of the energy market and the balancing capacity market.

Regarding the energy market it contains:

- producer surplus (supply bids);
- consumer surplus (demand bids); 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 optimisation function for trading is already developed and implemented in the SDAC, only the optimisation function for the exchange of balancing capacity or sharing of reserves is further elaborated. The co-optimisation function for the exchange of balancing capacity or sharing of reserves is based on the actual market value of CZC for each bidding zone which can be derived directly from bids in the bidding zones.

The conceptual description is:

- balancing capacity auction (per TSO, per bidding zone)
- objective: maximise economic surplus overall matched balancing capacity supply orders
  - $max \sum_{all\ matched\ supply\ orders} -\{supply\ order\ volume * supply\ order\ price\}$
- Inputs:
  - Balancing capacity demand

- Balancing capacity offers
- Allocated CZC to the balancing capacity market (or equivalently: net position in the balancing capacity exchange market)

- Outputs:
  - Matched balancing capacity orders and clearing prices
- Constraints:
  - The matched volume of balancing capacity offers must equal balancing capacity demand plus the sum of allocated CZC to the balancing capacity market.

5.4 Communication on allocated CZC

The information on the values of allocated CZC in [MW] per border, per product, per direction and per TSO are sent 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 co-optimisation allocation, including step 3 and step 4 is depicted in the figure below.

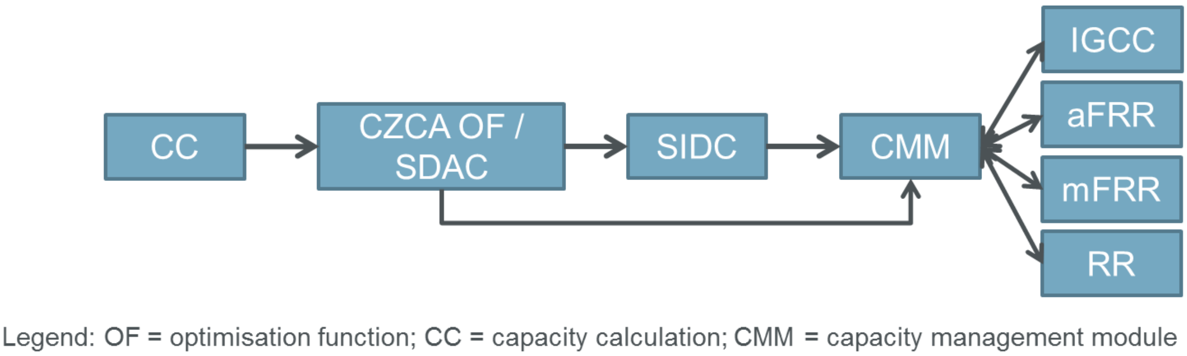


FIGURE 17: SCHEMATIC REPRESENTATION OF THE CAPACITY CALCULATION (USING THE CO-OPTIMISATION PROCESS)

The communication paths of the volume of CZC available for the market processes are as follows. The SDAC, including the CZC allocation optimisation function, determines the amount of CZC available for balancing capacity and remaining available CZC is communicated with the SIDC. Furthermore, the allocated CZC is communicated with the capacity management module supporting the balancing energy platforms.

5.5 Implementation Impact Assessment

Implementing a methodology for a co-optimised allocation process of cross-zonal capacity implies a notable (r)evolution of the SDAC process and more precisely of its algorithm. Therefore, based on the feedbacks of NEMOs and stakeholders received from the two dedicated stakeholder workshops and the public consultation, all TSOs propose in Article 13, to sequence the implementation of the methodology in two phases:

(i) By one year after the approval by NRAs of the CO CZCA methodology, all TSOs shall submit an implementation impact assessment ;

(ii) By two years after the approval by NRAs of the CO CZCA methodology, all TSOs shall send the common set of requirements of the algorithm (for co-optimisation) to the nominated electricity market operators and ACER.

The implementation impact assessment intends to address the criteria mentioned in Article 13 of the proposed methodology. Certain criteria have to be addressed apart from the proposal and the common requirements such as the technical feasibility and the governance issues. Moreover, certain choices of design (e.g. linking of bids) may have an important impact on the algorithm requirements and therefore, on the evolution of the SDAC process. TSOs consider that it is important to first assess the implementation impacts by one year after the approval of the methodology by NRAs to draft a sensible and adequate set of common algorithm requirements by two years after the approval of the methodology by NRAs.

All TSOs will perform the implementation impact assessment in coordination with NEMOs and ACER. It should be made transparent and after the approval could be published on the ENTSO-E website.

5.6 Sharing of congestion income of cross-zonal capacity

The rules propose to be applied for the sharing of congestion income are equal to the ones developed for the balancing energy market and based on the all-TSO proposal for a Congestion Income Distribution (CID) methodology in accordance with Article 73 of the Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a Guideline on Capacity Allocation and Congestion Management.

For each balancing capacity border on where 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 of the 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.

CZCA for the exchange of balancing capacity or sharing of reserves can lead to less CZC for the DAM. If long term transmission right (LTTR) are sold, and the resulting CZC may be lower than the transmission right volume due to allocation to balancing. Cases, where the remuneration of LTTRs exceeds the congestion income pursuant to Article 73 of the CACM Regulation, shall be dealt with through the methodology laid down in Article 61 of the FCA Regulation.

Compensation for LTTR losses applies if TSOs do not have enough DA congestion income due to either flow-based or technical profiles. Both – flow-based and technical profiles – are optimization methodologies that optimise economic surplus over several BZBs. The same applies for co-optimization, and it will be running within the day ahead capacity calculation methodology and will be a part of it.

In case the energy day-ahead market congestion income assigned to a BZB is insufficient to compensate the LTTRs on that BZB for the exchange of balancing capacity or sharing of reserves is allocated on that BZB, the entire deficit shall be compensated, according to the methodology developed according to Article 61 of the FCA Regulation.

In any case, the maximum compensation shall be allocated CZC for the exchange of balancing capacity or sharing of reserves times the day-ahead price difference on the relevant BZB. The resulting congestion income generated on that BZB calculated, according to the description above, is reduced by the compensation.

5.7 Firmness regime for the allocation of cross-zonal capacity

Allocated CZC for the exchange of balancing capacity or sharing of reserves after the co-optimisation process is firm after the selection of upward balancing capacity bids or downward balancing capacity bids by the capacity procurement optimisation function pursuant to Article 33(3) of the EB Regulation.

According to Article 38(9) of the EB Regulation, 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 with shorter activation times or for operating the imbalance netting process.

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.

5.8 Implementation timeline

By the 18th of December 2019, all TSOs shall submit a proposal for a methodology for a co-optimised allocation process of cross-zonal capacity. After the submission to ACER, three major steps remain (i) first approval by ACER, (ii) the implementation of the co-optimisation in the SDAC algorithm and (ii) finally if applicable, application of the methodology by balancing capacity cooperation, on a voluntary basis.

In other words, the approval by ACER is the building permits, the implementation is the construction of the house, and the application is the move into the house.

Implementing a methodology for a co-optimised allocation process of cross-zonal capacity implies a notable (r)evolution of the SDAC process and more precisely of its algorithm. Therefore, based on the feedback of NEMOs and stakeholders feedbacks, all TSOs propose in Article 13, an implementation in two phases:

(i) By one year after the approval by NRAs of the CO CZCA methodology, all TSOs shall submit an implementation impact assessment. The implementation impact assessment should be made transparent and after the approval shall be published on the ENTSO-E website. The implementation impact assessment process shall include:

a. Governance of the CZC allocation optimisation function;
b. Technical feasibility of the implementation of the CZCA optimisation function;
c. Flow-based compatibility;
d. Compatibility with the Methodology for the price coupling algorithm and the continuous trading matching algorithm
e. Impact analysis on the operational security of the interconnected transmission system;
f. Level of linkage between standard balancing capacity bids in time and between products and between standard balancing capacity bids and day-ahead market bids;
g. The reasoning for the two-steps approach; and
h. Costs estimation, categorisation and sharing.

(ii) By one year after positive outcome of the impact assessment and its subsequent publication of , all TSOs shall send the common set of requirements of the algorithm for co-optimisation pursuant to Article 58(3) of EB Regulation to ACER and all nominated electricity market operators designated in accordance with Article 4(1) of the CACM Regulation. All TSOs shall publish on the ENTSO-E website the common set of requirements of the algorithm for co-optimisation.

As the implementation feasibility is highly dependent on choices made (level of linking, etc.), the implementation impact assessment supports the definition of the adequate common set of requirements of the algorithm for co-optimisation submitted afterwards.

It is estimated that 24 months (see **Figure 18**) would be required to properly cover all the listed items (a to h) and properly address the co-optimisation algorithm requirements. To properly tackle sensitive issues like feasibility (b), compatibility (d), level of linkage (f) and to adequately address the level of linkage (f) will be key for the implementation of co-optimisation. Considering the all-stakeholders feedback who have unanimously requested to implement linkage of bids. This would encompass a detail evaluation of the current features and programmed developments (i.e. integrating 4MMC and MRC regions, extending the flow-based application to CORE and Nordic Regions, ensuring the support of 15/30 mins MTU in the algorithm) and see the impact with the ones proposed by this methodology.

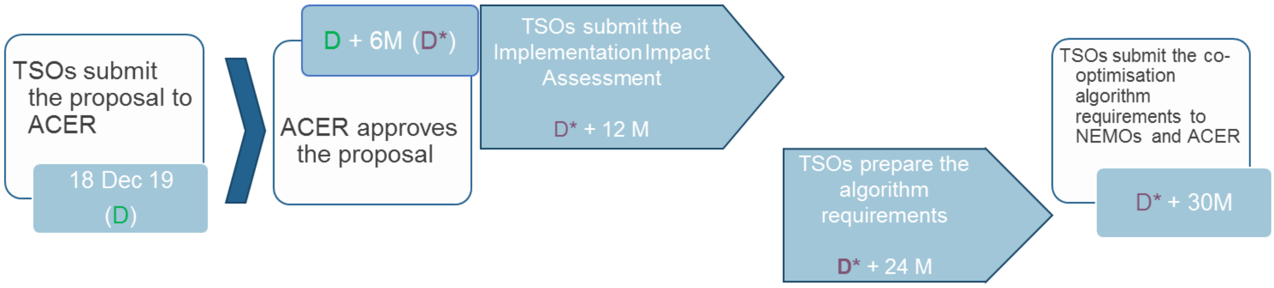


FIGURE 18: MAIN MILESTONES AFTER THE SUBMISSION OF THE CO CZCA METHODOLOGY

6 Stakeholder involvement

Fulfilling public consultation EB Regulation requirements, this proposal was subject between 15 May to 31 July to consultation[1] in accordance with Article 10(3) of the EB Regulation. More importantly, this proposal gathered the input from 18 stakeholders and market participants within this period on this important feature for the future European balancing capacity market.

Besides, ENTSO-E has held two workshops within 2019 with stakeholders. The first one on 4 February 2019 (Link) and the second one on 6 June (Link). In both workshops, the content of this methodology was presented.

It is worth mentioning that the corresponding Workshops for the proposal for a methodology for market-based allocation process of cross-zonal capacity for the exchange of balancing capacity or sharing of reserves pursuant Article 41 of the EB Regulation and the proposal for a methodology for the allocation of CZC based on an economic efficiency analysis pursuant Article 42 of the EB Regulation have been organised by current existing CCRs as defined in ACER decision No 06/2016.

[1] Please check: https://consultations.entsoe.eu/markets/ebgl-art40-co_czca/