Explanatory Document to All TSOs' proposal for the implementation framework for a European platform for the exchange of balancing energy from frequency restoration reserves with automatic activation in accordance with Article 21 of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing

20/04/2018

DISCLAIMER

This document is submitted by all transmission system operators (TSOs) to all NRAs for information purposes only accompanying the all TSOs' proposal for the implementation framework for a European platform for common activation of automatic Frequency Restoration Reserves in accordance with Article 21 of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing.

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1. Introduction

This explanatory document describes the scope and content of the all TSOs' proposal for the implementation framework for a European platform for the exchange of balancing energy from frequency restoration reserves with automatic activation (aFRRIF) in accordance with Article 21 of Commission Regulation (EU) 2017/2195 establishing a guideline on electricity balancing (EBGL).

This explanatory document has been prepared in support of the all TSOs' provision of the aFRRIF. Earlier work on relevant material in the PICASSO project, and previously the EXPLORE project, has been taken into account both in the aFRRIF and in the explanatory document. This includes input received in consultations previously organised in the two mentioned projects. The aim of the explanatory document is twofold:

1. Firstly, to actively engage stakeholders in order to gather formal input in preparation of the formal proposal to be provided to all NRAs' by 18 December 2018.

2. Secondly, to provide insight to stakeholders and other interested parties into the concept of the implementation framework, including the rationale for choices made by the TSOs during its design. It gives some feedback in regards to comments received from stakeholders on topics relevant for the implementation framework during the consultation on the aFRR-Platform design organised by the PICASSO project during the end of 2017[1], especially relevant to specific design choices.

Together with the all TSOs' proposal for pricing of balancing energy and cross-zonal capacity (Article 30 of the EBGL), the aFRRIF will lead to a new international market for aFRR. This is likely to lead to many changes for stakeholders, both from harmonisation efforts and as a result of the integration of the markets. Because of this, the feedback from stakeholders, in particular BSPs and BRPs, is valuable.

The structure of the document is as follows. After this general introduction, the context established by the EBGL is described. This is followed by a description of the relevant timelines related to the aFRRIF and the platform implementation (Chapter 3).

In Chapter 4 and Chapter 5, the harmonisation and integration aspects of the aFRR-Platform are discussed.

Chapter 4 focuses on harmonisation aspects, including the description of standard products and the description of the balancing energy gate closure time. It also describes the framework for further harmonisation.

Chapter 5 focuses on integration aspects, including the high-level design of the platform and its business functions: the activation optimisation function and the TSO-TSO settlement function. This chapter also describes the signal set between TSOs and the usage of cross-zonal capacity and other aspects of congestion management. Concepts related to the exchange of aFRR energy between synchronous areas are also included in this chapter.

Chapter 6 explains the proposed governance structure of the platform.

Finally, Annex I and Annex II show a cross-reference between the articles of the aFRRIF and this document, and a list of abbreviations.

[1] PICASSO Consultation Document, available under: https://www.entsoe.eu/Documents/Network%20codes%20documents/Implementation/picasso/PICASSO-Consultation_document.pdf

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2. EBGL and the scope of the aFRRIF

The main purpose of EBGL is the integration of balancing markets to enhance the efficiency of the European balancing processes. The integration should be done in a way that avoids undue market distortion. In other words, it is important to focus on establishing a level playing field. This requires a certain level of harmonisation in both technical requirements and market rules. To provide this level of harmonisation, the EBGL sets out certain requirements for the integration of the aFRR markets. Figure 1 gives an overview of the requirements of the EBGL, their interconnection with each other and their interconnections with topics out of scope of the EBGL.

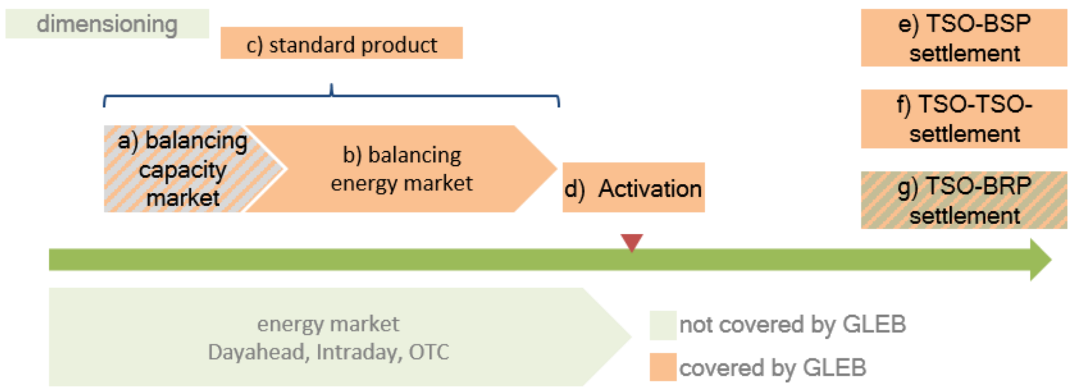

Figure 1: Scope of EBGL

Dimensioning for aFRR is a local responsibility in accordance with Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation. Each TSO determines the amount of aFRR to be procured in accordance with their dimensioning and organises its balancing capacity market accordingly. TSOs will be using standard products and, where necessary, specific products to fulfil their dimensioning requirements. The integration of balancing capacity markets is not required by the EBGL and is not in the scope of the aFRR Implementation Framework (aFRRIF) or the PICASSO project.

Instead, the focus is on the integration of balancing energy markets for aFRR in accordance with Article 21 of the EBGL through the exchange of standard balancing energy products. The integration of the balancing energy markets is proposed in line with a multilateral TSO-TSO model as shown in Figure 2. At their local TSO, BSPs can place balancing energy bids or update the balancing energy price of their bids until the balancing energy gate closure time for the standard aFRR balancing energy product bids (BE GCT), as defined in the aFRRIF under Article 7. These standard product bids are then forwarded to the platform until the TSO energy bid submission gate closure time for the standard aFRR balancing energy product bids (TSO GCT), as defined in the aFRRIF under Article 8, where they are merged onto a common merit order list (CMOL) for activation by all TSOs through a common activation optimisation function (AOF).

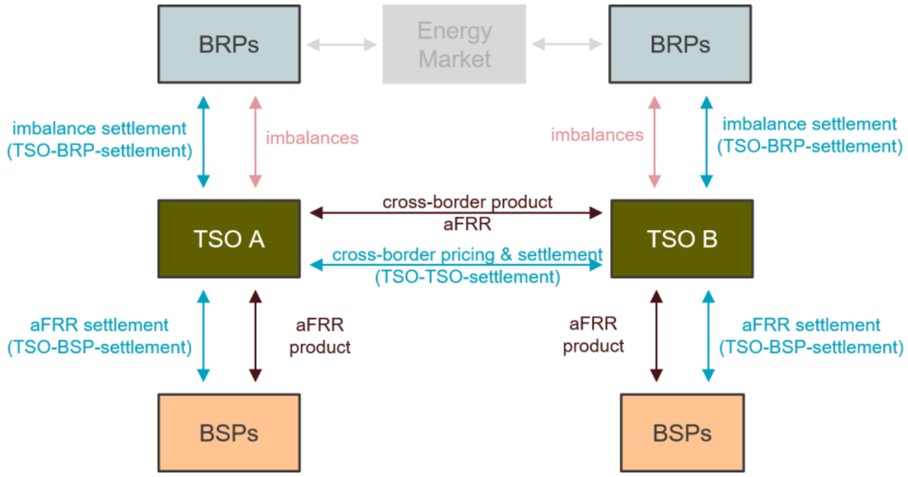

Figure 2: Scheme of TSO-TSO model

Article 21(3) in the EBGL lists a number of points to be included in the aFRRIF for definition of the European market for exchange of standard products for aFRR and the platform. Information on the proposal for these points can be found in the explanatory document in the locations listed hereunder.

- Roadmap and timeline for implementation (Chapter 3.2)
- Definition of standard products (Chapter 4.1)
- Framework for further harmonisation (Chapter 4.3)
- Definition of BEGCT and TSO GCT (Chapter 4.2)
- High level design of the platform (Chapter 5.1)
- Description of the functions of the platform (Chapter 5.3)
- Description of the CMOLs and the AOF algorithm (Chapter 5.4)
- Rules for governance, designation of entities, and cost sharing principles (Chapter 6)

The platform will ensure information is available for purposes of publication and reporting in accordance with Article 12 of EBGL. Publication is not further discussed in this document.

Settlement principles are out of scope of the aFRRIF as they are part of the proposals in accordance with Articles 30, 50, and 52 of EBGL for respectively TSO-BSP, TSO-TSO and TSO-BRP settlement.

Calculation and allocation of cross-zonal capacity in accordance with Title IV of EBGL is also out of scope. Congestion management relating to the aFRRIF and the platform is described in Chapter 5.6.

Also out of scope is the designation of activation purposes in accordance with Article 29(3), although it can be confirmed that as far as aFRR is concerned there is no intention to use bids for purposes other than balancing.

3. Roadmap and timeline for implementation

EBGL sets ambitious goals for the integration of the European balancing energy markets. Article 21(6) requires that all TSOs performing the aFRR process are connected to the aFRR-Platform no later than 30 months after the approval of the aFRRIF. This applies for all TSOs of the synchronous areas CE and Nordic, but not currently for the TSOs of the synchronous areas IE/NI, GB and Baltic.

In order to reach the ambitious goals of the EBGL and to be able to implement the European aFRR-Platform and for each TSO to connect in time, all TSOs have designated PICASSO to be the implementation project that shall become the aFRR-Platform. This chapter describes the relationship between all TSOs and PICASSO in delivering the aFRRIF and the aFRR-Platform. It also illustrates the timeline for implementation and accession as referred to in the aFRRIF Article 4.

3.1. PICASSO

The establishment of the aFRR-Platform is organised via the implementation project PICASSO, where technical details, common governance principles, and business processes are developed by the TSOs involved. Furthermore, TSOs shall implement and make operational the European platform where all aFRR balancing energy bids from standard products shall be submitted and the exchange of all balancing energy from aFRR shall be performed.

More information on the background of PICASSO can be found in the PICASSO consultation document of 21 November 2017. At the end of March 2018, the PICASSO project consist of sixteen members TSOs, as well as 10 observers. Figure 3 gives an overview of the current members and observers of the PICASSO project.

Figure 3: Overview of members and observers as of 31.03.2018

All involved TSOs actively contribute to the project.

All TSOs have developed the proposal for the aFRRIF through ENTSO-E and in close coordination with the PICASSO project. Analysis and discussions within the PICASSO project as well as stakeholders' input gathered by the project have served as input to ENTSO-E. Coordination of various topics with relevance for other implementation projects such as TERRE (RR), MARI (mFRR) and IGCC (IN) are coordinated by ENTSO-E via dedicated working groups.

3.2. Implementation schedule (Article 4)

As explained above, both the compilation of the aFRRIF and other proposals in accordance with EBGL and the implementation of the aFRR-Platform include strong involvement from the PICASSO project. As such, the timelines of the PICASSO project closely follow the timelines for the delivery of the aFRRIF as well as the timelines for implementation of the platform. The complete timeline, with tentative dates, is briefly presented in the current paragraph and in Figure 4. It also describes the steps required to achieve the timeline, as well as the interaction between the aFRR-Platform and the imbalance netting platform.

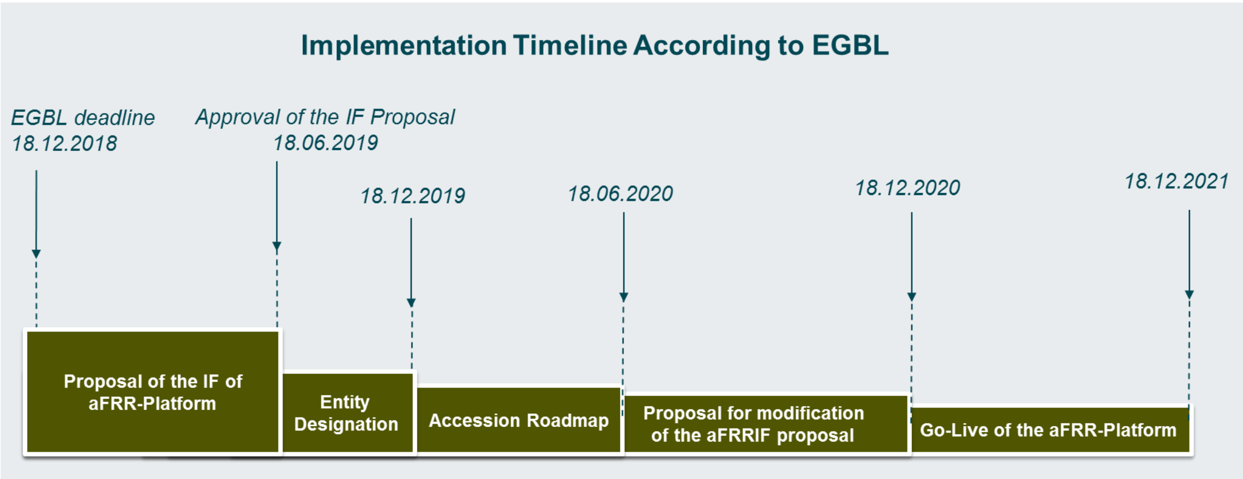

Figure 4: High-level implementation of the aFRR-platform according to EBGL

High-level implementation timeline

The timeline for implementation is mostly laid out by the requirements in Article 21 (4), (5) and (6). These indicate that full operation of the platform is expected 30 months after the approval of the aFRRIF. In order to achieve this target six months after the approval of the aFRRIF the entity or entities that will operate the platform shall be designated.

As experiences during implementation of the aFRR-Platform may necessitate change, EBGL allows for the possibility of a scheduled proposal for modification of the aFRR-Platform.

If case approval of the aFRRIF is given without a request for amendments by NRAs and without escalation to Agency for the Cooperation of Energy Regulators (ACER), this approval is due 6 months after the delivery of the aFRRIF to ACER. The whole timeline then runs until December 2021, by which time the current project planning aims to have the aFRR-Platform operational and all member TSOs using the platform.

Roadmap

Aside from designating the entities which will operate the business functions of the platform, ensuring that the obligations in regards to the timeline are met requires several steps:

- Establishment of the platform

- National changes to:
  - market design
  - legislation
  - systems
- Accession to the platform

For these steps to be finalised, the dedication of all TSOs is required. For this reason the aFRRIF requires TSOs to make changes to their national terms and conditions for balancing, and commits TSOs to the necessary adjustments of processes.

Aside from this commitment, an accession roadmap is necessary. It will not be possible to connect all TSOs at the same time, and some time will be required for interoperability and operational testing. Currently, the most feasible way forward is to have an accession process whereby groups of TSOs connect to the platform at the same time, with the last group connection completed ahead of December 2021.

A detailed accession roadmap will be developed within 12 months of the approval of the aFRRIF. This roadmap will take into account the time required for national changes as well as the required testing and end when the aFRR-Platform must be used by all TSOs using aFRR, at the latest.

Interaction between the aFRR-Platform and the imbalance netting platform

The aFRR-Platform implements an implicit imbalance netting process (Chapter 5). Therefore, if the geographical regions of the IN-Platform and the aFRR-Platform are the same, a separate IN-Platform is no longer necessary. The number of entities and operational effort would decrease while maintaining the same level of economic efficiency. Thus, overall efficiency of the balancing platforms can be increased, if the IN-Platform is superseded by the aFRR-Platform.

In the transition period, when the geographical regions are not the same (e.g. due to derogation) the consistent usage of available cross-zonal capacity (CZC) for the IN-Platform and the aFRR-Platform at the same time has to be ensured. A calculation of both processes in one activation optimisation functions guarantees this necessary consistency. TSOs foresee including both (IN and aFRR) processes in the AOF of the aFRR-Platform.

From an efficiency point of view an early merging of both platforms is beneficial. Therefore, TSOs recommend that NRAs incentivise and enable the geographical regions of the participating TSOs in the aFRR-Platform to be the same as the geographical regions of the participating TSOs in the IN-Platform.

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4. Harmonising the European aFRR market

When integrating European balancing energy markets, it is important to pay special attention to the level playing field for participants in those markets. Establishing a level playing field requires a certain level of harmonisation of both technical requirements and market rules. To provide this level of harmonisation, the EBGL sets out certain requirements. Some forms of harmonisation are a direct result of the EBGL requirements, such as the requirement for the platform to utilise merit order activation. Others will follow from the settlement proposals in accordance with Article 30 and 52.

The current chapter describes those aspects of the aFRRIF that explicitly lead to additional harmonisation among different countries involved in the exchange of aFRR for balancing energy. Specifically, it describes the following aspects of harmonisation, as required by Article 21(3) (f), (h), (i) and (j):

- Definition of standard product (Chapter 4.1)
- Definition of BEGCT and TSO bid energy submission GCT (Chapter 4.2)
- Framework for further harmonisation (Chapter 4.3)

4.1. Standard product (Article 6)

The EBGL sets up certain requirements for standard products in Article 25(4) and Article 25(5). Article 25(4) sets out the technical parameters:

> *The list of standard products for balancing energy and balancing capacity may set out at least the following characteristics of a standard product bid:*
>
> (a) *preparation period;*
>
> (b) *ramping period;*
>
> (c) *full activation time;*
>
> (d) *minimum and maximum quantity;*
>
> (e) *deactivation period;*
>
> (f) *minimum and maximum duration of delivery period;*
>
> (g) *validity period;*
>
> (h) *mode of activation.*

The harmonisation of the above mentioned parameters is optional. Due to the heterogeneous generation structure within Europe and the resulting differences in the existing aFRR market, TSOs foresee a progressive harmonisation, with only the essential concepts being harmonised before the launch of the platform. It is deemed necessary to harmonise the minimum bid size, bid granularity and validity period from the start of the platform and set a fixed date for the harmonisation of the full activation time.

The full activation time can be divided into a preparation period (during which no energy is delivered) and a ramping period. The requirements for the preparation period vary across Europe as it depends on the mode of activation in use (see Chapter 4.1.4) and the local generation structure. Nevertheless, for aFRR the preparation time remains very short as aFRR delivery is an automatic process. TSOs consider that specifying a harmonised full activation time will provide enough quality guarantee of the aFRR product, while the detailed requirements for the preparation period can remain at the national level.

Regarding the deactivation period, TSOs consider that the duration of the full activation time is also relevant as minimum requirement for deactivation.

The following subchapters lay out the foreseen harmonisation of full activation (and deactivation) time, bid sizing and validity period.

4.1.1. Full Activation Time (FAT) and Deactivation

The duration of activation of balancing products has a direct impact on the resulting frequency restoration control error (FRCE). For LFC areas smaller than the synchronous area, the Area Control Error (ACE) defines the FRCE. Hence, the maximum FAT has to be short enough to guarantee the FRCE target parameters required by Commission Regulation (EU) 2017/1485 (SO-GL). On the other hand, the FAT has to be long enough to ensure the availability of the required capacities and facilitate a liquid aFRR market.

From previous ENTSO-E discussions, the number of feasible candidates for FAT was limited to two: 5 and 7.5 minutes. TSOs performed an impact assessment of the two FAT options (5 minutes and 7.5 minutes), both on the technical aspects (frequency and FRCE quality) and on the economic aspects (capacity procurement costs).

Technical assessment

In order to qualitatively assess the impact of the aFRR FAT on the FRCE quality, TSOs simulated the aFRR activation process for the LFC blocks of Austria, Belgium, France, Germany and the Netherlands with different assumptions for the FAT. Since these LFC blocks constitute a large part of the interconnected network of Continental Europe (CE) and their generation structures reflect the heterogeneous generation in CE, the impact of the FAT on the combined FRCE of these LFC blocks is also a proxy for the impact on the CE system frequency.

The simulations have been performed on the basis of historical aFRR demands, available aFRR and energy exchanges due to imbalance netting of one complete year (April 2016 – March 2017). For the simulation, merit order activation has been assumed for all LFC blocks, since this activation scheme is a requirement from the EBGL. Moreover, it was assumed that the BSPs will react according to the FAT requirement.

The major results of the assessment are:

- Under the given assumptions, one LFC block does not comply with the level 2 FRCE target parameters when choosing a FAT of 7.5 minutes. Mitigation measures (controller tuning, increase of aFRR band) can improve the FRCE quality but are not sufficient
- The global FRCE quality and hence frequency quality would be better than the historical quality when choosing a FAT of 5 min and worse when choosing a FAT of 7.5 min.

Economical assessment

In addition to the technical assessment, certain TSOs performed an economical assessment to identify the impact of the FAT on the volume of the offered aFRR capacity bids and the impact on the aFRR capacity prices of the bids. This assessment aims to be generic and relatively easily applied by each TSO. Therefore, assumptions with a certain degree of simplifications were identified. TSOs consider these assumptions valid for a change of FAT in a range of 5 to 15 minutes.

- In case where the FAT is decreased compared to a TSO's local standard, the aFRR capacity offered by thermal units (CCGT, coal fired, nuclear) connected on this TSO's grid is reduced linearly with the FAT decrease.
- A FAT change has no impact on offered aFRR capacity for non-thermal units (PV, demand side management, hydro, wind)
- The relative price effect due to expected setpoint changes of units and corresponding increase of opportunity costs, in particular when units are facing a must-run situation, is considered.

- The impact of setpoint changes on efficiency and the corresponding impact on costs are not taken into consideration

Any new providers and/or changes in bidding behaviour due to the potentially increased prices are not taken into consideration. This assessment showed that for some TSOs with a longer FAT, the adoption of a common 5 minutes FAT would lead to significant increase of aFRR capacity procurement costs (up to 50%), and potential liquidity issues on aFRR capacity markets. For other TSOs, due to the generation structure and the high liquidity on aFRR capacity markets there is no expected cost decrease in aFRR capacity markets with longer FAT.

Bringing together technical and economical assessments

When the results of the technical and economical assessments are brought together, it can be concluded that both FAT options have unacceptable impacts for some TSOs. This statement is globally confirmed by the stakeholders' consultation:

- On the one hand, many BSPs already displaying a FAT of 5 minutes (or even less) strongly emphasise their wish to keep a 5 min FAT, arguing that a longer FAT would be an issue for ensuring a level playing field and / or would reduce the differences in ramping requirements between aFRR and mFRR products by too much.
- On the other hand, some BSPs displaying a longer FAT confirmed that the FAT reduction to 5 minutes would have a significant impact on the volumes that they could bid on the aFRR capacity market.

Facing this scenario, TSOs looked for **mitigation measures** for both FAT options. TSOs only studied mitigation measures which could be taken in the scope of the project, excluding local mitigation measures and other measure specifically targeting Deterministic Frequency Deviations (DFDs).

For a 7.5 minutes FAT, these measures should limit or avoid the negative impact on frequency and FRCE, in particular for TSOs already having a fast aFRR. The analysis has shown that improving the settings of the LFC controllers of TSOs or increasing the amount of procured aFRR was not sufficient to mitigate the negative impact of fulfilling the FRCE and frequency criteria for some TSOs. Another option was to propose a minimum requirement for TSO-TSO exchange based on a ramping faster than 7.5 minutes in the FRCE Adjustment Process (for more information please see Chapter 5.5). The effect of this proposal would be to limit the negative FRCE effect for TSOs importing aFRR provided by slow BSPs, by leaving all the FRCE caused by a BSP delivery slower than the minimum requirement for TSO-TSO exchange to the responsibility of the exporting TSO.

For a 5 minutes FAT, these measures should limit or avoid the capacity procurement cost increase for "slower" TSOs. In this case, these measures take the form of specific products with longer FAT. In accordance with Article 26 of EBGL, "slower" TSOs could use specific products with longer FAT in order to procure their required aFRR capacity in their local FAT context, hence avoiding the procurement cost increase. Several specific product designs were considered, but all of them resulted in increased complexity of local activation and/or of the PICASSO AOF. Moreover, the use of specific local products is always detrimental for the liquidity of the common aFRR market.

A solution with two standard products with different FAT requirements was also considered. In this case, both products would compete on the same market and each TSO could decide if it accepts only the "fast" product or both. Although this solution theoretically answers both FRCE / frequency quality and procurement cost concerns while having no negative impact on market liquidity, it was finally rejected because of its major impact on AOF complexity and because it could raise concerns about the split of the aFRR energy market.

At this stage, TSOs acknowledged that a 5 minutes FAT was the optimal long term option, due to of its advantages in terms of system response. Indeed the current weighted average with respect to the procured volume of local FAT in Continental Europe and Nordics is estimated at around 6.5 min, with the majority of the countries in the pro rata activation scheme (3/4 in terms of volume)[2]. It is generally acknowledged that moving to a merit order activation scheme with an additional FAT of 7.5 min would downgrade the current situation and may jeopardise the system's security. However, it was also clear that the move to a 5 minutes FAT could not be implemented too quickly, because time is needed for countries with longer FAT to develop a faster, broader local aFRR market in order to avoid the cost increases of aFRR capacity. Therefore, the best option which TSOs have identified was a stepwise approach:

- No harmonisation of FAT at the go-live of the platform, but the FRCE adjustment process will have a maximum ramping period of 7.5 minutes.
- As of 18 December 2025 the FAT will be set at 5 minutes and as a result the FRCE adjustment process will have a maximum ramping period of 5 minutes also starting from 18 December 2025.

This compromise answers the concerns of the "fast" TSOs and BSPs about setting a clear target of a fast-reacting aFRR market, while leaving time for "slower" TSOs to develop a faster and broader local aFRR market to mitigate the impact on procurement costs.

The maximum ramping period of 7.5 minutes defines the minimum requirement for the exchanged aFRR energy after FRCE adjustment. This means that if the local FAT is longer than 7.5 minutes, the aFRR exchange is determined based on the minimum requirement. Through this, the connecting TSO will become responsible for the imbalance caused by the difference in speeds between the BSP reaction and the TSO-TSO exchange after FRCE adjustment. In case the local FAT is less than 7.5 minutes then the local activation exceeds the minimum requirement. The aFRR exchange after FRCE adjustment will be determined based on the actual activation. This design aims at providing an incentive for market design changes towards facilitating faster products. Solving liquidity issues with slower specific products will not be necessary due to the FAT not being defined in the standard product. In other words, products with a slower FAT will also comply with the standard product definition.

4.1.2. Bid size and granularity

The current bid sizing of TSOs is relatively similar. The minimum bid size, which defines the minimum size of the energy bid volume offered, ranges between 1 and 5 MW. The minimum bid size affects the number of bids in the CMOL and therefore has an IT and administrative impact. On the other hand, the minimum bid size impacts the barriers for new market entries. The lower the minimum bid size, the lower the barrier for new market players.

It can be seen from the results of stakeholder consultation that the majority of respondents are in favour of a minimum bid size of between 1 and 5 MW, with a slight preference for 1 MW.

Moreover, no TSO showed any major concerns about a 1 MW minimum bid size, and 1 MW was considered to be a good way to facilitate lower entry barriers and manageable complexity at the AOF level. This point, concerning the manageable complexity at the AOF level, has to be confirmed during or after the IT implementation of the AOF. If TSOs realise that the minimum bid size of 1 MW and the possible significant increase of the total number of bids could significantly slow down the AOF or cause problems in data management, then the minimum bid size might be re-evaluated, for example increased to 5 MW, in line with the amendment process outlined in Article 6 of EBGL. As the aFRR activation is a real-time process, the runtime of the AOF algorithm should be kept sufficiently short.

As aFRR energy bids are divisible (see Chapter 4.1.5), TSOs consider the maximum bid size mostly an IT limitation, which will be set to 9999 MW.

[2] E-bridge report on merit order aFRR and harmonizing FAT (https://www.entsoe.eu/Documents/MC%20documents/balancing_ancillary/151224_Report_Study_merit_order_aFRR_and_harmonising_FAT_vs_0_1_draft_selection_for_BSG_meeting_on_15_January.pdf)

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The bid granularity defines the possible increment of offers above the minimum bid size. TSOs apply a bid granularity of 1 MW, in line with the wishes of most stakeholders and the capability of LFC controllers of all TSOs.

4.1.3. Validity Period

The validity period defines the amount of time for which a bid is valid and firm. This means that activation requests from the TSO to the BSP can only happen within the validity period. A shorter validity period gives a BSP the opportunity to adapt the price and volume of their bids closer to the boundary conditions given by the market and the fluctuating generation by renewable energy sources.

A validity period of 15 minutes agrees with the current discussion on the following topics: harmonized imbalance settlement period, scheduling periods and the market time unit on intraday market.

On the other hand, a short validity period generally leads to more frequent changes of the CMOL. This sets higher requirements on the technical processes on the sides of TSO and BSP, which will be tackled by highly automated processes for bid processing.

Furthermore, changes to the CMOL between two consecutive bid validity periods lead to up- and down-ramping of aFRR bids and might cause deteriorations in the FRCE and frequency quality in cases where the ramping speeds of activated and deactivated bids do not match. TSOs have assessed this effect on the basis of a sensitivity analysis, taking into account the hypothesis that more frequent CMOL changes also lead to a lower share of replaced bids at the end of each validity period, since changes in the bid placement of BSPs can be distributed over a longer timeframe. The correlation with deterministic imbalances has also been considered in the analysis.

The analysis shows, that a short validity period of 15 minutes does not significantly reduce the FRCE and frequency quality in comparison to a longer validity period of 30 or 60 minutes.

Therefore, TSOs propose a validity period of 15 minutes, in line with expected validity period for mFRR.

4.1.4. Mode of Activation

The mode of activation for aFRR is automatic due to the nature of the aFRR process. This means, that the LFC-controllers automatically send setpoint for activated bids. During the validity period of their offered bids, the setpoint signals sent to BSP can constantly change their values, depending on the aFRR demand.

In Europe two different approaches and their variants are used for the calculation of the setpoint signal which is sent to the BSPs. These two approaches are described below.

Ramping approach

The first approach is based on the limitation of the rate of change of the setpoint sent to the BSPs and it requires the BSP to follow the setpoint in a narrow tolerance band. This is displayed in Figure 5. Ramped setpoint (orange line) is sent to the BSP. The BSP has to follow the sent setpoint in the given tolerance band (yellow area). BSP settlement can take into account the requested energy volume defined by the controller output. TSOs can incentivize the BSP to stay within the tolerance band by applying penalties and additionally by a consistent TSO-BRP settlement.

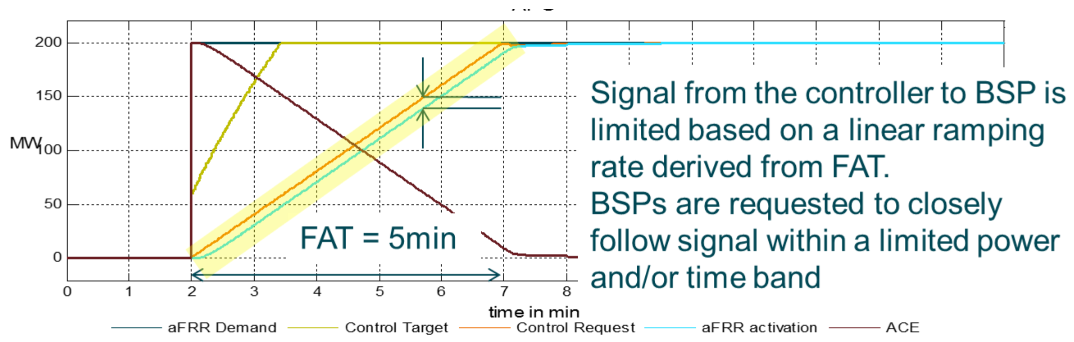

Figure 5: Ramping approach

TSOs applying this approach would give BSPs the opportunity to nominate ramp rates which would exceed the minimum dynamic requirements. Through this BSPs with fast activation would have the opportunity to gain even more in the TSO-BSP settlement thanks to the higher delivered volume.

This approach is mainly applicable for countries with BSPs which can follow ramp rates closely and where the ramp rate is known in advance (e.g. for CCGT).

FAT approach

The second approach does not foresee a limited rate of change for the setpoint sent to the BSP. BSP settlement takes into account the energy volume based on the delivered aFRR. This approach is depicted in Figure 6.

Due to the unramped setpoint BSPs cannot precisely follow the given request and as such the tolerance band may be larger than in the previous approach, depending on the prequalification requirements. The given TSO-BSP settlement implicitly incentivises BSPs to activate as fast as possible and increase the volume to be settled. Additionally TSOs can incentivise BSPs to deliver the minimum dynamic requirements by applying penalties in the event of „underfulfilment".

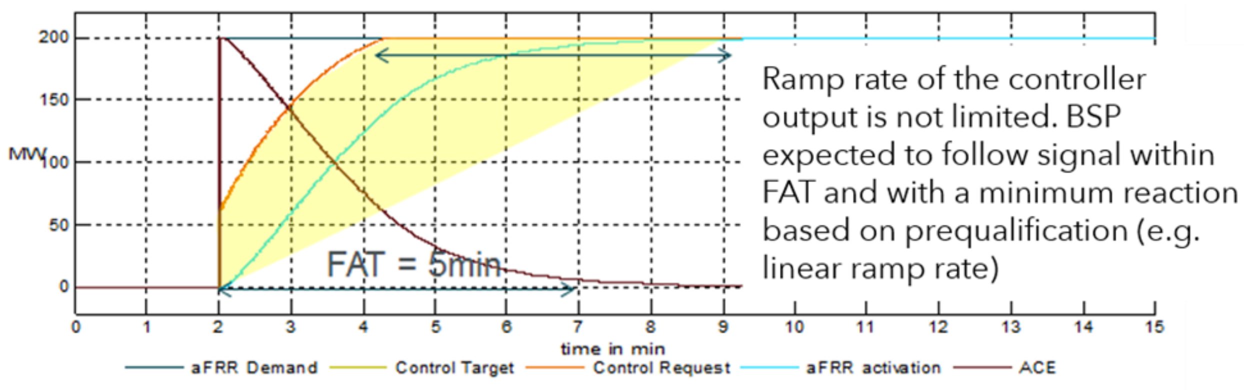

Figure 6: FAT Approach

This approach is mainly used by countries with a high share of BSPs where the ramp rate is not known in advance (e.g. coal mill delay) or where additional costs would apply (e.g. discrete pumps).

However, in practice both approaches should lead to similar results and both allow for the facilitation of the TSO-TSO exchange proposed by TSOs. Both approaches also allow valorising fast flexibility. Moreover, giving the flexibility for each country to keep its historical approach mean that the adaptation of all existing interfaces between TSOs and BSPs, and possibly adaptations of controllers at BSP side, can be avoided. Hence, TSOs have agreed not to harmonise this part of the product characteristic and through this give every TSO the opportunity to apply the appropriate method corresponding to the existing generation structure of its LFC area.

4.1.5. Other characteristics of aFRR energy bids

Article 25(5) of EBGL, lays down the obligatory parameters for standard products:

> *The list of standard products for balancing energy and balancing capacity shall set out at least the following variable characteristics of a standard product to be determined by the balancing service providers during the prequalification or when submitting the standard product bid:*
>
> *(a) price of the bid;*
>
> *(b) divisibility;*
>
> *(c) location;*
>
> *(d) minimum duration between deactivation period and the following activation*

This subchapter will specify the bid related characteristics that are required by the EBGL and how TSOs envision their setup.

According to Article 31 (4) of EBGL, bid prices should be expressed in the currency of EURO and the validity period.

Another parameter for the bid definition is 'divisibility', i.e. whether a minimum bid volume constraint during activation applies or not. Due to the nature of the aFRR process, energy bids have to be divisible in order to be activated continuously. The activation request can be lower than the minimum quantity and minimum granularity.

The EBGL requires the standard product to specify the location of a bid. TSOs require at least the LFC area to be indicated for each bid; however, a more detailed geographical location might be required locally.

The EBGL requires the standard product definition to specify the minimum duration between the end of a deactivation period and the following activation. TSOs consider a value of zero for this minimum duration feature, as the aFRR product is considered to be continuously available for activation. BSPs with resting constraints should consider offering only balancing energy bids not related to a contract for balancing capacity in order not to offer the bids for a particular period when resting is needed.

To start by investigating cross-platform communications before the platforms are implemented would be complicated, as this could in turn increase the complexity of the initial implementation. However, as explained in Chapter 4.2, there is a collaboration between the PICASSO, MARI and TERRE projects towards finding the best possible sequence of balancing energy gate closure times for the different balancing processes, in order:

1. to consider different bidding approaches (e.g. unit-based or portfolio bidding) and the fact that basically a flexibility can provide either one or different balancing services at the same time: for example one flexibility can offer mFRR or aFRR, a BSP could participate in the aFRR process if not activated by the mFRR process. As well one flexibility can offer aFRR, only if activated by mFRR process.

2. to offer as much as possible the possibility of BSPs submitting their flexibilities on the different balancing platforms, by permitting the TSO to allow BSPs to submit conditional bids locally for a flexibility where its availability to the subsequent balancing process (e.g. aFRR bid) is linked to the state of activation of a bid for another balancing process (e.g. mFRR process);

3. to offer, as much as possible, the possibility of the TSO to releasing the bids for the local intraday market according to Article 29 (10) of EBGL.

This submission of bids (including conditional bids) will be done by BSP themselves in the local TSO-BSP bidding interface. Furthermore, according to the national terms and conditions, a TSO can have the possibility of updating or flagging the availability status of a bid submitted to PICASSO platform. No other modifications of bids other than flagging as available or unavailable after the TSO GCT are foreseen by the TSOs.

Furthermore, TSOs do not foresee the possibility of handling complex bids directly by the aFRR-Platform, such as linked or exclusive bids; considering such bids in the aFRR optimisation would make solving the optimisation problem within the time needed for the aFRR process unfeasible.

4.2. Bidding process and balancing energy gate closure time (Article 7 and 8)

This paragraph explains and justifies the choices that were made for the BEGCT and the TSO GCT. Before the justification itself, an overview of the aFRR bidding process and a definition of the key concepts will be provided. Special care will be taken to show the interactions with the design of the other balancing processes (MARI for mFRR and TERRE for RR) and cross zonal and local intraday markets.

4.2.1. General overview of bidding process and key definitions

This subchapter illustrates the future bidding process flow for aFRR energy between BSPs and TSOs. The timeline is given in Figure 7. Figure 8 shows the main steps of the bidding process for balancing energy and other key moments before the start of a validity period at time t.

For each validity period, there will be:

(a) The balancing energy gate opening time for BSPs (BSP BEGOT): this is the first moment at which BSP can submit energy bids for a specific validity period.

(b) The balancing energy gate closure time for BSPs (BSP BEGCT): this is the point in time after which submission or update of a balancing energy bid is no longer permitted for a specific validity period. This implies that the submitted balancing energy bids become firm from the BSP towards the local connecting TSO for this validity period at the moment of BEGCT. The submission of energy bids is performed via a local TSO-BSP interface. Hence, each TSO will still operate its own tendering platform for collection of bids. For TSOs applying central dispatching model, the BEGCT for aFRR integrated scheduling process bids shall be defined pursuant to Articles 24(5) and 24(6) of EBGL.

(c) The TSO energy bid submission gate closure time (TSO GCT): this is the point in time when each TSO will have to submit its local merit order list (LMOL, one per direction of activation) containing at the minimum the standard product bids to the PICASSO platform, which will then collect and merge all the LMOLs to form the two common merit order lists (CMOLs), one per direction of activation. The resulting CMOLs will contain all bids which are valid for use by the common activation optimisation function (AOF) during the respective validity period. However, each TSO shall have the possibility at all time after the TSO GCT (including within the validity period) of changing the availability status of this bid. The setting of bid as available or not could be caused due to reasons described in Article 29 (9) of EBGL or due to the national Terms and Conditions that allow for instance conditional bidding of one underlying asset to different balancing processes. This sequence is repeated for each validity period.

The time period between BSP BEGCT and TSO GCT will be used by TSO to perform all the required local processes on the bids received at BEGCT (e.g. consistency checks, IT fall-back rules and congestion management needs). Besides the above mentioned bidding related processes, Figure 7 shows two more relevant gate closer times from the ID process. The cross-zonal intra-day gate closure time (cross-zonal ID GCT), marking the point in time when the bid submission for cross-zonal ID closes, is currently determined to be one hour in advance and the BEGCTs for balancing processes need to be shorter than or equal to the cross-zonal ID GCT according to the requirements from Article 24 of EBGL. Additionally the local intra-day gate closure time (local ID GCT) is shown marking the point in time when the bid submission for local ID closes. Note that the exact value may be different in each country and this local ID GCT is given for illustrative purpose, in order to emphasise the fact that local trades are still possible in some markets after the cross-zonal ID GCT.

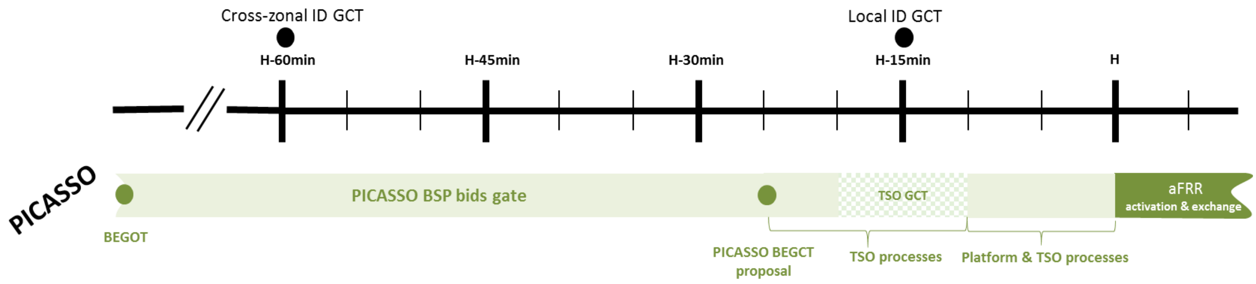

Figure 7: General overview of bidding process

Although the EBGL does not require its definition in the IF, the BEGOT is a parameter that TSOs will also have to set for each of the balancing energy processes (aFRR, mFRR and RR). The BEGOT means the point in time at which BSPs can start to offer their balancing energy bids to their connecting TSOs.

The offered bids only become firm as of BEGCT. A long duration between the BEGOT and BEGCT could reduce the criticality in the event of business or IT-problems by reducing the need for fall-back solutions during real-time operation. It could also increase bidding flexibility for BSPs by reducing the workload or the frequency of interaction if some BSPs are not able or willing to offer their bids often enough. A long enough BEGOT also provides more time to place aFRR bids.

However, for the initial phase of the PICASSO Platform operation TSOs do not foresee a harmonisation of the BEGOT and leave this decision up to each TSO. Nevertheless, TSOs are aware that the BEGOT is a potential harmonisation topic.

4.2.2. BEGCT

The BEGCT marks the last point in time at which when BSPs can submit their balancing energy bids to the local platform. The EBGL requires a harmonised unique BEGCT for each of the balancing processes (aFRR, mFRR and RR) – which could overlap or differ between those processes. Each local BEGCT for the same balancing process must therefore be at the same point in time across different LFC-areas in order to ensure a level-playing field for BSPs.

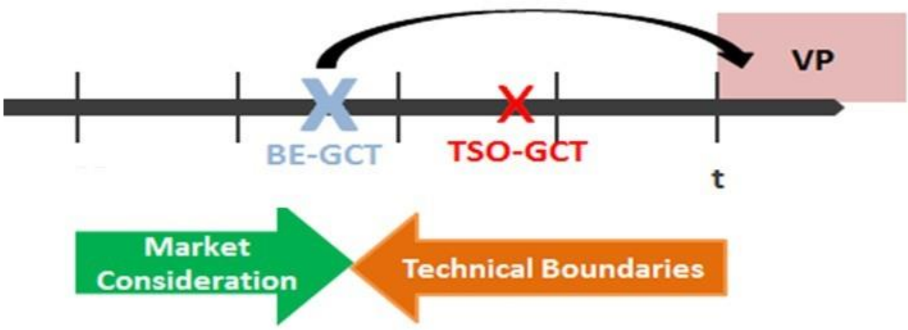

Figure 8: Market considerations vs. technical boundaries

The EBGL states three main requirements for the BEGCT, namely: not to be before the cross-zonal ID GCT as stated in the previous chapter, to be as close as possible to real time and to ensure sufficient time for the necessary balancing processes (at local and platform level). The constraints for the choice of BEGCT can be categorised in two groups: the market considerations and the technical boundaries as illustrated in Figure 8.

First the market considerations translate the wish to offer flexibility among the different balancing processes and between the balancing processes and local ID markets. The timing sequence should allow BSPs to reoffer the bids that have not been activated in previous markets into the next ones as much as possible. Where applicable, this could be feasible between RR and aFRR processes and between aFRR and local ID processes in the case of the application of Article 29(10) of EBGL, if BSPs are able to resubmit bids quickly enough. However, as the point in time of activation for mFRR is close to the start of the validity period (VP), it is not possible to set an aFRR BEGCT that would allow BSPs to reoffer bids which have been released from the mFRR platform. Moreover, bids that are capable of direct activation cannot be reused as they could be activated after the start of the validity period.

The technical boundaries are set by the amount of time used by the platform and the TSOs to perform consistency checks, congestion management analysis, fall back rules or IT communications. These technical boundaries move away the BEGCT from the start of the validity period and further underlines the challenges of setting a sequence that would allow the BSPs to re-offer the flexibility which was offered in mFRR and was not activated.

Given these market and technical considerations, the proposal of setting the BEGCT at 25 minutes before the validity period, except for central dispatch markets, is a trade-off between providing options to re-use flexibility for the RR, FRR and local ID markets and ensuring sufficient time for the necessary technical processes.

4.2.3. TSO GCT

The TSO GCT marks the point in time when each TSO will have to submit its LMOL per direction of activation to the PICASSO platform. The EBGL also requires a TSO GCT for each of the balancing processes (aFRR, mFRR and RR). Sufficient lead time for TSO and platform process is required, especially in the initial phase of operation of the aFRR-Platform to allow sufficient time for fall-back procedures for merging local MOLs to the CMOL.

Taking these technical considerations into account, TSOs propose setting the TSO GCT between 20 and 10 minutes before the beginning of the validity period.

4.2.4. Further evolutions of BEGCT and TSO GCT

Proposals for BEGCT and TSO GCT have been based on the current analysis of the different constraints by the TSOs. When developing the detailed specifications, when implementing the platform and the local systems or when gaining experience during the first months and years of the aFRR-Platform, it could become apparent that these GCTs should be changed. Changes in both directions are possible. If it is concluded that the limited window does not give sufficient time to develop robust operational processes, GCTs further away from the real time may be proposed. On the other hand, if it appears that the operational processes can be executed faster and that this would allow for more opportunities to reoffer flexibility, GCTs could be moved closer to validity period. In both cases, the change of GCTs would be performed according to the amendment process described in Article 6 of EBGL.

Figure 9 summarises the TSOs proposals for BEGCT and TSO GCT whilst taking into account the interactions with other balancing processes and the local ID processes.

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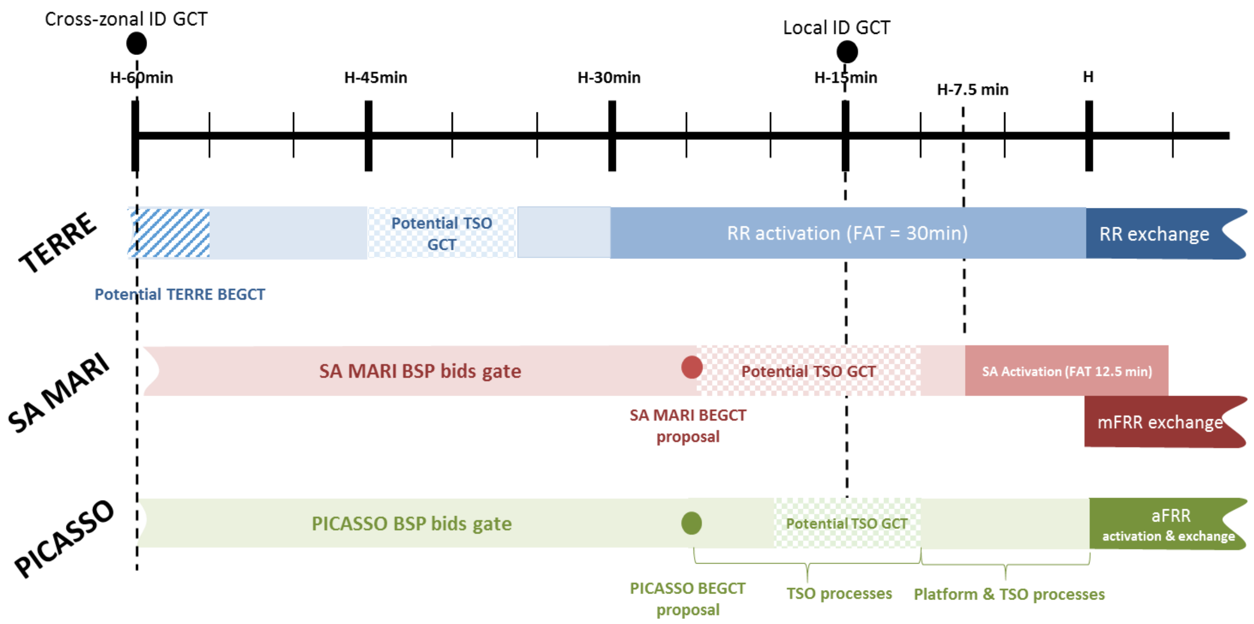

Figure 9: Interaction between BEGCTS for different balancing processes

4.3. Framework for further harmonisation

All TSOs recognise the benefits of harmonisation for the establishment of a level playing field and for the efficient functioning of a cross-border balancing energy market. This is why in Article 15 of the aFRRIF the TSOs propose a framework for harmonisation of terms and conditions, according to which the TSOs will aim to progressively harmonise as many design elements as necessary, in collaboration with stakeholders and NRAs.

Topics for harmonisation are identified through direct dialogue with stakeholders. Holding a stakeholder survey every three years to identify harmonisation needs is therefore proposed. A priority list will then be established, with the involvement of NRAs. The first survey will be organised no later than three years after the aFRR-Platform becomes operational.

All TSOs will specify options for the priority topics identified, and consult upon these options over a two month period. Taking the consultation results into consideration, a common harmonisation proposal including an implementation timeline will be drawn up which is then decided upon by all NRAs.

This process should lead to a stepwise harmonisation of aFRR markets that is both feasible and effective. It is assumed that those topics that would receive the highest benefits in harmonising will be tackled first as stakeholder input will help identifying those topics.

5. Integrating aFRR markets

This chapter describes the high level scheme of the PICASSO platform, including the main business functions necessary for operation of the aFRR optimisation process with their general input/output information. This chapter also presents the business rules in terms of CMOL usage and congestion management approaches, including aFRR exchanges between synchronous areas.

5.1. High level scheme of PICASSO platform input/output

The high level scheme of the aFRR-Platform with the main functions the PICASSO platform shall provide, are listed as follows:

- aFRR AOF: the function containing the activation optimisation algorithm which determines the bids that are activated.
    - TSO-TSO aFRR exchange module: the module included in AOF function which determines the TSO-TSO exchange based on clearing results. The FRCE induced on the connecting TSO follows from this exchange.
- TSO-TSO settlement function: the function which calculates the TSO-TSO settlement of aFRR exchanges based on the optimisation results and TSO-TSO exchanges.

A high-level scheme showing the interaction of the different functions of the aFRR-Platform with each other and with other processes is shown in Figure 10.

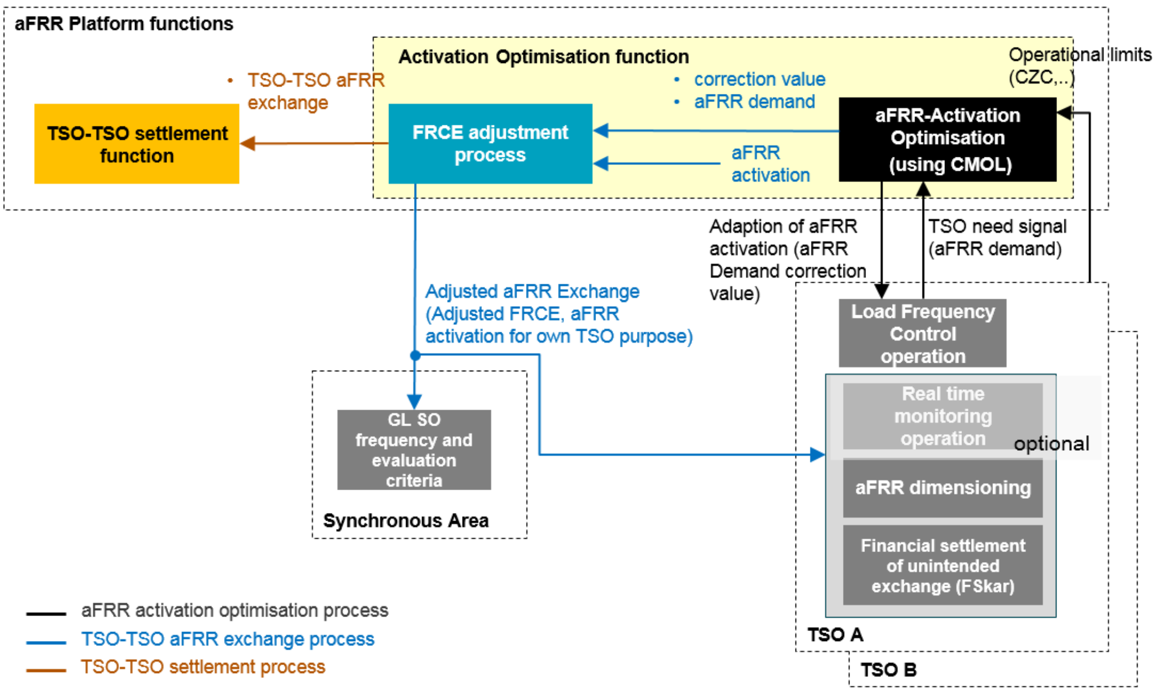

Figure 10: High level scheme of aFRR-Platform

5.1.1. Control demand model

TSOs agreed to use the control demand approach for the AOF. It is the same approach as currently used within IGCC and the German-Austrian aFRR cooperation and shown schematically in Figure 11.

In principle, the concept works as follows:

- Each TSO calculates the aFRR demand for each optimisation cycle and for each of its LFC areas, which is the sum of the currently activated aFRR and the local FRCE of the corresponding LFC area. The activated aFRR can be derived by measurement or estimated by simulation of the activation or by the sum of requested values from BSPs.
- The aFRR demand is provided as input to the AOF, which then uses it to determine the aFRR correction value for each LFC area based on the CMOL and available CZCs. The aFRR correction value is directly included within the aFRR control loop of each participating LFC area (see Figure

11). Through this, the individual controller input of each LFC area is adapted according to the outcome of the aFRR AOF. The sum of the aFRR demand and the aFRR correction value is the so-called corrected aFRR demand and reflects the amount of aFRR, which the individual LFC area has to provide.

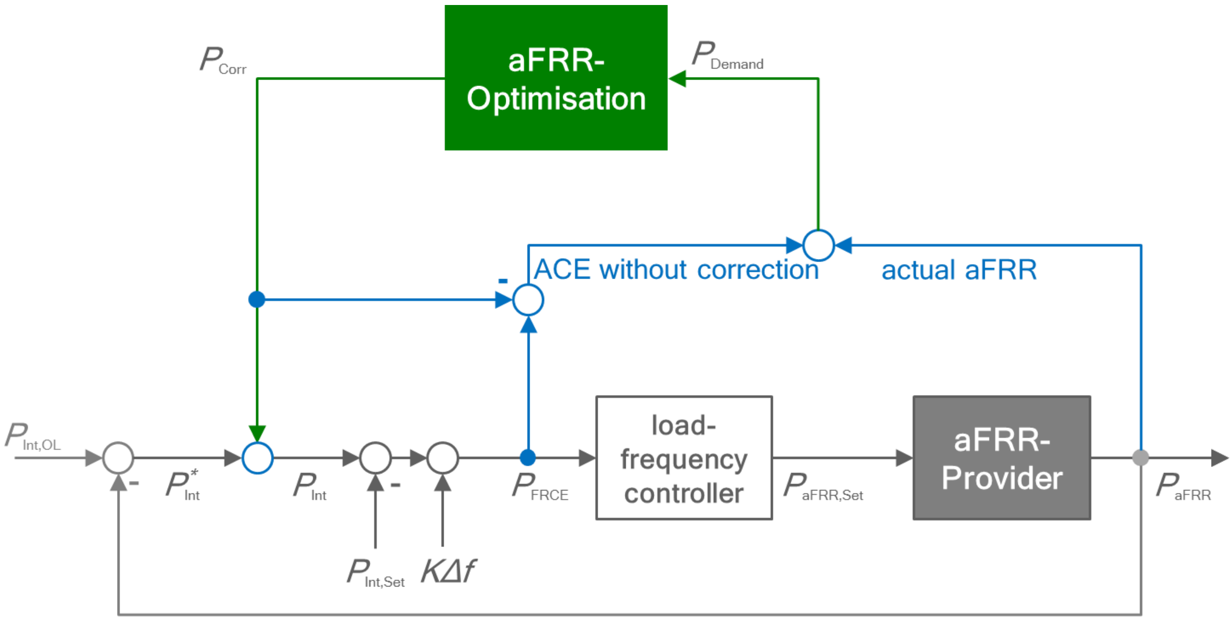

Figure 11: Scheme of the control demand process

The correction value P_{corr} from the AOF is sent, without taking into account possible ramping constraints related to the locally activated bids. In the event of a step change in the aFRR demand of the requesting LFC area, the full step change would be introduced in the FRCE of the connecting TSO. Figure 12 shows the basic functioning of the AOF within the control demand model at a high-level.

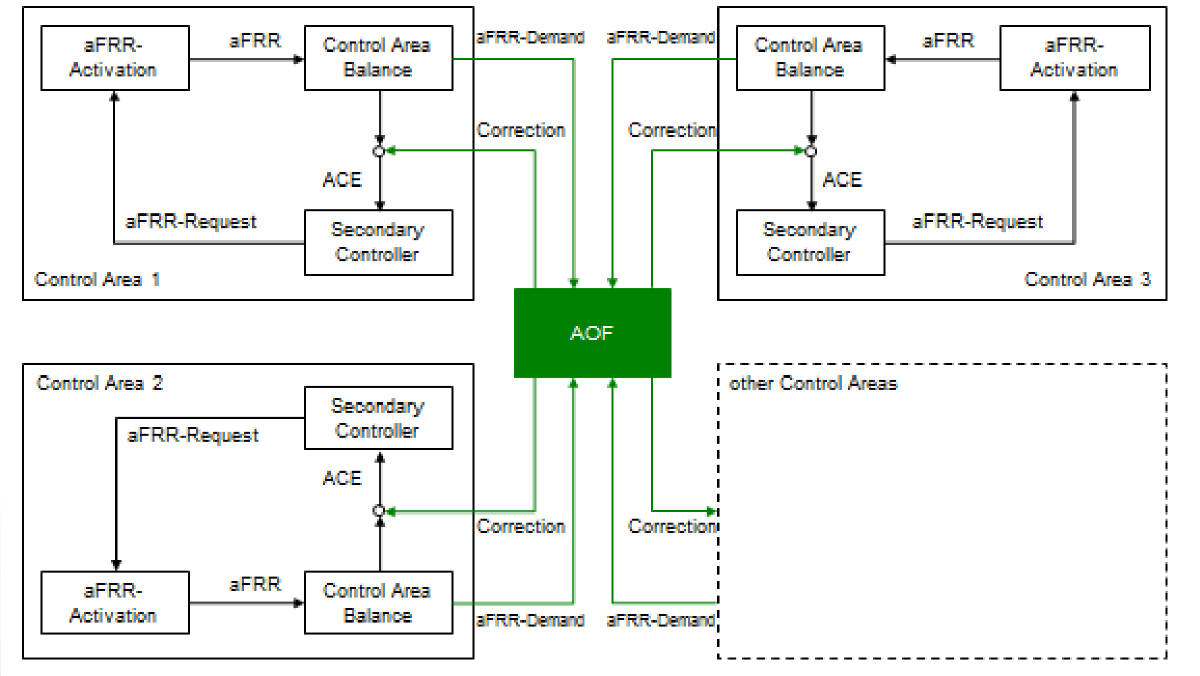

Figure 12: Activation optimisation function with control demand

The main reasons TSOs opt for such a control demand model are:

- The control demand model is already under operation in IGCC cooperation and German-Austrian aFRR cooperation. It has proven to work stably for ten years.
- It enables the maintaining of the local responsibility of TSO towards the monitoring of its own LFC area and BSP local aFRR delivery.
- It enables TSO to parameterise their load-frequency controller(s) in respect to local generation.
- Robustness is enhanced as it does not directly interfere with the local aFRR process.

Investigations have been carried out on the control request model as identified in the Explore report. The control request model considers the output of the local controllers as input to the AOF, rather than the aFRR demand. The output of the AOF changes the local control request. Our investigations indicated that the dynamic stability of the controller would require a much greater effort in terms of harmonisation of all interconnected controllers, whilst still not being able to guarantee stability. This model is therefore not seen as a relevant starting point in order to ensure timely implementation of the aFRR-Platform. However, its implementation on the longer term, subject to further investigation, is not excluded.

5.2. Full access to CMOL (Art 10)

TSOs propose that each participating TSO shall be allowed to request activation of a higher amount of aFRR than that submitted to the common merit order list. For the aFRR process, it is considered acceptable if the sum of aFRR demands of all LFC areas in one TSO occasionally exceeds the aFRR bid volume (sum of contracted and free bids) that this TSO has submitted to the platform.

In essence, TSOs foresee no general rules to exclude full access to the CMOL as:

- There is a benefit in allowing TSOs to have access to as much aFRR as possible, as this enables them to regulate their FRCE to zero and so restore the system frequency. In order to maximise the security of supply, the access to aFRR should not be limited.
- Neither the probabilistic nor the deterministic part of FRR reserve dimensioning depend on an activated aFRR. Therefore, the FRR dimensioning should not radically change due to the full access to CMOL.
- The full access to CMOL is subject to available CZC and therefore not guaranteed. Hence TSOs cannot rely on this and need to have enough local aFRR volumes available.

However, such full access to CMOL must not block the local access of each participating TSO to the aFRR volumes submitted to the platform within its LFC areas, or otherwise obtained through sharing or a common procurement process. Thus, the design of the aFRR optimisation function includes priority access to local aFRR volumes in case of unsatisfied demand (see Chapter 5.4).

Additionally, TSOs will monitor the satisfaction of the aFRR demands when activated volume exceeds the submitted volume to the platform, since the aFRR exchange process is subject to system operation concerns via, for instance, the TSO notification process as required by SOGL. In other words, the amounts of aFRR activated for each participating TSO will be monitored and satisfaction of aFRR demands could, for operational reasons, be limited to the volume submitted to the platform by TSOs (e.g. progressive increase of full aFRR exchange at the go live, volatility of flow changes in real time, DFDs handling).

5.3. Merging of CMOLs (Art 9)

In order to perform a global optimisation of the aFRR activation the aFRR-Platform shall be able:

- to merge all the local merit order lists received from each participating TSO, valid for one validity period, into two common merit order lists, respectively for upward and downward direction; and
- to optimise the aFRR demand received in every control cycle using the common merit order lists in order to satisfy the aFRR demands in the most economically efficient way.

To do so, each BSP shall submit the aFRR balancing energy product bids from the aFRR standard and specific product to the connecting TSO.

Each balancing service provider connected to a TSO applying a central dispatching model shall submit integrated scheduling process bids to the connecting TSO.

The connecting TSO shall submit all aFRR standard balancing energy product bids and where applicable all aFRR specific balancing energy product bids converted to aFRR standard balancing energy product bids to the aFRR-Platform in order to be included in the common merit order lists with the exception of the bids not forwarded in accordance with Article 29 (10) of EBGL.

Connecting TSOs applying a central dispatching model, shall convert the integrated scheduling bids received from the BSPs into available aFRR standard balancing energy product bids, and then submit these to the aFRR-Platform to be included in the common merit order lists.

Within the validity period where the bids are valid, each participating TSO shall submit the aFRR demand on a control cycle basis for each of its LFC areas to the aFRR-Platform in order to be able to regulate the FRCE to zero.

For each control cycle the aFRR-Platform shall perform an optimisation of activation based on the two common merit order lists containing all the available aFRR standard balancing energy product bids submitted by the participating TSOs and all aFRR balancing energy aFRR demands submitted by the participating TSOs.

The activation optimisation function shall contain the continuously updated common merit order lists that shall contain all available aFRR standard balancing energy product bids depending on real time situation: i.e. between the balancing energy gate closure time up to real time, the common merit order lists shall be updated considering for example failure of aFRR providers or unavailability due to local congestions.

5.4. Activation Optimisation Function (AOF) (Article 10)

The optimisation function shall fulfil the following high-level principles in one optimisation step leading to a global optimum:

(a) Control FRCE to zero – The amount of aFRR to be activated according to the AOF should cover the aFRR demand of each LFC Area (full access to the CMOL)

(b) Netting of aFRR demand – The amount of activated aFRR should be minimised

(c) Minimise the cost of activation – Activate the most economic efficient bids

(d) Operational Security – Respect transmission limits as described in Subchapter 5.6

The AOF shall ensure merit order activation from the common merit order lists through an optimisation cycle with a fixed interval of less than 10 seconds, using the demands and constraint inputs received by each participating TSO in real time:

- <u>aFRR demand per LFC area</u>: TSO aFRR demands are inelastic (i.e. no price limit) for aFRR since a TSO shall always activate aFRR to regulate its own FRCE to zero. The aFRR demands from a TSO will solely be for balancing purposes. Other purposes, such as activation of bids for congestion management are not in the scope of the aFRR-Platform. The aFRR demand is updated at every TSO internal control cycle (between 1 to 10 seconds). The AOF uses the last update received from a TSO at every optimisation cycle.

- Operational limits: The operational limits used by the AOF are mainly based on the usage of available cross-zonal capacities and depends on the congestion management methodology (see Subchapter 5.6). The operational limits will be sent and updated in real time. The AOF uses at every optimisation cycle the last update received.

The outcome of the AOF is a correction signal for the aFRR demand in MW per LFC area sent to each LFC area. For every optimisation cycle, the AOF shall provide:

- The aFRR correction value combined with the initial aFRR demand in MW for each LFC area (correction of local aFRR demand) describes the local amount of aFRR to be activated in the LFC area to bring the FRCE value to zero.
- Information on which bids should be activated in each LFC area, together with an indication of cross-border marginal prices in each uncongested area.
- Usage of CZC in MW per border and an indication of the occurrence of congestion.

The main objective function of the algorithm shall use the common merit order lists in one optimisation step in order to:

(a) firstly, maximise the social welfare of the participating LFC areas by activating the economic efficient bids and ensuring minimisation of costs:

    i. Shall maximise satisfaction of the aFRR demand of individual LFC areas.

    ii. Shall minimise the total amount of aFRR activation avoiding counteracting aFRR activation.

(b) secondly, minimise the amount of frequency restoration power exchange on each border between LFC areas.

For the aFRR process, and because aFRR demands are inelastic and the bids are divisible, the objective function will result in one multilinear problem. Having a linear problem is necessary to be able to perform the optimisation in a few seconds. Then, for the same reasons in terms of mathematical description of the model the maximisation of social welfare will always lead to the minimisation of costs.

The choice of one optimisation step, meaning netting and activation of bids to satisfy upward and downward aFRR demands at the same time will enable distribution of the netting in the most economically efficient way. By this a global optimum for netting and aFRR activation is ensured. The potential of netting is actually always maximised whether a one-step or a two-step optimisation approach is used. It will only result in a different distribution between the participating TSOs. The main advantage of one step optimisation is that the distribution of the netting potential is always performed implicitly according to costs minimisation objective: in other words, the algorithm would net the demands according to the highest priced bids in priority. With two optimisation steps, the distribution of the netting potential will always be performed according to arbitrary rules (e.g. pro rata of aFRR demands like IGCC) defined a priori and leading to potential misuse of CZC and sub-optimal distribution of the netting potential between the participating TSOs. Additionally, having two separate optimisation steps for netting and activation will greatly increase the complexity of the general optimisation problem when the rules of priority access to the submitted volume to the platform would have to be taken into account, since netting and activation shall always be performed respecting priority access to control areas, LFC blocks, etc. The more complex the LFC structure, the more optimisation steps should be performed, leading to complex architecture, additional arbitrary rules and sub-optimal solutions.

Since the objective and the nature of the two real time processes of aFRR and IN are different, there might be a need for the TSOs to separate the processes into two optimisation steps. However, in the case of a transition period where the region of the aFRR-Platform does not match the region of the IN platform (e.g.

in case of derogation) the inclusion of both processes in one activation optimisation function is beneficial. For this purpose two separate optimisation steps for netting and activation are useful. This would also be the case if non-EU TSOs decide to join the IN platform but not the aFRR-Platform

The optimisation algorithm shall consider the process responsibility structure of the participating synchronous areas: i.e. the hierarchisation of the participating synchronous area including LFC areas with their borders shall be taken into account. The different configurations of common procurement and/or exchange or sharing of reserve within/or between LFC blocks shall always be respected from a system operation security perspective.

In the algorithm this means that when all demands are satisfied, not any specific rules (additionally to social welfare maximisation and cross border minimisation) shall apply. However, in the event of unsatisfied demands:

- The LFC areas which form one LFC block and perform common dimensioning shall have priority access to the offered aFRR balancing energy bids and transmission capacity inside the LFC block.
- The LFC areas which form one control area shall have priority access to the offered aFRR balancing energy bids and transmission capacity inside the control area.
- LFC blocks performing common procurement or sharing of reserves shall have priority access to at least the commonly procured or shared volume.

For this purpose, prioritisation rules will be set up accordingly in the algorithm to guarantee a distribution of the unsatisfied demands in compliancy with the LFC structure of the participating synchronous areas. The distribution of unsatisfied demands could be performed in one optimisation step.

Finally, the algorithm will aim at minimising aFRR exchanges, everything else being equal, meaning that when several solutions provide the same level of social welfare maximisation, the chosen solution will be the one which distributes the netting and activation of bids ensuring the lowest possible usage of CZC for aFRR exchanges. This also applies to a solution where several bids are equal in pricing to the cross border marginal price. If the bids are located in different LFC areas then the activation of bids will be performed according to aFRR cross-border exchange minimisation. If the bids are located in the same LFC area then the activation will be performed according to local rules. This approach means not having to harmonise the distribution of activation case when prices are equal, which may depend on different local regimes and leads to a simplified objective function for the aFRR-Platform to guarantee better performance.

Finally, the AOF takes into account the following constraints:

- The power balance equation is a constraint formulated for each LFC area. The constraint ensures that for each LFC area, the cross border aFRR exchanges including implicit netting, the aFRR balancing energy bids selected for activation within the LFC area and the satisfied aFRR demand, are summed up to zero.
- The sum of all automatic frequency restoration power interchanges is equal to zero, meaning that every time the algorithm is used, the resulting aFRR balancing energy exchanges are such that they sum up to zero.
- The frequency restoration power exchange on a border shall not exceed the available cross-zonal capacity as explained in Chapter 5.6.

It is noted that the available cross-zonal capacity defined in the previous timeframes may be defined in a set of borders (see also Chapter 5.6). In such cases, the sum of the frequency restoration power exchanges on each of the borders or that set of borders should not exceed the available cross-zonal capacity.

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5.5. FRCE adjustment process

In the control demand model (see Chapter 5.1.1) the TSO-TSO exchange (the aFRR correction signal) is immediate with no ramping time. In practice, there is a delay between the TSO-TSO exchange and the actual delivery by the BSPs, mostly due to its physical ramping. The main objective of the FRCE adjustment process is to mitigate the impact of FRCE exchange on local TSO responsibilities.

As part of the AOF, the aFRR-Platform will develop a FRCE adjustment process in order to provide the different processes, including settlement processes, aFRR exchanges between countries that are more representative of the physical reality of the BSP delivery.

The main objectives this process shall fulfil are:

- Maintaining the local TSO responsibility for their LFC areas in regards to their own imbalanced volumes, and for the dynamic behaviour of their imbalance.
- Guaranteeing the financial and physical neutrality of the connecting TSO in regards to the financial settlement of unintended exchange process and the dimensioning requirements of each TSO.
- Ensuring that the connecting TSO is responsible in the event of under - delivery of the minimum requirements.
- Favouring each TSO to incentivise their BSPs to react faster than the minimum requirements.

The main constraints to be fulfilled by the FRCE adjustment process are:

- To respect the CZC constraints
- To respect the sum of all exchanges is always equal to zero

The FRCE adjustment process can be based on an adjustment of the induced FRCE methodology. The concept is further illustrated in Figure 13 and Figure 14. As mentioned in Subchapter 5.1.1 on the control demand model, the exchange of aFRR demand will be a step function, e.g., in the event of an outage. As effective aFRR delivery follows a certain dynamic, there will be FRCE induced by the aFRR demand exchanges, as illustrated by the orange areas in Figure 13 and Figure 14. The FRCE Adjustment process (FAP) will aim at determining the induced FRCE for each TSO and subtract the impact of the aFRR activation for cross-border purpose. The FAP will integrate the possibility of BSP providing a faster reaction compared to the aFRR FAT. In case of faster reaction, the requesting TSO will benefit from it and obtain a faster correction of its FRCE. In the event of non-compliant delivery due to a slow BSP (slower than the minimal requirement), the connecting TSO will remain responsible and the requesting TSO will receive a reaction corresponding to the minimum requirement.

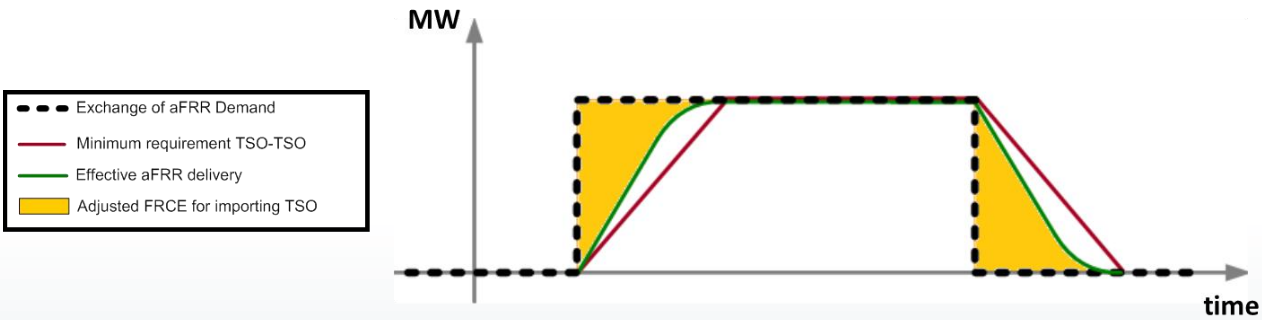

Figure 13: Example for FRCE adjustment volume and TSO-TSO exchange

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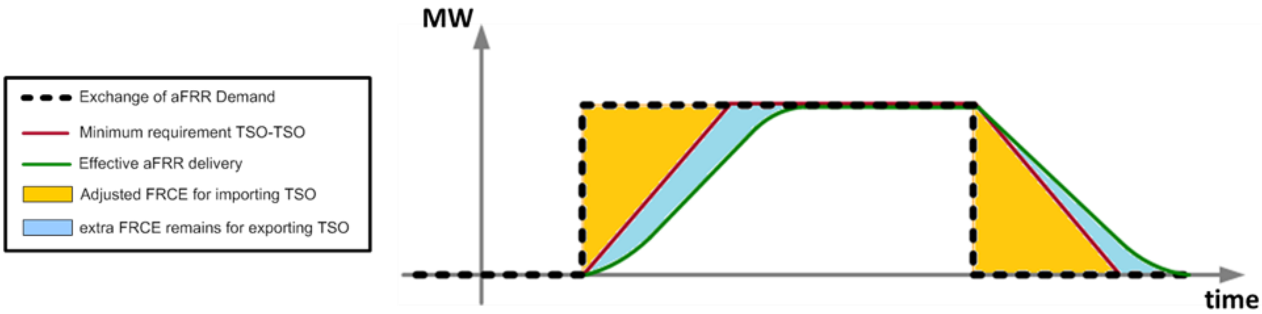

Figure 14: Example of FRCE adjustment volume and TSO-TSO exchange with non-compliant aFRR activation

The FAP will be included in a separate module of the aFRR-Platform that works sequentially after the AOF. Based on the aFRR correction signals for each TSO from the AOF, and the level of aFRR activation provided by each TSO, the module will provide FRCE values for each TSO induced by the aFRR activation for cross-border purposes. The adjusted FRCE reflects the FRCE caused by imbalances in the LFC area, i.e., the increase of FRCE due to the system´s inherent difference between the cross-border aFRR delivery and local activation of BSPs is compliant with the respective FAT and is compensated by the adjustment. The adjusted FRCE will be used for subsequent processes such as evaluation of the fulfilment of FRCE target values in accordance with SO-GL, settlement of unintended deviations, dimensioning etc.

During the transition period between the go live of the aFRR-Platform and the target for harmonisation of the FAT 5 min of the aFRR standard product in December 2025 the FAP will also be used to guarantee a minimum cross-border delivery corresponding to a FAT of 7.5 min (Chapter 4.1).

5.6. Congestion management (Art 10)

The available cross-zonal capacity is calculated in accordance with Article 37 of EBGL. Initially there will not be any harmonised recalculation of cross-zonal capacity after intra-day markets. Recalculation of the CZC for balancing is outside the scope of this proposal and will be performed at a later stage on a capacity calculation regional level, in accordance with Article 37 of EBGL which requires a common methodology to be defined 5 years after coming into force.

However, Article 36 of EBGL also provides the possibility of allocating CZC for the exchange of balancing capacity and sharing of reserves that need to be taken into account in the calculation of available CZC.

If parts of the whole European intra-day market are performed in a flow-based domain, an extraction of available cross-zonal capacity per bidding zone border will be used, comparable to the process between the market coupling in the CWE region and the succeeding intra-day market. The available cross-zonal capacity used for aFRR process will take into account previous balancing processes.

In more detail, the algorithm will consider available cross-zonal capacities defined between LFC areas and will make sure that the cross-border exchange of aFRR resulting from the optimisation does not exceed the available cross-zonal capacity.

In order to respect operational security limits and manage or avoid congested situations TSOs shall also be able to limit the available CZC. These additional limitations shall be published. If requested by the participating TSOs, the TSO applying these additional limitations will provide a justification. The algorithm is then required to take these manual limitations into account in the optimisation result.

Bidding zone borders inside an LFC area and the respective cross-zonal capacity limitations shall not be explicitly considered by the optimisation algorithm, for the reasons that the aFRR demand is defined and located per LFC area and it is not possible to calculate the inner-bidding zone cross-border flows in such a case.

If no cross-zonal capacity is defined between LFC areas of LFC blocks according to Commission Regulation (EU) 2015/1222 establishing a guideline on capacity allocation and congestion management (CACM GL), the available cross-zonal capacity on this border is considered infinite in default mode or equal to the respective IT Platform´s technical limit. The current thinking is that the technical IT limits are designed to implement a plausibility check on the ATC limits that are used as input by the AOF. The goal is to prevent the ATCs that are manifestly erroneous (due to IT or communication errors for instance) being used by the algorithm. Any value sent as an input would be capped to a certain value. This value will however not be limitative with respect to any realistic physical follows that could happen at this border. Typically the maximum physical capacity of the border could be used to cap the ATC sent. As the borders have a very different physical capacities and different natures, it is seen as more efficient to define a border specific plausibility check instead of a single IT technical limit for all borders. The TSO will agree on the more detailed values in such a way that the values are not limiting for the market.

To summarise this textual description, the following figure illustrates the potential configuration cases:

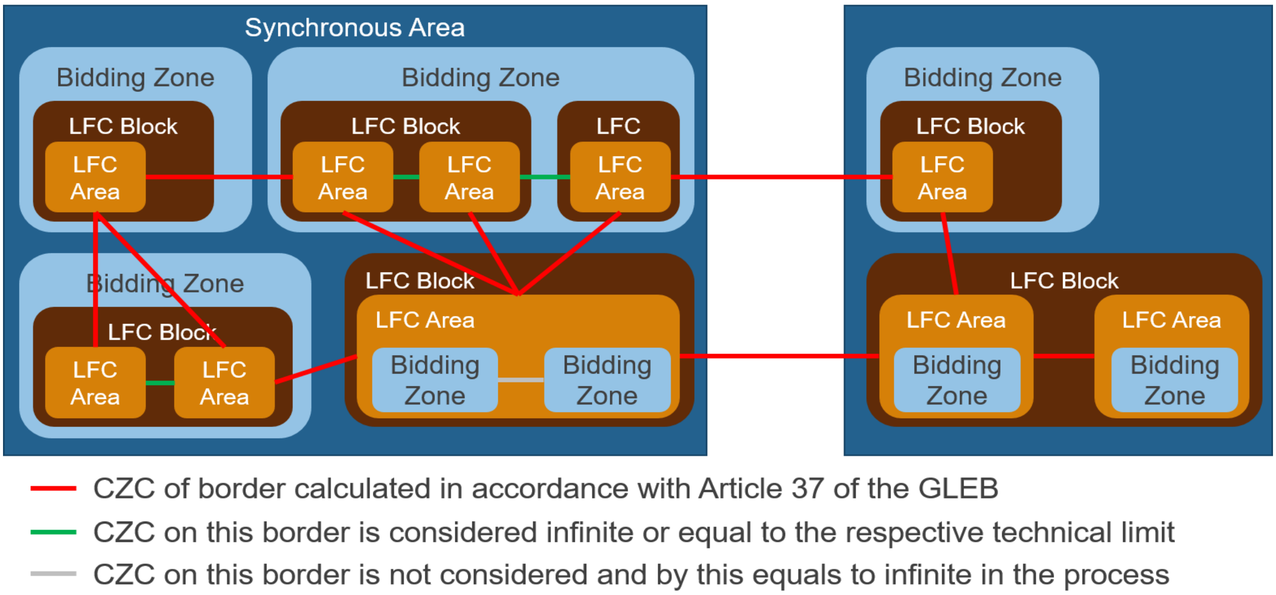

Figure 15: Example LFC structure configuration for participating synchronous areas

(a) A bidding zone can consist of one LFC block which consists of one LFC area (e.g. France)

(b) A bidding zone can consist of one LFC block with more than one LFC areas (Germany after the bidding zone split with AT and neglecting DK1)

(c) A bidding zone can consist of more than one LFC block and each of the LFC block can have more than one LFC area (bidding zone of Germany and Austria before the bidding zone split)

(d) A LFC block can consist of one LFC area which includes more than one bidding zone (Italy, current NORDIC configuration)

(e) A LFC block consists of more than one LFC area where each LFC area equals one bidding zone (future NORDIC system)

For the illustrated configurations the CZC is initially defined as follows:

1. The CZC between bidding zones (red links) is calculated in accordance with Article 37 of EBGL.

2. CZCs within bidding zones (green links) are considered infinite or equal to the respective technical limit.

3. CZC between bidding zones within a LFC area (grey links) cannot be considered by the AOF and are as such considered as infinite in the AOF.

4. If a technical profile on the sum of several borders[3] is defined in the intra-day market, such limits will also be taken into account in the AOF.

CZC will be used as the main constraints of the objective function of AOF and in the event of congestion, several uncongested areas will be defined with associated impact on cross border marginal prices.

CZC updated values will be provided to aFRR-Platform in real time on a local control cycle basis.

In case of CZC between TSOs, TSO can choose one of both to send the CZC values in real time. If both TSOs want to send the CZC values in real time, then the minimum value of CZC will be used by AOF.

In a downgraded situation, when no other measures are feasible, participating TSOs responsible for sending the CZC will have the possibility of reducing the CZC values manually in real time (requested individually or by any affected TSO for operational limitation in accordance with Article 150 of the SO-GL), in the event of congestion or constraint link to a CZC border.

In order to deal with local congestion, a participating TSO may have the possibility of marking bids unavailable in the common merit order lists between the BEGCT and the real time. This is a measure for which no additional mechanism in the algorithm and harmonisation is considered necessary by the TSOs.

The need for any other congestion management measures that might be raised in future (e.g., a flow based congestion management approach) will be fully justified by the TSOs as well as their impacts on settlement rules. This may require an update of the implementation framework.

5.7. Exchange of aFRR energy between synchronous areas

The exchange of aFRR energy between synchronous areas is also covered by the PICASSO project. Currently the TSOs are investigating whether HVDC over synchronous areas could be considered normal AC borders within a synchronous area from a FRCE adjustment perspective.

Two main technical complexities are under investigation:

- for each HVDC over synchronous areas, the kind of available CZC shall be defined and be taken into account by the algorithm; and
- the aFRR exchange over the HVDC shall be as close as possible to the aFRR delivery of the BSPs within each synchronous areas in order to neutralise the impact on frequency of each participating synchronous area.

For the second point TSOs are already considering a particular monitoring of aFRR exchange with possible additional overall limits if judged necessary after further investigations.

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[3] Such technical profiles are defined (at least) on the borders out of Poland; from NO2 and NO5 into NO1; and from NO2 and SE3 into DK1

6. Governance of the aFRR-Platform

As indicated in Chapter 3, the PICASSO platform will become the aFRR-Platform. The current chapter describes the governance of the aFRR-Platform as proposed in the aFRRIF in Articles 11-14. This includes the following topics:

- Entities operating the business functions;
- Decision processes;
- Cost-sharing arrangements.

6.1. Entities

Article 21(4) of EBGL requires the designation of entities to operate the business functions of the platform by all TSOs (through ENTSO-E) six months after the approval of the aFRRIF. In Article 11 of the aFRRIF it is proposed that these entities can only be one or more TSOs or one or more companies that are owned by TSOs.

As the balancing processes are real-time processes that are key to a stable system operation, it is important to keep the responsibility for these processes with the TSO. The aFRR-Platform directly interfaces with the TSO systems operating the load-frequency control and will as such form an integral part of the balancing processes. For this reason the platform functions are required to be operated by TSOs, either directly or indirectly.

6.2. Decision processes

In order to implement and operate the aFRR-Platform, the member TSOs of the PICASSO project are required to make decisions on a wide variety of topics. In doing so, TSOs will aim for unanimity and will focus on good communication and the processes that facilitate that aim. It is important for all concerns to be taken seriously, as local arrangements may differ and the effects of different choices may not be apparent at first.

However, if unanimity is not possible, for example due to conflicting local needs, qualified majority voting will be used. The qualified majority voting principles are modelled after those given in the EBGL, although voting is in principle done by member TSOs. This includes member TSOs who are not participating TSOs. This would also include non-EU TSOs that are member TSOs.

In case of a vote, a quorum of at least 2/3 of the TSOs involved in the vote is required. Requiring a quorum ensures that each party is aware of the voting process, and that the argumentation of all parties can be taken into account in a proper way in the decision process.

The decision process described above for member TSOs is without prejudice to the provisions of the EBGL. This means that the decisions on the formal deliverables of the EBGL (such as the decision on the aFRRIF) is taken according to the All TSOs' decision process described in the EBGL. All TSOs of the European Union will then take part, whether or not they are members of the PICASSO project.

6.3. Cost sharing

When sharing the costs of establishing, amending and operating the aFRR-Platform, a distinction is made between:

- common costs;
- regional costs;

- national costs,

Article 14 of the aFRRIF gives a detailed overview of which costs fall under which header. Common costs include the costs for implementation and operation of the aFRR-Platform, while national costs include development of national infrastructure to be able to connect to the platform. Regional costs can also include costs for implementation of the aFRR-Platform, when specific implementation aspects are only relevant for a specific region. It can also cover the costs of regional studies.

Common costs shall always result from a decision of the member TSOs of the aFRR-Platform. Costs made prior to January 2018 shall not be shared or considered as historical costs.

It is important to note that only participating TSOs will take part in sharing the common costs for operating and hosting the aFRR-Platform. Member TSOs that do not use the platform do not contribute to operational costs. Common costs are shared between members TSOs or participating TSOs as relevant in a manner that is consistent with the principles set out in Article 23(3) of EBGL:

- one eighth of common costs shall be divided equally between each Member State and the third country;
- five eighths of common costs shall be divided proportionally to the consumption of each Member State and the third country; and
- two eighths of common costs shall be divided equally between member TSOs or where applicable participating TSOs.

Sharing of regional costs is decided upon in accordance with the regional decision process described above.

7. Annex I: aFRRIF mapping

This Annex gives a cross-reference between the articles of the aFRRIF and this document, indicating the chapters where more information can be found.

Article 1 Subject matter and scope	Chapter 1, 2, 3.2
Article 2 Definitions and interpretation	N/A
Article 3 High-level design of the aFRR-Platform	Chapter 5.1, 5.2
Article 4 The roadmap and timeline for the implementation of the aFRR-Platform	Chapter 3
Article 5 Functions of the aFRR-Platform	Chapter 5.1, 5.7
Article 6 Definitions of standard aFRR balancing energy product	Chapter 4.1, 5.5
Article 7 Balancing energy gate closure time for the standard aFRR balancing energy product bids	Chapter 4.2
Article 8 TSO energy bid submission gate closure time for the standard aFRR balancing energy product bids	Chapter 4.2
Article 9 Common merit order lists to be organised by the activation optimisation function	Chapter 5.3
Article 10 Description of the optimisation algorithm	Chapter 5.4, 5.5, 5.6
Article 11 Proposal of entities	Chapter 6
Article 12 Governance	Chapter 6
Article 13 Decision-making	Chapter 6
Article 14 Categorisation of costs and detailed principles for sharing the common costs	Chapter 6
Article 15 Framework for harmonisation of terms and conditions related to aFRR-Platform	Chapter 4.3
Article 16 Publication and implementation of the aFRR-Platform	N/A
Article 17 Language	N/A

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8. Annex II: Abbreviations

The following abbreviations have been employed in this document.

ACER	Agency for the Cooperation of Energy Regulators
aFRR	Automatic Frequency Restoration Reserves
AOF	Activation Optimisation Function
BEGCT	Balancing Energy Gate Closure Time
BEPP	Balancing Energy Pricing Period
BRP	Balancing Responsible Party
BSP	Balancing Service Provider
CACM	Capacity Allocation and Congestion Management
CBA	Cost-Benefit-Analysis
CCGT	Combined Cycle Gas Turbine
CMOL	Common Merit-Order List
CZC	Cross-Zonal Capacity
DFD	Deterministic Frequency Deviation
EBGL	Guideline on Electricity Balancing
FAT	Full Activation Time
FRCE	Frequency Restoration Control Error
FRP	Frequency Restoration Process
FRR	Frequency Restoration Reserves
GLSO	Guideline on System Operation
HVDC	High Voltage, Direct Current
IGCC	International Grid Control Cooperation
ISP	Imbalance Settlement Period
mFRR	Manual Frequency Restoration Reserves
MOL	Merit-Order List
MP	Marginal Price
RR	Replacement Reserves
RRP	Replacement Reserves Process
TSO	Transmission System Operator
XB IP	Cross-border Imbalance Pricing
XB MP	Cross-border Marginal Pricing

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