ELECTRICITY BALANCING IN EUROPE

NOVEMBER 2018

EUROPEAN ELECTRICITY BALANCING GUIDELINE

AN OVERVIEW OF THE EUROPEAN BALANCING MARKET AND ELECTRICITY BALANCING GUIDELINE

European Network of
Transmission System Operators
for Electricity

entsoe

ENTSO-E:
THE EUROPEAN NETWORK OF TRANSMISSION SYSTEM OPERATORS FOR ELECTRICITY, REPRESENTS 43 ELECTRICITY TRANSMISSION SYSTEM OPERATORS (TSOs) FROM 36 COUNTRIES ACROSS EUROPE.

CONTENTS

1 INTRODUCTION

The European power system is transforming rapidly to integrate more renewables, develop flexibility and enable consumers to play a more central role. For electricity markets, this transition means that trading needs to move closer to real time, i.e. closer to delivery while respecting system security. National and regional markets are becoming increasingly integrated towards a common European market. New players such as aggregators, storage and demand response operators are entering the market. As the underlying system is changing and integration advances, the efficient balancing of the power system also needs to be developed to enable the clean energy transition for all Europeans. Efficient balancing markets shall ensure security of supply at the lowest cost and can deliver environmental benefits by reducing the need for back-up generation.

The Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing (EBGL) lays down detailed rules for the integration of balancing energy markets in Europe, with the objectives of fostering effective competition, non-discrimination, transparency and integration in electricity balancing markets, and by doing so, enhancing the efficiency of the European balancing system as well as security of supply.

This document provides an overview of the European balancing energy market target model and explains the main concepts and processes related to balancing energy markets and European platforms for the exchange of balancing energy products. In particular, it focuses on the interaction between the different balancing processes and briefly describes the legal framework of the European balancing energy target model. This is a simplified overview, which does not cover all the aspects and differences of the described processes and platforms.

The target group of this overview is wide: from TSOs to the general public. It should be understandable to readers with a basic knowledge of electricity markets.

2 GENERAL FUNCTIONING OF BALANCING MARKETS

Balancing means all actions and processes through which transmission system operators (TSOs) continuously ensure the maintenance of system frequency within a predefined stability range, as well as compliance with the amount of reserves needed with respect to the required quality. The balancing process consists of three main steps: 1) TSOs dimension their need for balancing reserves, 2) TSOs procure the required balancing capacity and 3) TSOs procure balancing energy.

This paper, as does the EBGL, focuses on balancing energy markets. Balancing energy markets represent the entirety of the institutional, commercial and operational arrangements that enable a market-based balancing of the system. Well-functioning day ahead and intraday markets act as a foundation for the balancing market, in which the **TSO's role** is to ensure that considering the other markets' results, demand and supply remain balanced by operating the system close to real time (Figure 1).

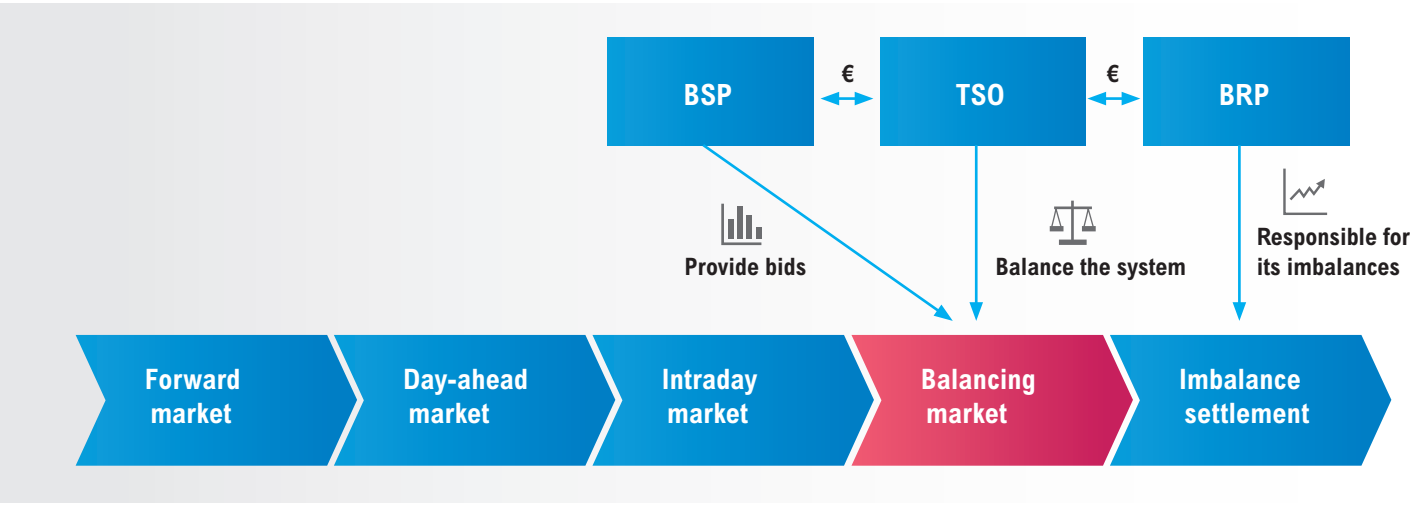

Figure 1. Balancing market sequence in electricity markets and its participants

Balancing service providers (BSPs) such as generators, demand response facilities and storage operators can offer balancing services (capacity and/or energy) to the TSOs, who in turn use these services to balance the system.

Balance responsible parties (BRPs) such as electricity producers, consumers and suppliers shall keep their individual position (sum of the energy volume physically injected or withdrawn from the system and their trades) in balance or help the system to be balanced, as they are financially responsible for the imbalances of their portfolios.

The EBGL requires the harmonisation of certain balancing market processes and rules, including the establishment of common principles for the activation and exchange of balancing energy. Based on these requirements, all TSOs jointly with relevant stakeholders will cooperate to develop sets of rules and methodologies and to establish the balancing pan-European platforms, described in the following chapters.

3 BALANCING PROCESSES

European TSOs use different processes and products to balance the system and restore the frequency, based on historic developments and different balancing philosophies. Balancing energy in Europe is organised in up to five steps (Figure 2):

- Frequency containment reserve **(FCR)**
- Imbalance netting **(IN)**
- Frequency restoration reserves with automatic activation **(aFRR)**
- Frequency restoration reserves with manual activation **(mFRR)**
- Replacement reserves **(RR)**

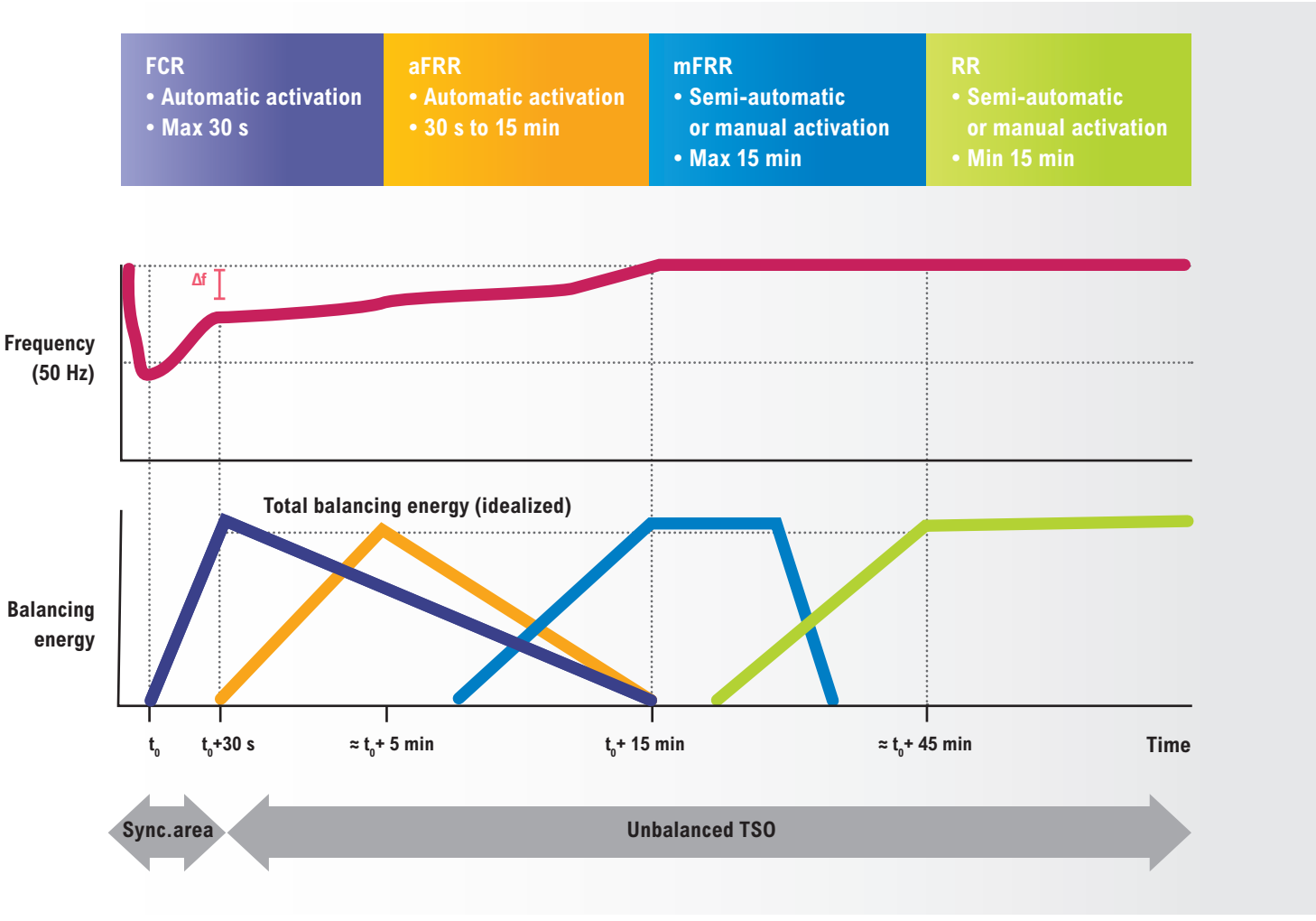

Figure 2. Balancing market processes for frequency restoration

The explanation and purpose of named processes are given in the table below.

RESERVE POWER TYPE	DEFINITION	PURPOSE[1]
FCR	The active power reserves available to contain system frequency after the occurrence of an imbalance.	The frequency containment process stabilises the frequency after the disturbance at a steady-state value within the permissible maximum steady-state frequency deviation by a joint action of FCR within the whole synchronous area.
FRR (aFRR and mFRR)	The active power reserves available to restore system frequency to the set point value frequency and, for a synchronous area consisting of more than one load-frequency control area (LFC area), to restore power balance to the scheduled value.	The frequency restoration process controls the frequency towards its set point value by activation of FRR, and replaces the activated FCR. The frequency restoration process is triggered by the disturbed LFC area.
RR	The active power reserves available to restore or support the required level of FRR to be prepared for possible additional system imbalances, including generation reserves.	The reserve replacement process replaces the activated FRR and/or complements the FRR activation by activation of RR. The replacement reserve process is activated in the disturbed LFC area.
IN	A process agreed between TSOs that enables the avoidance of the simultaneous activation of aFRR in opposite directions, taking into account the respective frequency restoration control errors as well as the activated aFRR and correcting the input of the involved frequency restoration processes accordingly.	The imbalance netting process is designed to reduce the amount of simultaneous and counteracting aFRR activation of different participating and adjacent LFC areas via imbalance netting power exchange.

Table 1. Definition and purpose of balancing processes

The common European platforms for the IN process, the exchange of balancing energy from aFRR, the exchange of balancing energy from mFRR and the exchange of balancing energy from RR are being developed to harmonise such processes across Europe (see Chapter 6). The IN process, being a TSO-TSO activity, will not be discussed in detail in this paper; the following general process descriptions do not apply to the imbalance netting process.

1 Supporting Document for the Network Code on Load-Frequency Control and Reserves (https://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Annexes/ENTSO-E%E2%80%99s%20supporting%20document%20to%20the%20submitted%20Network%20Code%20on%20Load-Frequency%20Control%20and%20Reserves.pdf) Supporting Document for the Network Code on Load-Frequency Control and Reserves

4 THE DIFFERENT STEPS OF THE BALANCING PROCESS

All balancing processes follow similar functioning principles, as represented in Figure 3. BSPs can send to their connecting TSOs the balancing energy standard or specific product bids or update the balancing energy price of their bids until the balancing energy gate closure time (1), TSOs forward them to the relevant balancing energy exchange platform until the TSO energy bid submission gate closure time for the balancing energy product bids (2), together with the available cross-zonal capacities (CZC) and relevant network constraints (3) and TSO balancing energy demands (4). The activation optimisation function (AOF) (5) generates or accepts as input data the common merit order lists (CMOLs) and calculates and provides as output data (6) – the selected bids to be activated, the netted demands, cross-border exchange (if any) and used cross-zonal capacities (8) – based on which TSOs request their BSPs to activate balancing energy bids according to the algorithm outcomes. Some bids might appear unavailable, due to network constraints. The bids can be activated for balancing purposes and system constraints purposes. The information from the platform regarding the commercial flows between LFC areas or bidding zones and settlement between TSOs is also provided for the transparency and settlement purposes respectively.

An example of the balancing process for the exchange of balancing energy from frequency restoration reserves with manual activation is given in Figure 3; for different products the illustrated process might slightly differ due to product specificities and timing. In the following, these steps are elaborated in more detail.

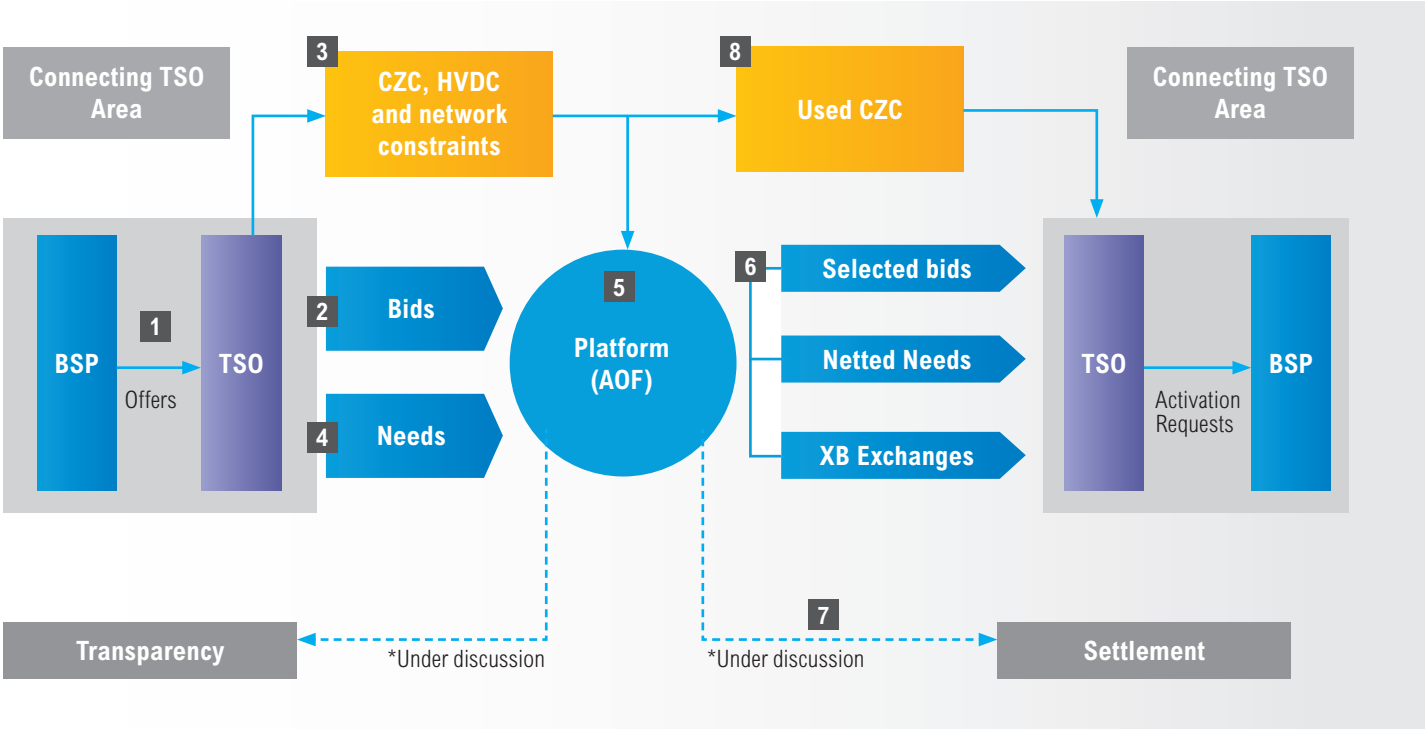

Figure 3. General process of balancing process (applied to mFRR)

4.1 PRODUCTS

In order to facilitate the exchange of balancing energy across borders, the EBGL requires the definition of a set of standard products for RR, aFRR and mFRR (for direct and scheduled activation) to be exchanged using pan-European platforms. TSOs may request their respective NRA to approve the usage of specific products to fulfil their dimensioning requirements. Balancing energy bids from specific products and bids from the integrated scheduling process from TSOs applying a central dispatch system can be converted into balancing energy bids from standard products according to certain rules, therefore further in the text the term standard product will also be used for balancing energy bids from specific products converted into balancing energy bids from standard products.

The EBGL sets up certain requirements for the technical parameters of standard products (Figure 4). The list of standard products for balancing energy and balancing capacity may set out at least the following characteristics of a standard product bid: (1) preparation period, (2) ramping period, (3) full activation time, (4) minimum and maximum quantity, (5) minimum and maximum duration of delivery period, (6) deactivation period, validity period and the mode of activation.

The list of standard products shall set out at least the following variable characteristics of a standard product to be determined by the BSPs: the price of a bid, its divisibility, location and minimal duration between the end of one activation and the following one.

Due to differences in the existing balancing markets, TSOs foresee a progressive harmonisation, with only the essential concepts being harmonised before the launch of the pan-European platforms. More detailed information about standard products can be found in the implementation framework proposals for the aFRR[2] , mFRR[3] and RR platforms[4].

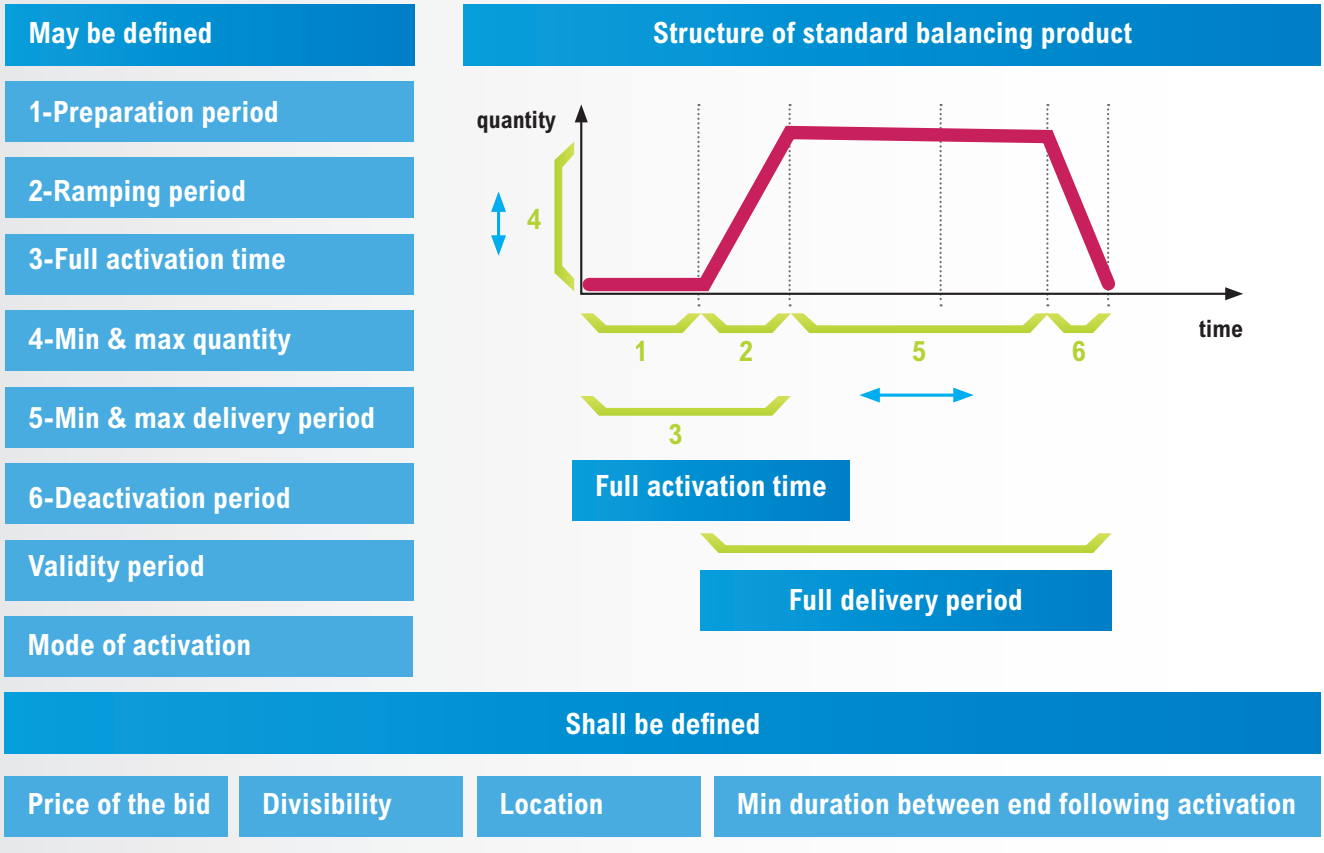

Figure 4. Characteristics of a standard product

2 https://consultations.entsoe.eu/markets/afrr_implementation_framework/supporting_documents/20180426_aFRRIF_Implementation_framework.pdf

3 https://consultations.entsoe.eu/markets/mfrr_implementation_framework/supporting_documents/mFRR%20Implementation%20Framework%20%20Proposal.pdf

4 https://docstore.entsoe.eu/Documents/Network%20codes%20documents/NC%20EB/180618_RR-Implementation-Framework_for-NRA-submission.pdf

4.2 GATE CLOSURE TIMES

The balancing energy gate closure time (BE GCT) is the point in time at which BSPs are no longer permitted to submit or update a balancing energy bid to their connecting TSO. The BE GCT for BSPs and the TSO GCTs shall be distinguished - first BSPs send and update their bids until BE GCT, after which all submitted bids should be firm, and subsequently TSOs forward the bids to the relevant platforms until a certain point in time - TSO energy bid submission GCT (TSO GCT). An individual BE GCT is defined for each balancing energy product. Figure 5 summarises the TSO proposals for BE GCTs and TSO GCTs, whilst taking into account the interactions with other balancing processes.

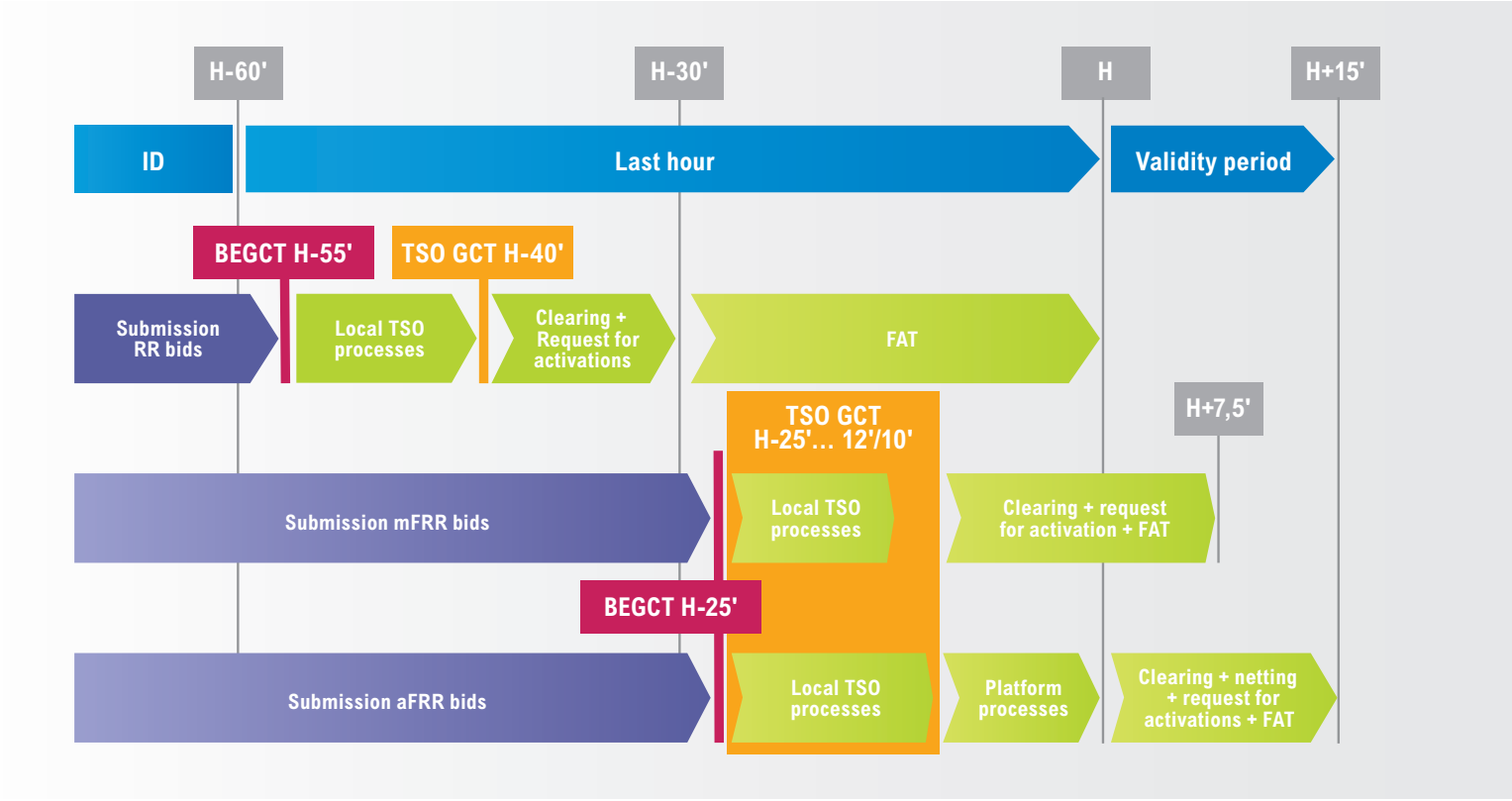

Figure 5. GCT for different products and stakeholders

** RR BE GCT will be H-55 minutes. For an interim period of no more than 12 months after the entry into operation of the RR-Platform, the RR BE GCT will be H-60 minutes*

4.3 BID AND DEMAND SUBMISSION, COMMON MERIT ORDER LIST CREATION

After bid submission to the platforms, the CMOLs consisting of balancing energy bids, are created. Separate lists for downward and upward activation are created. In parallel, TSOs submit their balancing energy demands for the relevant timeframes. As a result, the respective CMOLs are merged with the TSO balancing energy demands. The upward CMOL is merged with the TSOs' downward needs, and the downward CMOL with the TSOs' upward needs. An example of such an input is illustrated in Figure 6. The timing and complexity for different products (aFRR, mFRR, RR) differs; however, the general principles remain similar.

4.4 ACTIVATION OPTIMISATION FUNCTION

All European platforms will have an activation optimisation function (AOF), which aims to balance the system in an efficient way and minimise the exchange of balancing energy amount on borders between bidding zones or LFC areas. As input, the algorithm will receive BSP standard product bids (CMOLs), TSOs' individually determined balancing energy demands and technical limitations in the system (CZC or HVDC constraints). The AOF creates a cost curve consisting of the TSO balancing energy demands and the CMOLs of all bids. Based on this curve, as well as on all defined technical constraints, it provides the satisfied demands, the selected bids, the input data for the cross-border marginal prices and the cross-border exchanges (Figures 6 and 7).

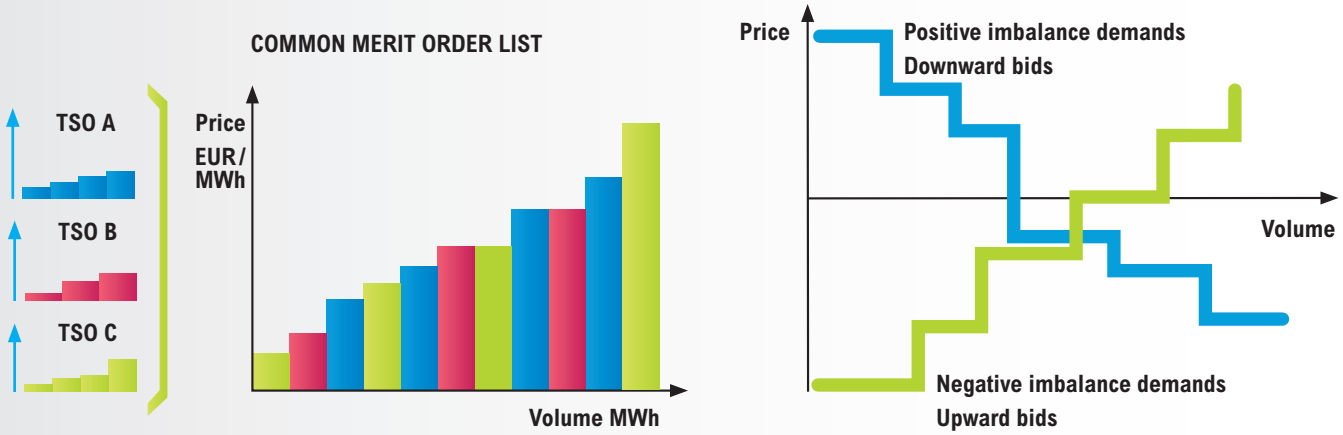

Figure 6. CMOL creation of balancing energy bids and merging with TSOs' balancing energy demands

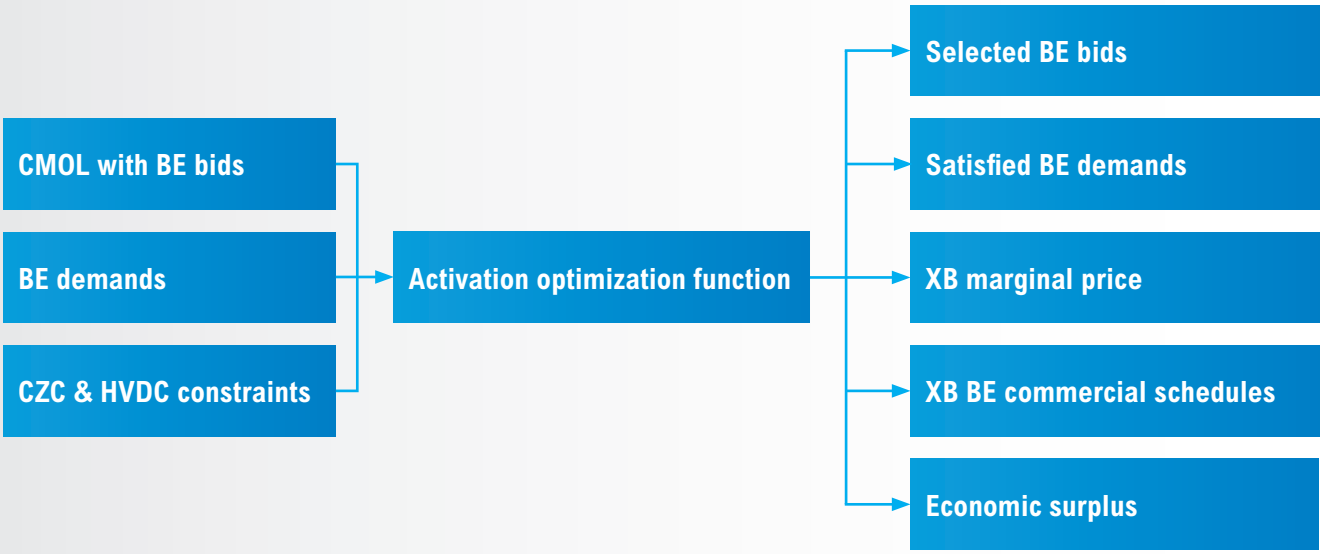

Figure 7. AOF general scheme demands

5 BALANCING ENERGY PRICING AND SETTLEMENT

The EBGL foresees that the settlement process shall be based on marginal pricing (pay-as-cleared). The marginal price represents the price of the last bid of a standard product, which has been activated to cover the energy demand within a specified area (Figure 8). The AOF will compute the balancing energy price per bidding zones and/or LFC areas. In the event there are no congestions between adjacent areas, the price will be the same in these areas, referred to as uncongested areas. In the event a congestion occurs, there will be a price split (same as in the day-ahead market coupling). In the event of evolving congestions over time, the uncongested areas can be different per products. The calculation of the marginal pricing will consider the differences between the different processes, therefore, for each balancing product the price will be calculated separately for each optimization cycle. Depending on the balancing process, the optimization cycle is expected to vary between seconds to 15 minutes (i.e. ISP).

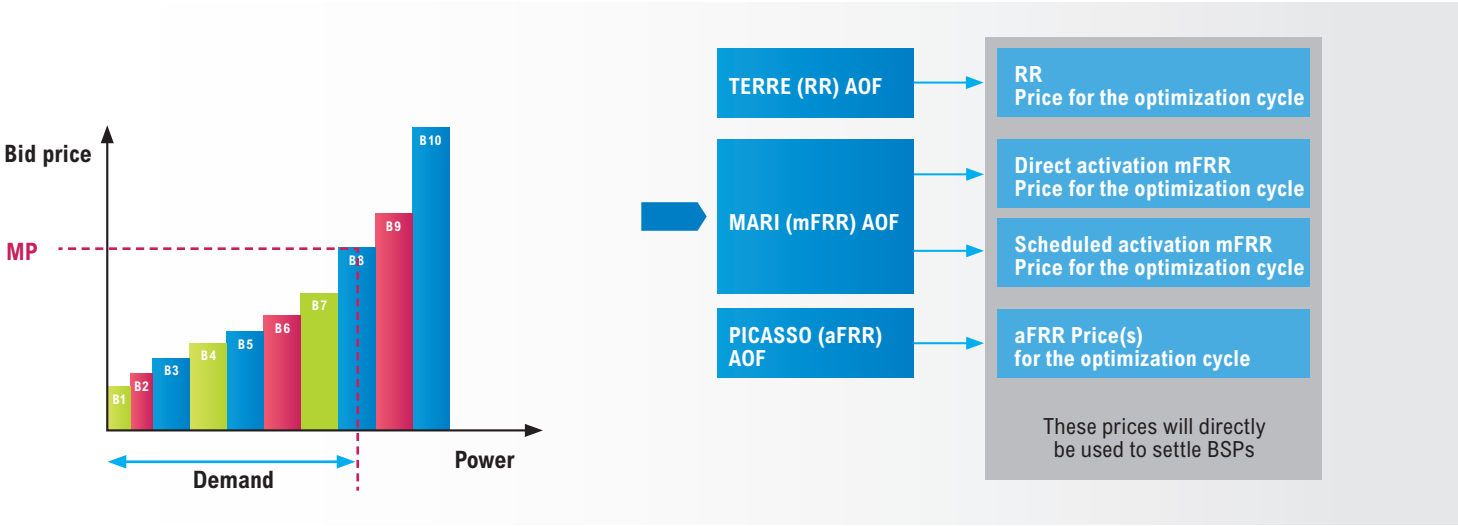

Figure 8. Marginal price forming and balancing energy pricing for different processes

Each connecting TSO settles with its BSPs according to the marginal price of the relevant product's market price (for aFRR, mFRR with direct and scheduled activation and RR). As a result of the European balancing processes, TSOs settle between each other according to their satisfied demands and selected balancing energy bids.

6 IMBALANCE SETTLEMENT

Imbalance settlement is a core element of the balancing markets. It is a financial settlement mechanism aimed at charging or paying BRPs for their imbalances for each imbalance settlement period (ISP). The general principles of settlement processes aim to:

- establish adequate economic signals which reflect the imbalance situation,
- ensure that imbalances are settled at a price that reflects the real time value of energy,
- provide incentives to BRPs to be in balance or help the system to restore its balance,
- facilitate the harmonisation of imbalance settlement mechanisms,
- avoid distorting incentives to BRPs, BSPs and TSOs,
- support competition among market participants, and
- provide incentives to BSPs to offer and deliver balancing services to the connecting TSO.
- TSOs shall not incur economic gains or losses with regard to the financial outcome of the settlements of:
- imbalance with BRPs,
- balancing energy with BSPs, and
- intended and unintended exchanges of energy with TSOs, due to balancing processes.

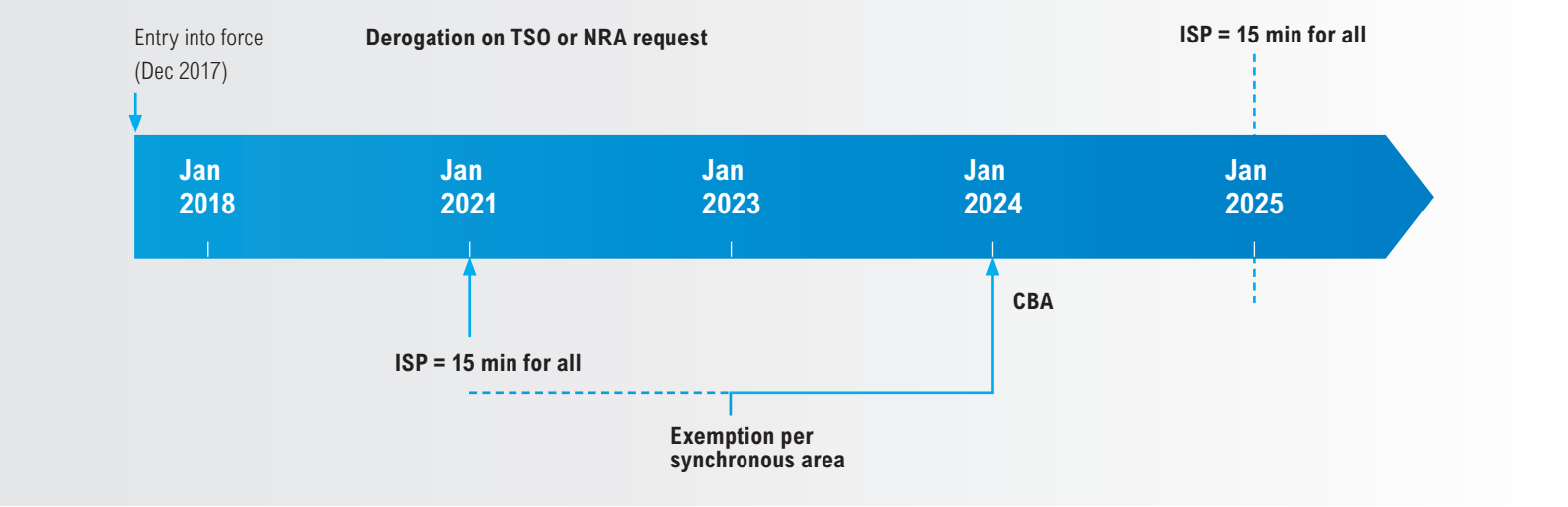

Figure 9. Timeline for 15 min ISP implementation

Imbalance pricing is done within a certain timeframe, the ISP. In the European Union, countries currently apply ISPs of 60, 30 and 15 minutes. The EBGL requires all TSOs to harmonise the ISP by 2021, or at the latest by 2025, to an ISP of 15 minutes (Figure 9).

Figure 10 represents the general cashflows that result from the balancing market processes according to the EBGL and illustrates the principle that TSOs shall incur no economic gains or losses as a result of energy settlements from balancing markets: BRPs are settled for their imbalances, BSPs are settled for balancing energy and for balancing capacity, and TSO-TSO settlement is foreseen for energy exchange with other TSOs as a result of the European balancing processes. Arrows denote the direction of payments; some settlements may involve bidirectional payments, hence the double arrow. References to relevant project/processes and chapters in EBGL have been added.

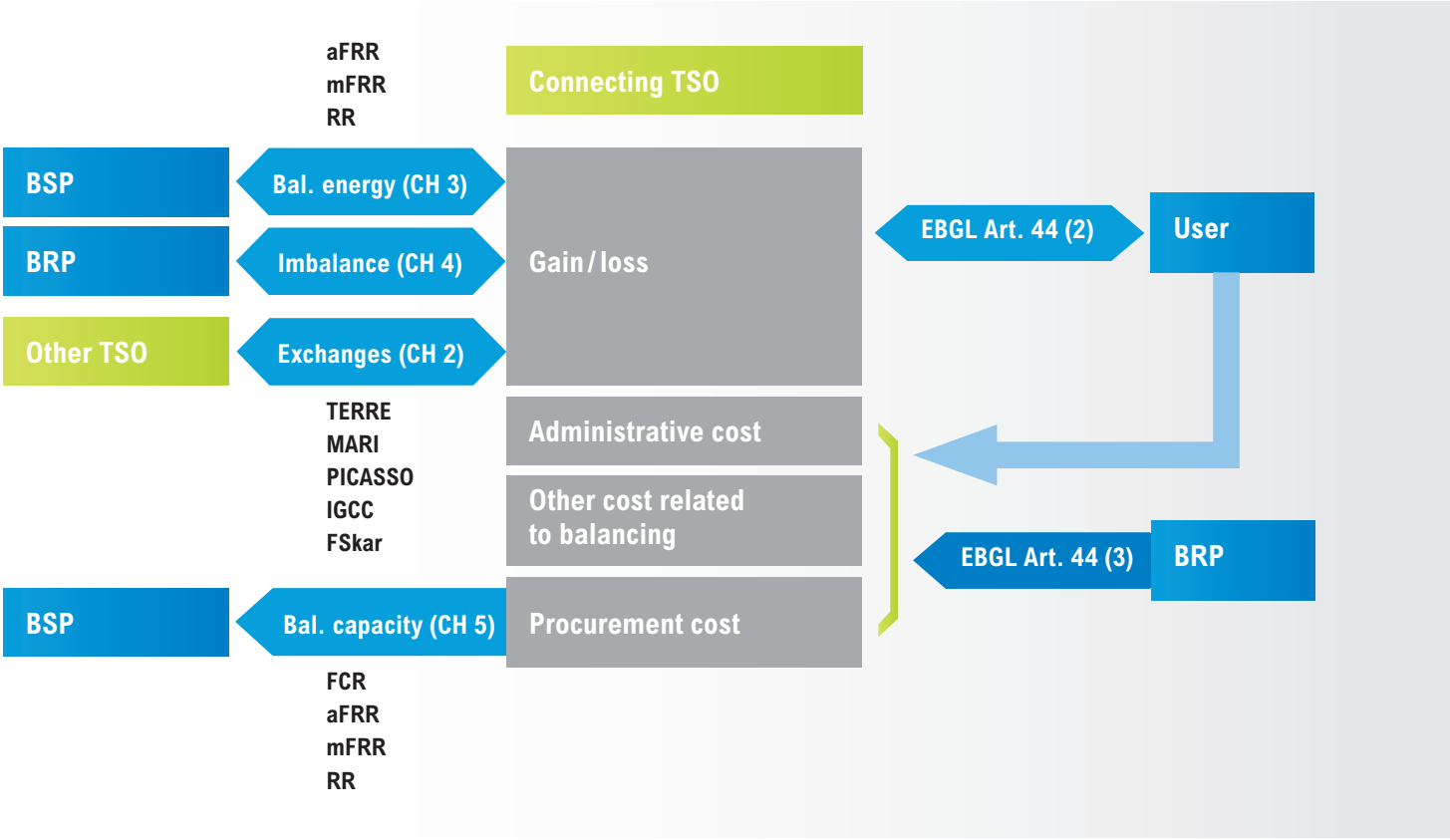

Figure 10. Cashflows in balancing market

The general principle of imbalance settlement is that all injections and all withdrawals should be covered by balancing responsibility and, depending on the imbalance situation, an imbalance cost is imposed per ISP on the BRPs that are not in energy balance over that ISP.

The imbalance settlement with BRPs will be based on a combination of marginal prices of different balancing markets (see Chapter 5). The EBGL requires the implementation of a single imbalance pricing as the preferable option. The application and justification of dual imbalance pricing by a TSO shall be approved by the relevant regulatory authority.

7 EUROPEAN PLATFORMS AND PROJECTS FOR THE EXCHANGE OF BALANCING ENERGY

The EBGL foresees the implementation of the common European platforms and thereby the harmonisation of the European balancing market processes. For each of the processes (IN, aFRR, mFRR and RR) the EBGL requires the development of a European platform. In order to achieve this goal, European TSOs have established the following implementation projects (Figure 11):

- International Grid Control Cooperation **(IGCC)** – for imbalance netting process;
- Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation **(PICASSO)** – for aFRR process;
- Manually Activated Reserves Initiative **(MARI)** – for mFRR process;
- Trans-European Restoration Reserves Exchange **(TERRE)** – for RR process.

Currently, the named platforms are being developed according to the EBGL required timeline. The aim is to find the most efficient solutions; therefore the optimal amount of platforms, the optimal amount of entities for the operation of the functions of the platforms and the cooperation between the platforms are regularly addressed.

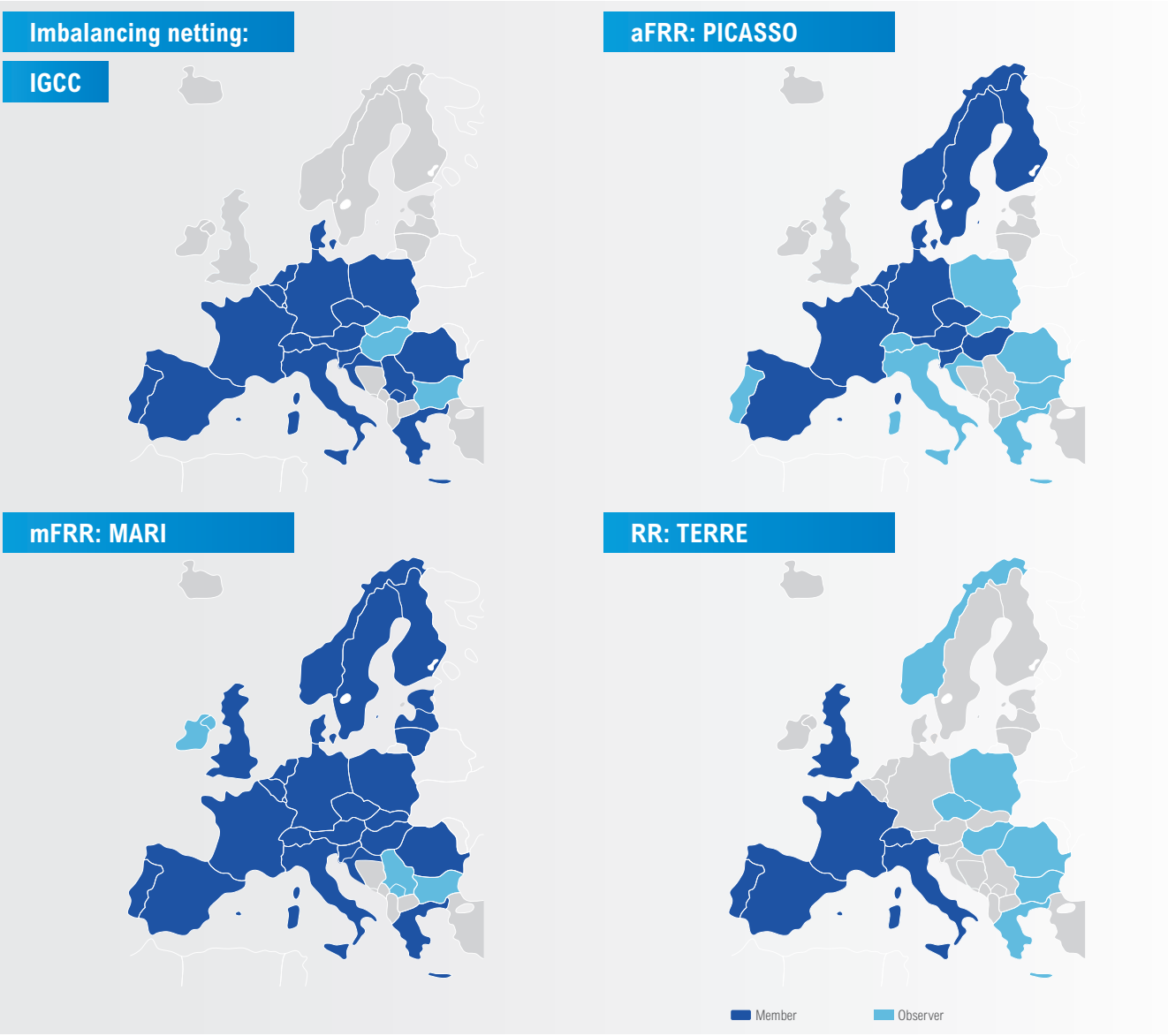

Figure 11. European balancing implementation projects and their TSO members (as of November 2018)

mFRR platform (MARI): MAVIR (HU), HOPS (HR) and SEPS (SK) are in the process of becoming full members.
aFRR platform (PICASSO): ESO (BG), Swissgrid (CH) and ADMIE/IPTO (GR) are in the process of becoming full members.
More information is available HYPERLINK "https://electricity.network-codes.eu/network_codes/eb/" here.

8 TIMELINE

The EBGL sets a challenging timeline for European platform implementation (Figure 12); however, TSOs have confirmed their intention to meet the required deadlines.Glossary

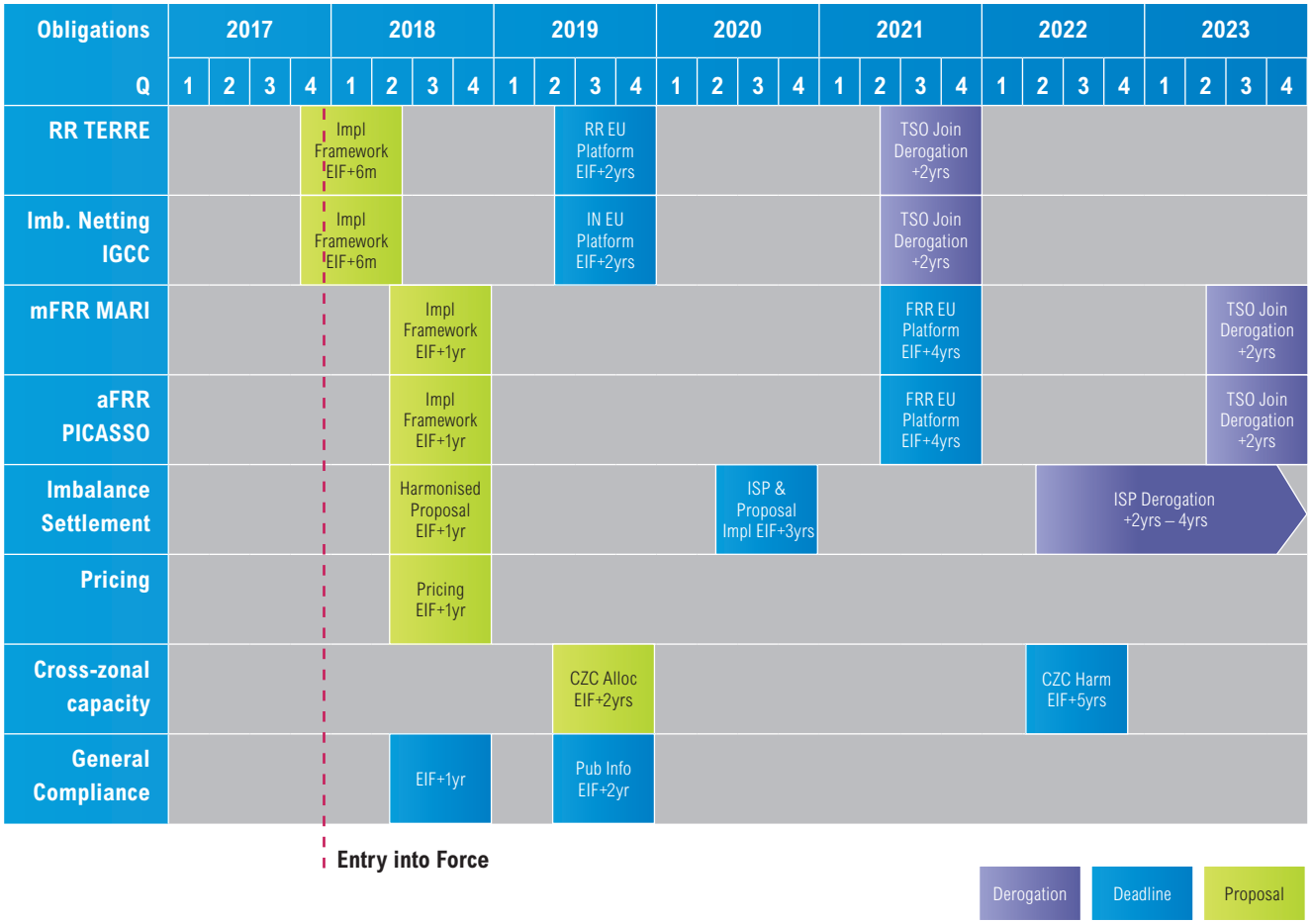

Figure 12. The EBGL required timeline for the implementation of European balancing platforms

GLOSSARY

aFRR	frequency restoration reserves with automatic activation
AOF	activation optimisation function
aFRR	frequency restoration reserves with automatic activation
IGCC	international grid control cooperation
AOF	activation optimisation function
LFC area	load-frequency control area
BE GCT	balancing energy gate closure time
mFRR	frequency restoration reserves with manual activation
BRP	balance responsible party
MARI	manually activated reserves initiative
BSP	balancing service provider
NRA	national regulatory authority
CMOL	common merit order list
PICASSO	platform for the international coordination of automated frequency restoration and stable system operation
CZC	cross-zonal capacity
RR	replacement reserves
EBGL	Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing
TERRE	trans-European restoration reserves exchange
FCR	frequency containment reserve
TSO	transmission system operator
HVDC	high voltage direct current
TSO GCT	TSO energy bid submission gate closure time
IN	imbalance netting
XB	cross-border

ANY QUESTIONS? CONTACT US!

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