INDEPENDENT POWER TRANSMISSION OPERATOR

High-level design of the aFRR process in the Greek balancing energy market for participation in the European aFRR platform, PICASSO, for the exchange of balancing energy from frequency restoration reserves with automatic activation

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1 Abbreviations

ACE	Area Control Error
aFRR	FRR with automatic activation
aFRR IF	Implementation framework for the European platform for the exchange of balancing energy from frequency restoration reserves with automatic activation
AGC	Automatic Generation Control
AOF/INF	Activation optimisation function / Imbalance netting function
BMR	Balancing Market Rulebook
BSE	Balancing Service Entity
BSP	Balancing Service Provider
BSP aFRR GCT	Gate Closure Time for aFRR bids submission by BSPs to the TSO
CBCL	Cross-border Capacity Limits
CBMP	Cross-border Marginal Price
CMOL	Common Merit Order List
CMOL	Common Merit Order List
CSP	Common Service Provider. It is a TSO that provides a common service (e.g. the PICASSO platform) to all other participating TSOs.
CZC	Cross-zonal Capacity
EBGL	Regulation (EE) 2017/2195 (Electricity Balancing Regulation)
FCR	Frequency Containment Reserve
FRR	Frequency Restoration Reserves
GCT	Gate Closure Time
IGCC	The International Grid Control Cooperation
ISP	Integrated Scheduling Process
LFC Area	Load Frequency Control Area
LMOL	Local Merit Order List
LMOL	Local Merit Order List
mFRR	FRR with manual activation
MTU	Market Time Unit
PCorr	Corrected aFRR demand for local activation, after AOF/INF optimization
PICASSO	Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation
TSO aFRR GCT	Gate Closure Time for LMOL submission by the TSO to PICASSO platform

WD	Working day

2 Introduction

This document presents the high-level design of the participation of the Hellenic Balancing Energy Market (specifically regarding the aFRR balancing energy) to the “Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation” (PICASSO). The Greek participation in this platform is mandatory as per Regulation (EE) 2017/2195 (EBGL), art.21 and ACER Decision 02/2020 (“ACER Decision on the Implementation framework for aFRR Platform”).

The PICASSO platform is an ambitious project involving more than 30 European TSOs as presented in the map below.

30 TSOs + ENTSO-E (Observer)		
PICASSO Members (26 TSOs)		PICASSO Observers (4 TSOs + ENTSO-E)
Austria	Hungary	Latvia
Belgium	Italy	Lithuania
Croatia	The Netherlands	Estonia
Czech Republic	Norway	North Macedonia
Denmark	Poland	ENTSO-E
Finland	Portugal	
France	Romania	
Germany	Slovak Republic	
	Slovenia	
Sweden	Spain	
Bulgaria	Greece	
Switzerland	Luxembourg	

FIGURE 1[1]: PICASSO IMPLEMENTATION PROJECT

Pursuant to the provisions provided in article 62 of the EBGL, IPTO has requested a derogation from the provisions of art. 20(6) of EBGL concerning the implementation of the PICASSO platform for two years from the legal go-live date (July 24, 2022). Participation in the PICASSO platform is a highly challenging project that requires significant and extensive modifications to systems, infrastructure, and procedures that affect both the scheduling and the real-time processes, as well as to the terms and conditions of market participation. RAE, with its Decision 363/2022, granted IPTO the requested derogation deadline, i.e., until the 24th of July 2024.

[1] ENTSOE: https://www.entsoe.eu/network_codes/eb/picasso/

The aFRR-Platform Accession roadmap for all relevant TSOs is presented below.

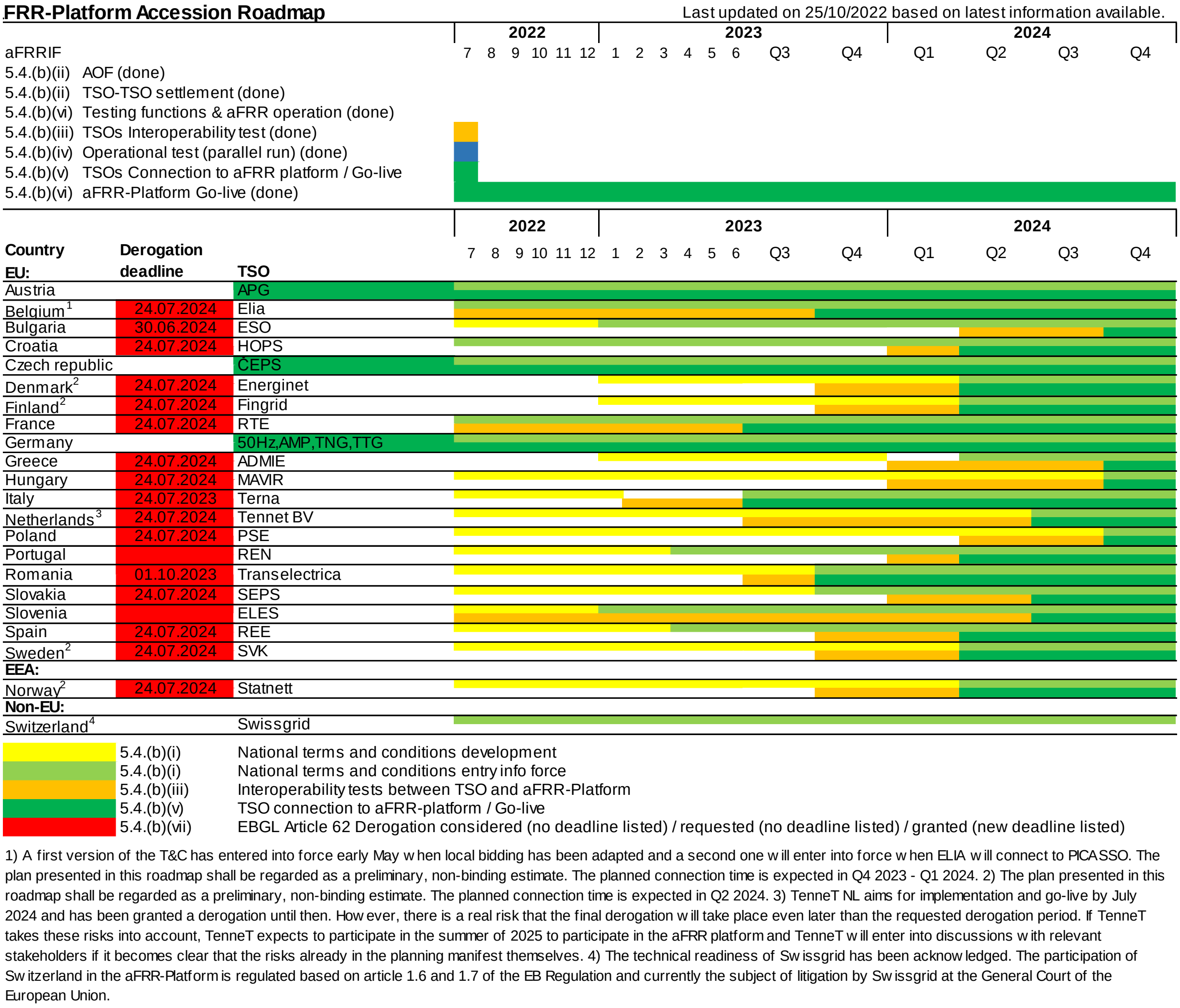


Figure 2[2]: aFRR-Platform Accession Roadmap

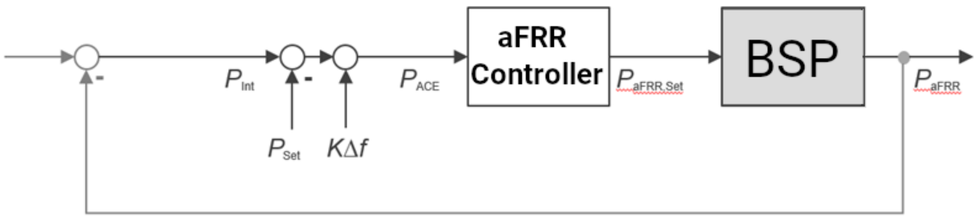
Any change in systems, infrastructure, procedures and terms and conditions requires careful planning, adequate consultation with market participants, and, of course, testing, to avoid affecting the smooth functioning of the balancing market and the operational security of the system. Given the magnitude of the modifications required and the fact that competition will increase from the participation of all power resources among Europe in a common market for balancing, sufficient time is needed for market participants to be informed and prepared.

[2] 221025_PICASSO_6th_Accession_roadmap_ext.pdf

3 General description of PICASSO

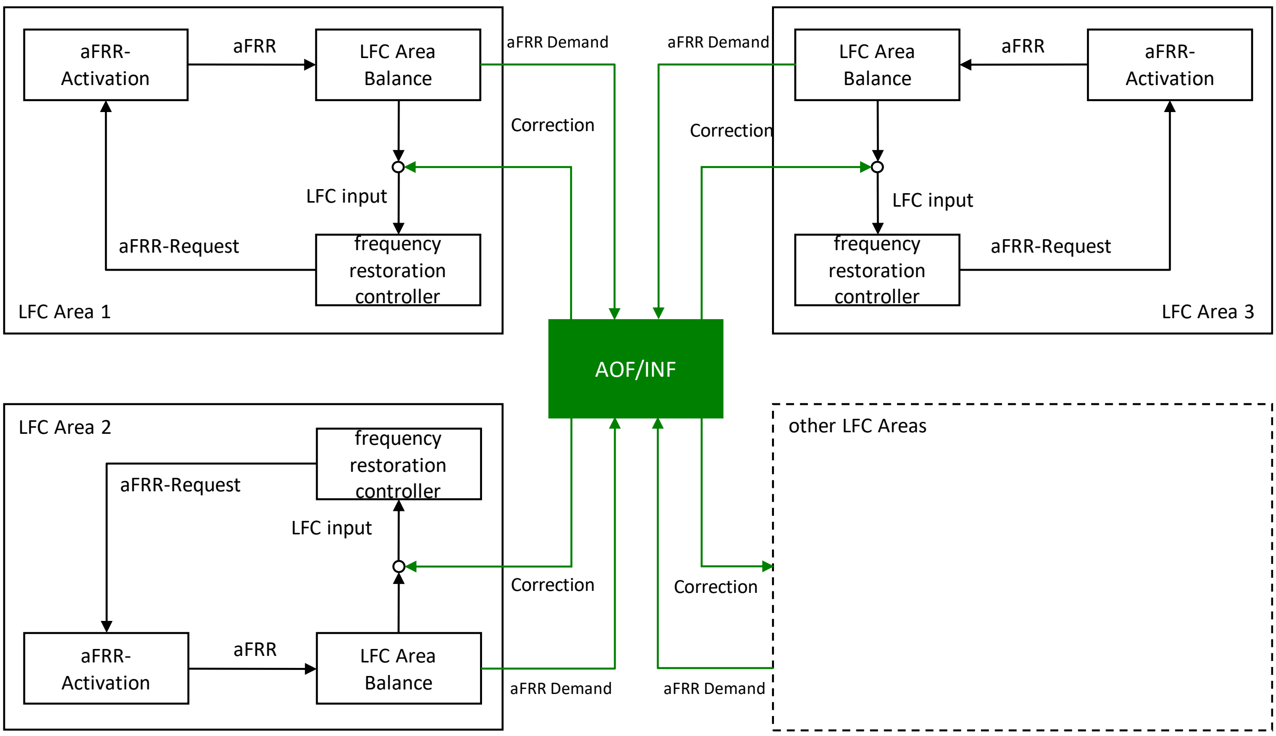
The Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation (PICASSO) is the implementation project endorsed by all TSOs to establish the European platform for the exchange of balancing energy from frequency restoration reserves with automatic activation or aFRR-Platform. Participation in PICASSO will facilitate cross-border activation of aFRR to maximize the economic surplus of all participating LFC Areas.

Currently, aFRR activations are triggered automatically for each LFC Area based on its ACE. The ACE is calculated based (i) on the difference between the total interconnector active power flow and the control program and (ii) the FCR activations in the LFC Area (KΔf). Afterwards, the local aFRR Controller calculates the control target and sends the control request to the BSPs.



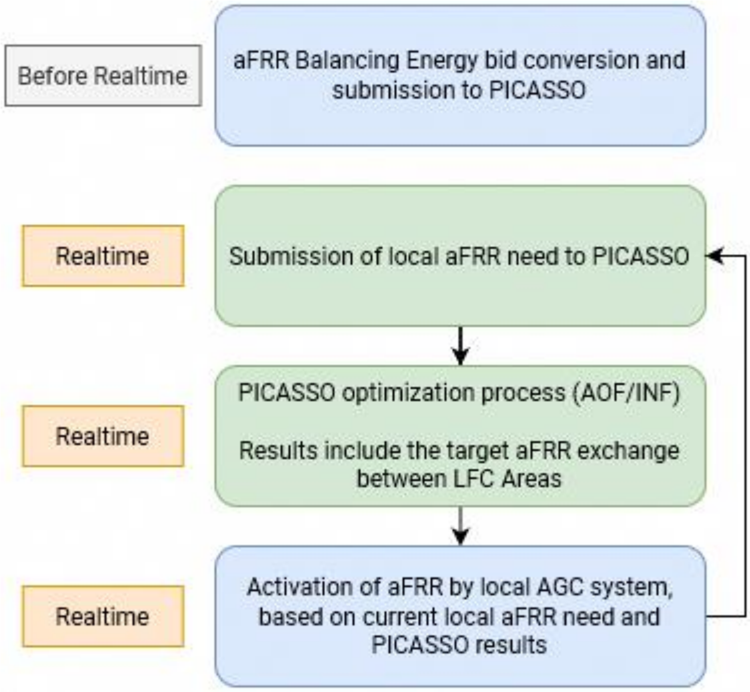
Control demand model

Following participation in PICASSO, the aFRR activation process shall be modified to consider a correction signal that corresponds to the PICASSO optimization (AOF/INF) results which reflect aFRR exchange with other LFC Areas.



aFRR activation in multiple LFC Areas under PICASSO

A simplified diagram of the process of aFRR activation using the PICASSO platform is presented below.



4 aFRR energy bids

4.1 aFRR energy standard product characteristics

The characteristics of the standard product bids for aFRR are specified according to the provisions of article 25(1) of the EBGL and article 7 of the aFRR IF. The main characteristics of the standard aFRR product and the current local product are presented below:

Bid Characteristics	Description	Current Local Product	Standard aFRR product
Full Activation Time	The time period between the activation request by TSO and the corresponding full activation of the standard product.	7.5 minutes	5 minutes
Minimum bid size	The minimum bid size of the energy bid volume offered.	1 MW	1 MW
Maximum bid size	The maximum bid size of the energy bid volume offered.	limited by BSE max capacity	limited by BSE max capacity, up to 9,999 MW
Granularity	The possible increment of bids above the minimum bid size.	0.1 MW	1 MW
Maximum Price	The maximum price of the standard balancing energy product bid.	+9.999 EUR/MWh	99,999.00 EUR/MWh
Minimum Price	The minimum price of the standard balancing energy product bid.	-9.999 EUR/MWh	- 99,999.00 EUR/MWh
Price resolution	The minimum resolution for the price of the standard balancing energy product bid.	0.01 EUR/MWh	0.01 EUR/MWh
Validity Period	The time when the balancing energy bid offered by the BSP can be activated, whereas all the characteristics of the product are respected. The amount of time for which a bid is valid and firm. The first validity period of each day begins right at 00:00 market time. Validity periods are consecutive and not overlapping.	15 minutes	15 minutes
Direction	Positive or negative		
Volume	MW		
Price	EUR/MWh		
LFC Area	IPTO LFC Area		
Divisibility	aFRR balancing energy bids are fully divisible.		
Activation/deactivation	aFRR balancing energy bids can be activated and deactivated at any moment within the bids' validity period,		
Minimum delivery time	There is no Minimum delivery time		

In addition to the above, some product characteristics are not harmonized within PICASSO, but can be decided at a national level.

4.2 aFRR energy local product characteristics

Following participation in PICASSO, local aFRR bid characteristics submitted in the LMOL will be harmonised with the aFRR standard product characteristics. However, in order to take into account the differences between the various local markets, some aFRR product bid characteristics may be decided at a national level in the terms and conditions for BSPs. This is foreseen to ensure TSOs securely manage the system while, at the same time, guaranteeing liquidity for the aFRR-Platform. The deactivation period and the maximum duration of the delivery period will be defined individually by each TSO in accordance with their terms and conditions for BSPs.

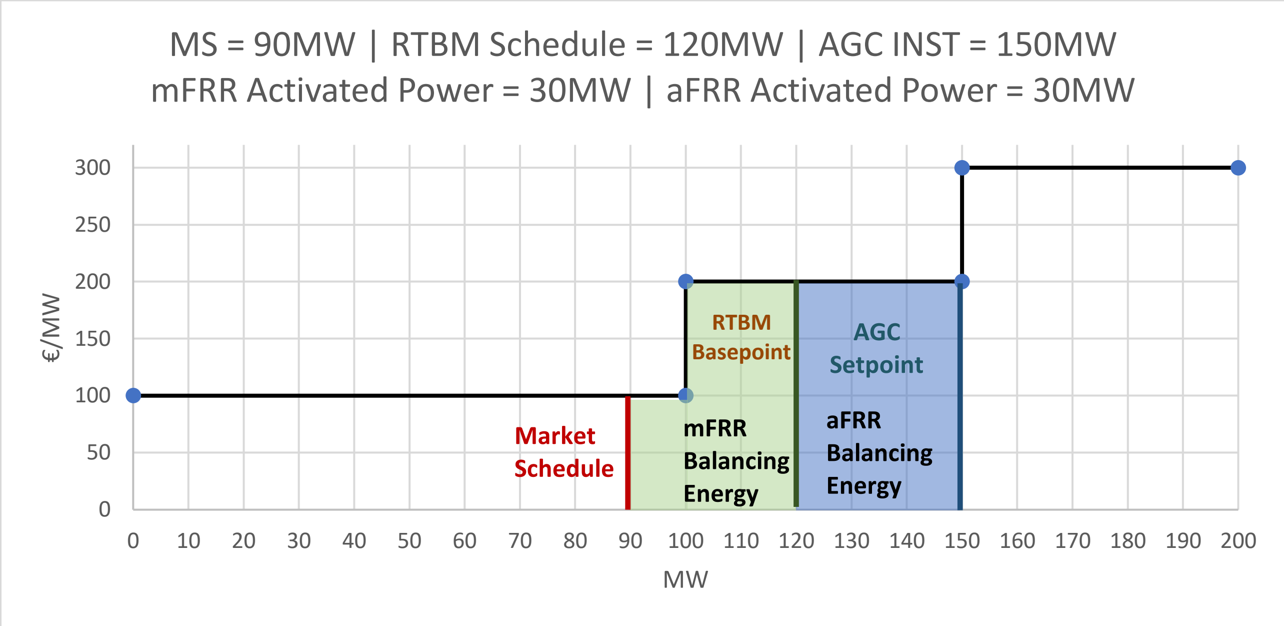
The bid structure is as follows:

i. Bids will contain price-volume pairs that refer to the energy cost (in €/MWh) of the offered aFRR Power (in MW).
ii. Total bid volume (aggregation of all bid steps) should not exceed the maximum aFRR Capacity of the BSE, as declared in the standing data.
iii. Only fully divisible bids are allowed.

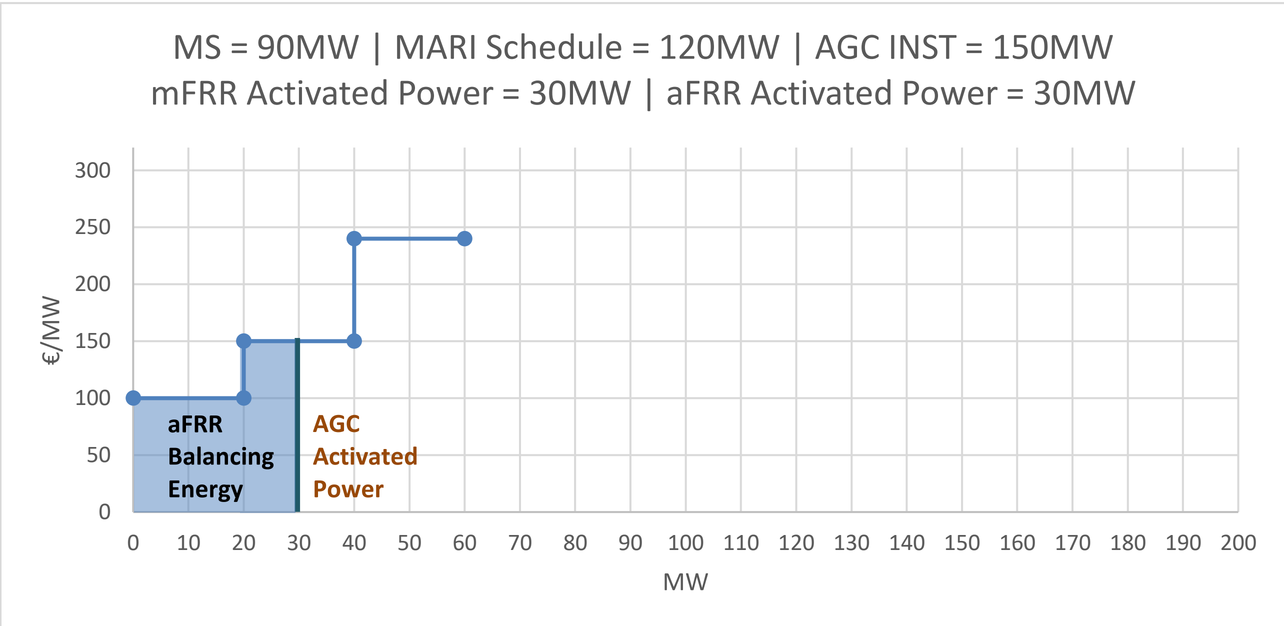
According to art. 7 of the mFRR IF, both upward and downward mFRR energy bids have a price resolution of two decimals, i.e., 0.01 €/MWh and price of the bid can be positive, zero or negative. In addition, according to the Technical Decision "Technical limits for bidding prices and clearing prices in the Balancing Market", after inclusion of IPTO in one of the European platforms, MARI or PICASSO, and up to 48 months after the legal deadline envisaged in EBGL, the maximum and minimum prices limits set for bidding prices and clearing prices for balancing energy should be equal to +15.000€/MWh and -15.000€/MWh accordingly. After the 48 months period the maximum and minimum limits set for bidding prices and clearing prices for balancing energy should be equal to +99.999€/MWh and -99.999€/MWh.

In contrast to the current aFRR bid format, the volume of the aFRR energy bid when IPTO joins PICASSO will be equal to the technical capability of the BSE to provide aFRR. Moreover, the selection of the bid will start from the point of 0 MW, according to the following example regarding a BSE with a Market Schedule of 90MW, an mFRR activation of 30 MW (MARI schedule of 120MW) and an aFRR activation of 30MW upwards aFRR.

- In the current market, the aFRR bid concerns the range from 0MW up to the Technical Maximum of the BSE (200MW in this example) and the part of the bid that is taken into consideration is the part starting from the RTBM basepoint and up to the AGC setpoint.



- Under PICASSO, the aFRR bid concerns the technical capability of the BSE to provide aFRR (60 MW in this example) and the part of the bid that is taken into consideration starts from 0 MW up to the AGC setpoint.



4.3 Submission of available aFRR energy bids to PICASSO

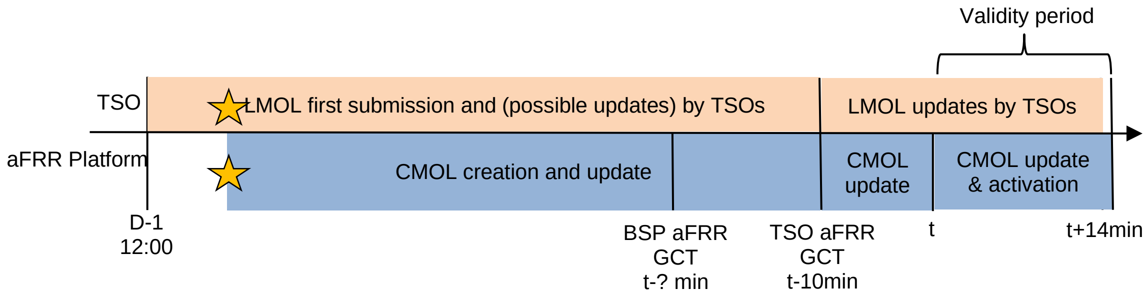
Each LMOL is created after the BSP aFRR GCT and submitted to PICASSO up to 10 minutes before the start of its validity period.

An LMOL may be complete or incremental:

- **Complete LMOL:** contains all valid bids for the respective validity period and replaces previously submitted LMOLs. It is possible to modify, add or remove bids compared to the previous LMOL.
- **Incremental MOL:** contains only bids which shall be changed in comparison to previously submitted LMOLs. It is possible to add and modify bids; however, it is not possible to remove bids compared to the previous LMOL.

In case of outages or other events that can lead to a bid being unavailable for activation (e.g. due to activation of the BSE bids in MARI, being suspended or disconnected from the AGC, etc.), this bid is flagged as unavailable, the LMOL is amended and resubmitted to PICASSO without delay. If an amendment to an LMOL is required after TSO aFRR GCT, only the availability status and the volume of bids may be amended. In that case, the TSO must also submit a Bid Availability Market Document that includes the amendment and the reason for this change. This information will be published by PICASSO. After each submission or resubmission of an LMOL, PICASSO acknowledges its successful receipt and subsequently combines all valid LMOLs into a common list that incorporates all submitted data from all participating TSOs. This list is named CMOL (combined merit order list) and is used from PICASSO to optimize aFRR activation.

The LMOL submission and the respective CMOL creation processes timings are shown in the following picture:



4.4 Non-contracted aFRR balancing energy bids

Currently, aFRR Balancing Energy is provided only by the BSEs that have been awarded aFRR Balancing Capacity in the ISP. Following participation in PICASSO, provision of aFRR by non-contracted BSEs is also being considered, i.e. BSEs will have the right to provide aFRR Balancing Energy even if they were not awarded aFRR Balancing Capacity (submission of non-contracted balancing energy bids).

The main principles for provision of aFRR by non-contracted BSEs are the following:

- All prequalified for aFRR provision BSEs may submit non-contracted aFRR balancing energy bids for voluntary aFRR provision.
- Submission of non-contracted aFRR Balancing Energy bids is allowed for BSEs that have already been awarded aFRR Balancing Capacity for the remainder of their available aFRR capacity.

- Submission of non-contracted aFRR Balancing Energy bids, for their available aFRR capacity, is allowed for BSEs that have not been awarded aFRR Balancing Capacity.
- Activation of non-contracted aFRR bids will be remunerated for the provision of aFRR Balancing Energy with the same rules as contracted aFRR bids.
- Non-contracted balancing energy bids will not be remunerated for Balancing Capacity.
- BSPs have to submit non-contracted aFRR Balancing Energy bids before the relevant BSP aFRR GCT.

An indicative procedure to manage non-contracted aFRR bids is described below:

- The selection among contracted and non-contracted aFRR balancing energy bids will be performed on an hourly basis.
- BSEs willing to provide non-contracted aFRR for each hour shall submit aFRR balancing energy bids to IPTO ahead of time. For each hour, IPTO will select the most economic bids corresponding to the aFRR Balancing Capacity need for the hour. These bids will be available for activation in real time for the specific hour.
- IPTO may reject non-contracted aFRR balancing energy bids providing a justification in case of rejection.

5 Conversion to standard aFRR energy products

For an MTU (15 minutes period) a selection process is required in order to identify the bids that are available for activation. The selection process is presented below. A bid (or bid part) from a BSE is considered available if in a given MTU:

i. The BSE is synchronized (for those BSEs that synchronization is relevant) and not scheduled to start-up, shut-down or transition to another configuration.

ii. The BSE is not in commissioning or testing operation.

iii. The bid part concerns activation of upward aFRR energy up to the AGCmax of the BSE.

iv. The bid part concerns activation of downward aFRR energy not below the AGCmin of the BSE.

v. The bid part concerning activation of aFRR energy in any direction is less or equal to the maximum aFRR capacity of the BSE.

vi. The bid part concerns activation of aFRR energy that would not violate any applicable constraints (e.g. network constraints, mandatory water constraints etc.). In case a constraint is applicable to a group of BSEs instead of a specific BSE, only the most economic bid parts with an aggregate volume up to the constraint are considered available from these BSEs.

vii. The bid part concerns activation of aFRR energy up to the aFRR quantity selected by the process described in section 4.4.

For each MTU, following the above selection process, all the aFRR energy bid steps considered available are sorted based on their price, and combined into a merit order list (Local Merit Order List – LMOL) for each direction (upward, downward). Each LMOL can concern only one MTU.

In accordance with the EBGL (article 29) and the aFRR IF (article 9) it is possible to mark specific bids as unavailable for activation due to internal congestion or due to operational security constraints. These bids will be included in the LMOL but will not be available for activation from PICASSO.

6 aFRR Cross-Zonal Capacity Limits

6.1 Limits per LFC Area border

The activation of aFRR from other LFC Areas to cover local needs is limited by the cross-border capacity limits (CBCL) which depend on the interconnecting lines. This information is an input to the PICASSO platform. This information will be provided to PICASSO centrally for all LFC Areas from the Capacity Management Module (CMM). Until the CMM is operational, IPTO will send the CBCL for each border adjacent to its LFC Area to PICASSO, considering the available capacity after the Intraday market results and considering all cross-border schedules and reserved capacity. The PICASSO platform expects CBCLs to be provided via real-time signals and does not process any scheduled values.

Temporary additional restrictions related to operational safety (according to SOGL 149 (3)) can be specified. The same applies to (permanent) HVDC restrictions if applicable. The submission of negative CBCL values to enforce a flow is not allowed.

For each border, the CBCL is provided by the two TSOs that are responsible for the adjacent LFC areas. The AOF will use the minimal value of the CBCL received from these two TSOs. By this, it is ensured that each TSO can unilaterally set effective additional limits for the interchange on these borders.

6.2 Profile Limits

In addition to CBCLs, limits can be provided in the form of net profiles or directed profiles that limit the total flow on a predefined set of borders (e.g. all borders surrounding a given LFC area, LFC block or any other arbitrarily defined region).

- A net profile can be used to limit the net position (net of import and export flows) of a region and does not block transit flows through the region.
- A directed profile limits the total import or export of a region without taking into account flows in the opposite direction. Directed profile limits can be used to effectively limit transit flows.

6.3 Other CZC limits

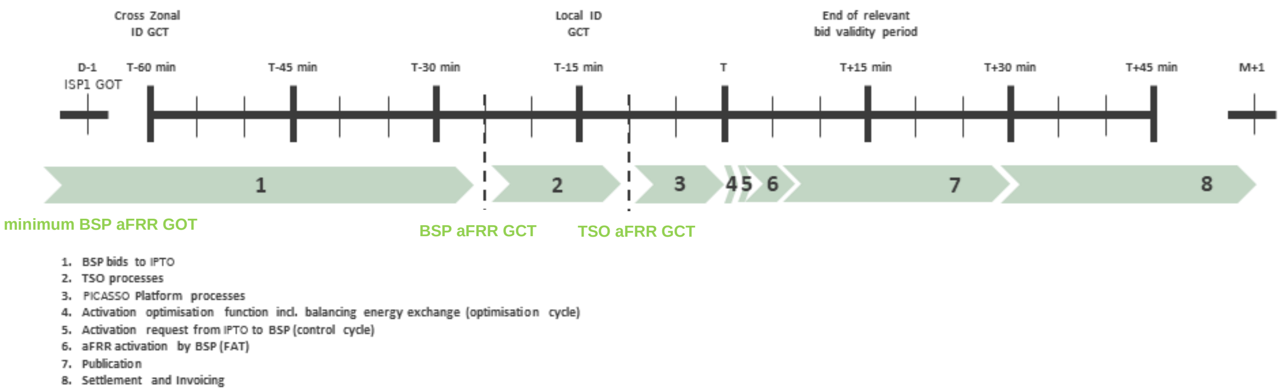
Ensuring operational security remains the responsibility of IPTO for its control area. The “affected TSO procedure”, described below, is implemented to fulfil the requirements from SOGL to implement balancing platforms in a way that ensures operational security. Under the “affected TSO procedure”, an affected TSO is allowed to limit borders that are not under his responsibility. The TSOs shall strive to coordinate themselves as much as possible to avoid unnecessary and uncoordinated limitations.

7 Activation of aFRR

7.1 PICASSO process overview

1. Each BSE may submit to IPTO or update his aFRR bids starting from the BSP aFRR Gate Opening Time (BSP aFRR GOT) and up to the BSP aFRR Gate Closing Time (BSP aFRR GCT). The BSP aFRR GCT will be decided in the future, but it shall be not later than 20 minutes before the aFRR delivery time. The bids shall adhere to the specifications stated in section 4.
2. IPTO converts the BSE bids to standard aFRR product bids as specified in section 5 and submits them to the PICASSO platform before the TSO aFRR GCT, which is 10 minutes before the aFRR delivery time.
3. PICASSO validates and merges all received bids into a Common Merit Order List (CMOL), until the start of the aFRR delivery time.
4. During the aFRR delivery time which has a duration of 15 minutes:
    i. Each TSO informs PICASSO about the local aFRR Demand.
    ii. PICASSO, considering the CMOL, selects the offers that satisfy the total aFRR need across all LFC Areas in a way that maximizes social welfare, given cross-zonal capacity constraints.
    iii. PICASSO informs each TSO regarding the required aFRR power interchange (exchange of aFRR energy with LFC areas). The sum of the local aFRR demand and the received aFRR power interchange reflects the amount of aFRR which the individual LFC area should provide.
    iv. The local AGC system activates aFRR in the LFC Area in a market-based manner in accordance with the LMOL.
    v. The responsible BSEs activate the requested aFRR.
7. PICASSO publishes its results to the Transparency Platform 30 minutes after the aFRR delivery time.
8. The aFRR exchanges scheduled via PICASSO are settled between participating TSOs, in the following month.

A more detailed description of the aFRR activation procedure is presented in section 7.3.



7.2 Main information flows under PICASSO operation

No	Name	Description/Notes	Sender	Receiver	Frequency
1	TSO aFRR & IN participation status	Used to determine TSO participation in the next PICASSO AOF & INF run	TSO	PICASSO	real-time (on each change of state)
2	aFRR cross-border capacity limits	The aFRR CBCL for each of the aFRR balancing border the TSO is responsible for, as the export and the import limit for aFRR interchange. This function will be done via the CMM when it is implemented (see section 4.1)	TSO	PICASSO	real-time (each control cycle)
3	Profile limits	The profile limits for import and export for each managed profile. Profile limits can either be set to limit the total flow for either PICASSO, or IGCC, or both.	TSO	PICASSO	real-time (each control cycle)
4	LMOL	Local Merit Order List. May be updated after TSO aFRR GCT due to operational security reasons or locally conditional bids.	TSO	PICASSO	For each 15’ period, submission before TSO aFRR GCT.
5	Power transfer distribution factor (PTDF)	Not used by the AOF / INF for the optimization and capacity allocation, only to provide an estimation of the real flows on the borders of the TSO’s providing it. The PTDFs have an hourly resolution. Sent on a voluntary basis	TSO	PICASSO	Ideally hourly, at least on a daily basis
6	local aFRR demand	Provided for each LFC area. The local aFRR demand is defined as the sum of the already activated aFRR and the FRCE without the influence of the intended exchange of balancing energy resulting from the cross-border aFRP or INP	TSO	PICASSO	real-time (each local control cycle)
7	• Activated aFRR or • FRCE without the influence of cross-border aFRP and INP	Provided for each LFC area, negative for downward activation, positive for upward activation.	TSO	PICASSO	real-time (each local control cycle)

8	AOF & INF status	Status of the AOF and the INF (online, offline)	PICASSO	TSO	real-time & ex-post
9	TSO AOF & INF participation status	Participation status of all TSOs to the AOF & INF (online, offline)	PICASSO	TSO	real-time & ex-post
10	aFRR demand satisfaction	The satisfied and unsatisfied aFRR demand for each LFC area	PICASSO	TSO	real-time & ex-post
11	aFRR correction value & IN correction value	Provided for each LFC area. Values are negative for imports, positive for exports.	PICASSO	TSO	real-time (each optimization cycle)
12	CBMP	Provided for each LFC area. Used for TSO-TSO settlement and as input to the local TSO-BSP settlement.	PICASSO	TSO	real-time (each optimization cycle) and ex-post
13	Total aFRR interchange	Provided for each balancing border of each LFC area. (PICASSO & IGCC)	PICASSO	TSO	real-time (each optimization cycle)
14	IN interchange	Provided for each balancing border of each LFC area. (IGCC)	PICASSO	TSO	real-time (each optimization cycle)
15	Adjusted aFRR interchange	Provided for each LFC area. This is the estimation of actual import or export for the respective LFC area based on the activated aFRR. Values are negative for imports and positive for exports. (PICASSO)	PICASSO	TSO	real-time (each optimization cycle)
16	Adjusted aFRR for local purpose	Provided for each LFC area. This is the adjusted aFRR corresponding to the aFRR activation for local purpose of the LFC area(s). Values are positive for upward activation and negative for downwards activation.	PICASSO	TSO	real-time (each optimization cycle)
17	FRCE	Provided for each LFC area. Values are positive for power surplus (need for downwards aFRR) and negative for power deficit (need for upwards aFRR).	PICASSO	TSO	real-time (each optimization cycle)
18	Corrected demand (Pcorr)	Provided for each LFC area. Values are negative for power surplus (need for downwards aFRR) and positive for power deficit (need for upwards aFRR).	PICASSO	TSO	real-time (each optimization cycle)

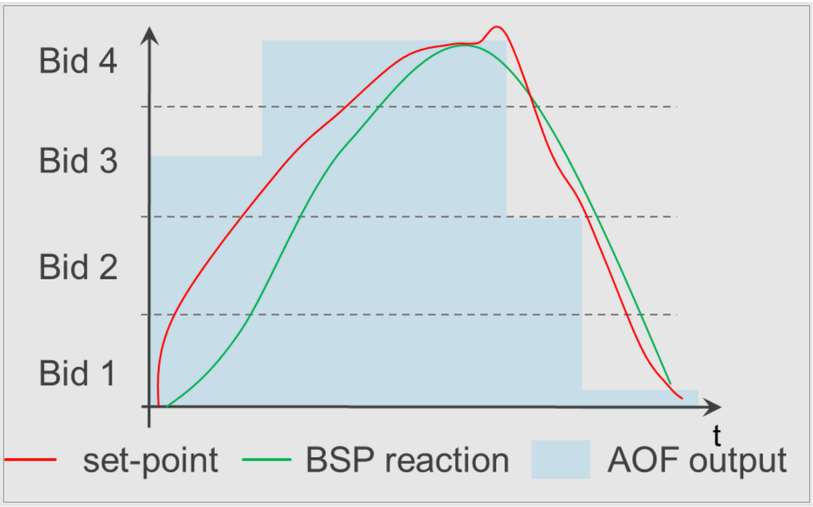
		This value can be used in the local AGC system for dynamic limitation of the LFC output.			

7.3 Local Activation of aFRR balancing energy under PICASSO

The PICASSO process is presented below:

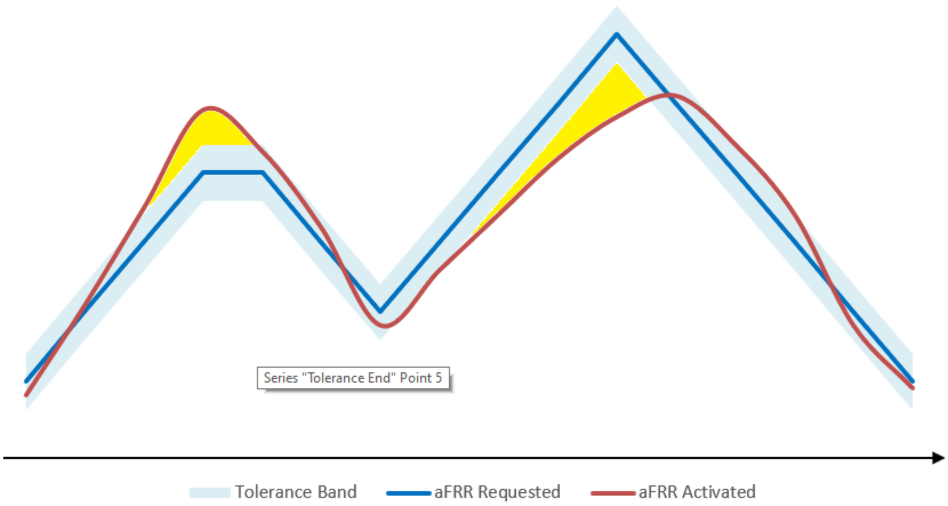
9. IPTO calculates the local aFRR demand which is determined according to the following calculation: $P_{\text{demand}} = P_{\text{LFCinput}} - P_{\text{Corr\_aFRR}} - P_{\text{corr\_IGCC}} + P_{\text{aFRR}}$, where:
   - P_{LFCinput} is the current local aFRR need, as determined from the local AGC.
   - $Pcorr$ for aFRR and IGCC is the current corrected demand for AOF and INF as received by PICASSO
   - P_{aFRR} is the amount of already activated aFRR. It is determined based on the measured volumes.
10. The local aFRR demand is sent as an input to the PICASSO AOF/INF function.
11. The PICASSO AOF/INF function selects the bids that satisfy the total aFRR need across all LFC Areas in a way that maximizes social welfare, based on the CMOL and given constraints such as the available cross-zonal capacity. This selection is done by the PICASSO AOF/INF optimization function and concerns cycles of 4 seconds.
12. PICASSO informs each TSO regarding the required aFRR power interchange, separately for IGCC (P_{Corr_IGCC}) and PICASSO (P_{Corr_aFRR}), as per the AOF/INF function results. The sum of the local aFRR demand and the received aFRR power interchange values for IGCC and PICASSO reflects the amount of aFRR, which the individual LFC area has to provide. The correction values P_{Corr_IGCC} and P_{Corr_aFRR} are sent without taking into account the activation dynamics of the assets delivering balancing energy.
13. The local AGC system finally activates aFRR in the LFC Area, in order to satisfy the local aFRR demand plus the additional PICASSO activation requirements reflected in the corrected demand (P_{Corr_IGCC} + P_{Corr_aFRR}) in accordance with the SOGL, art. 147(4a). The corrected demand (sum of P_{Corr}) reflects the amount of aFRR, which the individual LFC area has to provide to other LFC Areas. In the event of a step change in the aFRR demand of the requesting LFC area, the full step change would be induced in the uncorrected FRCE (P_{LFCinput}) of the connecting TSO. By this, it will increase the uncorrected FRCE of aFRR exporting LFC areas.
14. In order to activate the required aFRR, the local AGC system selects bids to activate in accordance with the LMOL in a market-based manner, following merit-order principles. Because of the dynamics of the aFRR process, the actual aFRR activation may differ from the PICASSO results, which makes it is possible to activate bids that are above the PICASSO CBMP, if these are needed to meet the actual aFRR demand.
15. The local AGC instructs the BSPs to activate aFRR in accordance with the selected aFRR bids, at the end of the local AGC cycle.
16. Both the PICASSO AOF/INF cycle and the local AGC cycle have a duration of 4 seconds.
17. The LMOL and CMOL lists are kept always in sync, meaning that in case of BSP outages, the LMOL is updated and sent to PICASSO to be merged into the CMOL.

As already stated in point (6) above, due to the dynamics of the aFRR process, it is possible that a bid that has not been selected for activation by the PICASSO AOF/INF, will be activated by the local AGC system. This bid could have a price higher than the PICASSO CBMP. The figure below presents an example.



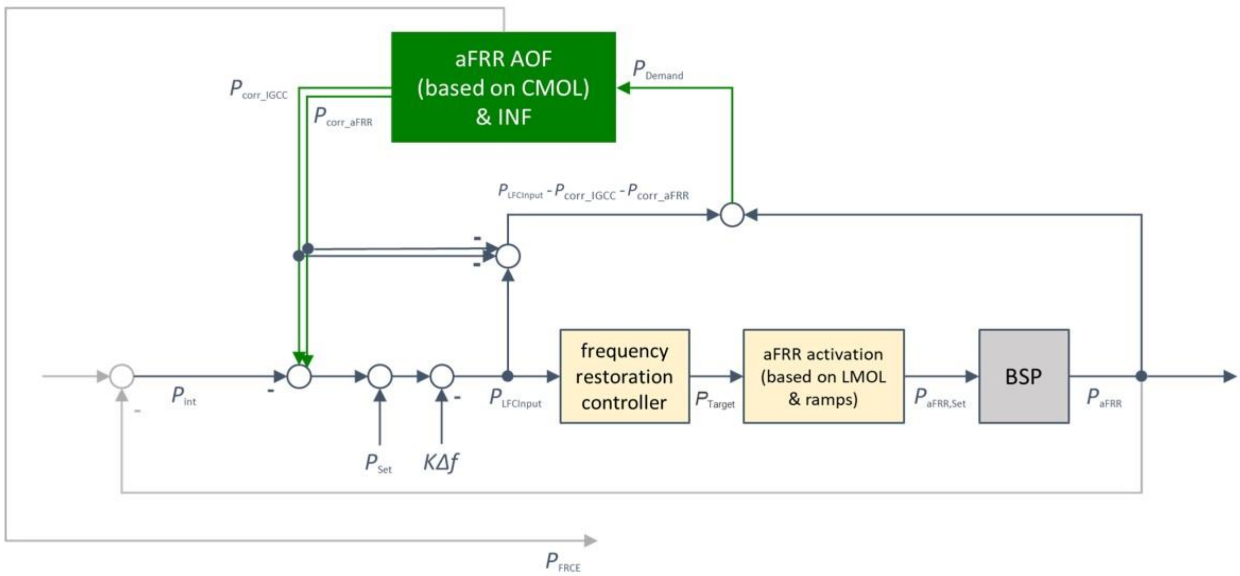
BSE dynamic aFRR Response

BSEs should follow the profile of the requested activations as closely as possible. IPTO may set a tolerance band around the requested activation profile and perform random checks in order to monitor that the delivered profile by the BSEs is within the prespecified tolerance band. Deviations of the delivered profile exceeding the tolerance band (yellow area in the graph below) are considered imbalances and non-compliance charges may apply.

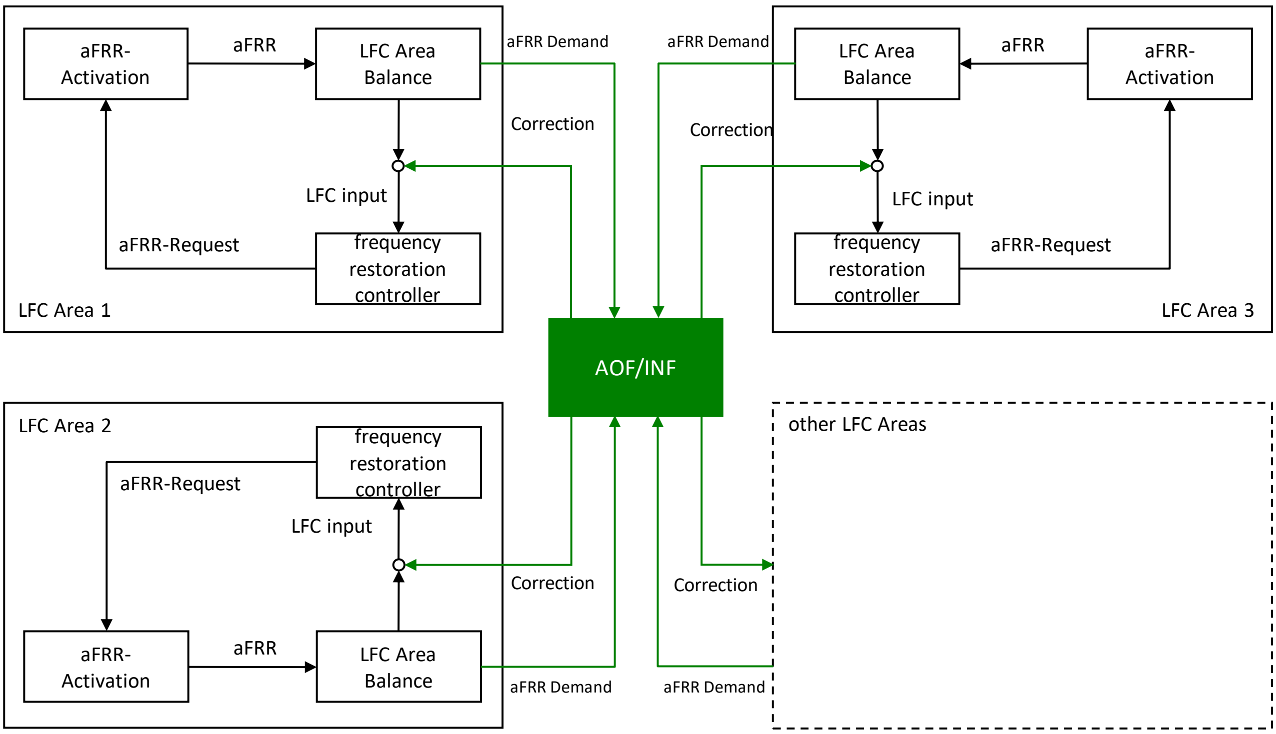


aFRR tolerance band

The model of the local AGC system when operating within PICASSO is shown in the following pictures:



Local control demand model under PICASSO in one LFC Area



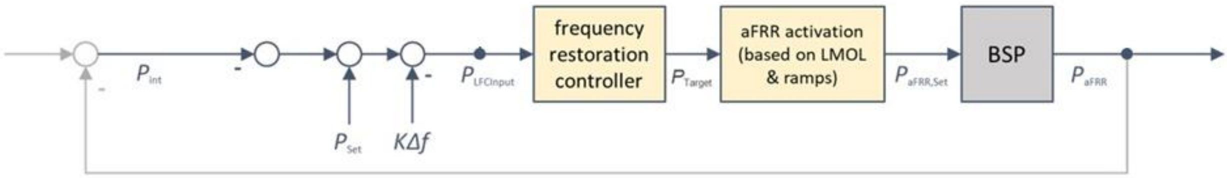
Control demand model under PICASSO in multiple LFC Areas

An example regarding the timing of the AOF/INF optimization cycle (OC) and the local AGC optimization cycle (LC) as well as the applicable Pcorr and CBMP is presented below:

Local AGC Cycle (4sec) (LC)		LC 0		LC 1		LC 2		LC 3	
PICASSO AOF/INF Optimization Cycle (4 sec) (OC)	OC 1		OC 2		OC 3		OC 4		
OC Pcorr used in LC calculation				Pcorr OC 1		Pcorr OC 2		Pcorr OC 3	

7.4 Local Activation of aFRR balancing energy without PICASSO

In case that for any reason (e.g. temporary disconnect) the PICASSO results (Pcorr, CBMP) are not available, aFRR is activated locally by the AGC in order to satisfy the local aFRR demand (not the corrected demand). In such cases, the aFRR bid activation process does not change.



Local control demand model when disconnected from PICASSO

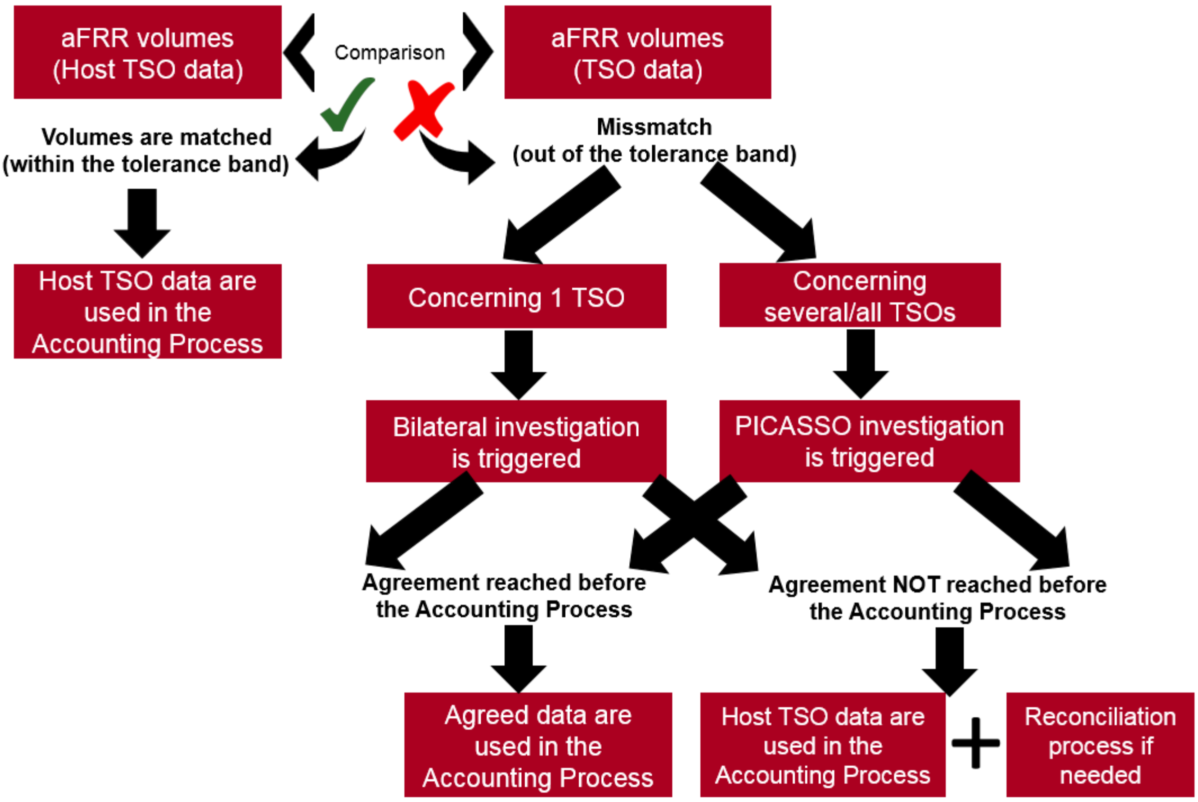
8 Pricing and Settlement

8.1 TSO-TSO settlement

The TSO-TSO settlement for the aFRR energy activated within PICASSO is done monthly, following the procedure stated below.

8.1.1 Volume Matching Process

Daily, on the first working day after the aFRR energy exchange, a matching process is performed to facilitate the determination of volumes used for the TSO-TSO settlement. In this process, IPTO compares the sum of aFRR activated under PICASSO (Pcorr) in every AGC cycle within an MTU (15' period), per LFC Area under his responsibility and direction (import or export). This volume is compared to the corresponding volume calculated by the CSP regarding the corrected demand sent to IPTO. In case of a mismatch greater than a tolerance band, a bilateral investigation or an investigation involving more TSOs is triggered in order to solve the issue and determine the volume to be settled, as shown in the following figure. The tolerance band is defined within a bilateral agreement between IPTO and the CSP.



8.1.2 Settlement amounts calculation

Until the third working day of each month, PICASSO calculates the settlement amounts per MTU and border. For each optimisation cycle, the aFRR congestion income generated on each aFRR balancing border is equal to the price difference of the importing and exporting areas multiplied with the aFRR quantity exchanged on the border. PICASSO calculates and the Invoicing Agent collects the balancing congestion income per aFRR balancing border and ensures that the collected balancing congestion income is transferred to the TSOs or appointed entities.

The settlement results are included in the monthly settlement report and sent to the TSOs via email, ECP or Webservices (initially via email). In case a TSO finds an error or an inconsistency in the monthly settlement report, the TSO will communicate it promptly to the Host TSO between the third and fifth working day of the month. After the investigation, in case a new corrected settlement report is needed, it will be sent to all the TSOs and the validation period will be shifted accordingly.

8.1.3 Settlement procedure

The validated reports are sent to the Invoicing Agent before the end of the 7th WD. If an investigation process is ongoing and one or more TSOs cannot solve the error by the 7th WD:

- By default, the report is sent to the Invoicing Agent on 7th WD and invoices are issued. TSOs continue investigating. If the data in the settlement report are not correct, the Host TSO issues a corrected settlement report and invoices are adjusted accordingly.
- If this practice leads to frequent invoice corrections, the TSOs can agree on adjustments in the settlement process so that the settlement report is sent to the Invoicing Agent only after solving the error but not later than on the 18th WD of the following month. Each TSO is also allowed to argue for holding the invoicing process until the deviation has been solved. If this is acceptable, only after solving the mismatch (not later than the 18th WD) the report can be sent to the Invoicing Agent.

The objective of this process is to mitigate the number of errors and corrections. TSOs will have the chance to open a dispute through the reconciliation process in case there is an issue detected once this validation period has finished.

1. Payments from TSOs to the Invoicing Agent are cleared not later than 30 (thirty) calendar days after the invoice's date of issue.
2. Payments from the Invoicing Agent to the TSOs are cleared not later than 32 (thirty-two) calendar days after the invoice's date of issue.

8.2 TSO-BSP Settlement

The TSO-BSP settlement is not harmonized across TSOs, rather, it is decided on a national level. It is proposed to settle the activated aFRR energy as described below:

For each 1-minute period and BSE:

1. The settlement volume for upward aFRR balancing energy equals the average measured energy per AGC cycle in this 1-minute period minus the volume of the mFRR instruction in the same 15’ MTU, when the difference is positive.
2. The settlement volume for downward aFRR balancing energy equals the average measured energy per AGC cycle in this 1-minute period minus the volume of the mFRR instruction in the same 15’ MTU, when the difference is negative.
3. The settlement volume per direction cannot be greater than the average requested volume per direction. Activated quantities above that limit will be settled as imbalances.
4. The weighted average price ($UPCBMP_{WAE}$, and $DNCBMP_{WAE}$) of all CBMPs that were calculated by PICASSO for the 1-minute period is determined.
5. The settlement price for upward aFRR balancing energy equals the maximum of $UPCBMP_{WAE}$, and BSE’s bid price that corresponds to the BSE’s average measured upward aFRR balancing energy.
6. The settlement price for downward aFRR balancing energy equals the minimum of $DNCBMP_{WAE}$, and the BSE’s bid price that corresponds to the BSE’s average measured downward aFRR balancing energy.
7. The settlement amount per 1-minute period equals the settlement volume multiplied by the settlement price for both directions.

The settlement amount per MTU for each BSE equals the sum of the related settlement amounts per 1-minute cycle within the MTU.

Local AGC Cycle (4sec) (LC)		LC 0		LC 1		LC 2		LC 3	
PICASSO AOF/INF Optimization Cycle (4 sec) (OC)	OC 1		OC 2		OC 3		OC 4		
OC Pcorr used in LC calculation				Pcorr OC 1		Pcorr OC 2		Pcorr OC 3	
aFRR INST volume applicable for TSO-BSP settlement		INST LC0		INST LC1		INST LC2		INST LC3	
aFRR CBMP applicable for TSO-BSP settlement			CBMP OC1		CBMP OC2		CBMP OC3		

Timing of applicable CBMP per AGC cycle

More details regarding the TSO-BSP settlement timeline are presented in the MARI preliminary design document.