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

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1. Abbreviations

Abbreviation	Definition
AOF	Activation Optimization Function
ATC	Available Transfer Capacity
BE	Balancing Energy
BSE	Balancing Service Entity
BSP	Balancing Service Provider
CBCL	Cross-border capacity limit
CMOL	Common Merit Order List
CZC	Cross Zonal Capacity
DA	Direct Activation
EBGL	COMMISSION REGULATION (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing
FAT	Full Activation Time
GCT	Gate Closure Time
GOT	Gate Opening Time
GV	Guaranteed Volume
IF	Implementation Framework
MARI	Manually Activated Reserves Initiative
mFRR	Manual frequency restoration reserve
LMOL	Local Merit Order List
MTU	Market Time Unit (15 minutes)
SA	Scheduled Activation
XB	Cross-border

2. Introduction

Manually Activated Reserves Initiative (MARI) is the European project for the creation of the European platform for the exchange of balancing energy from frequency restoration reserves with manual activation (hereinafter referred to as “MARI platform” or “mFRR platform”). According to art. 20 of EBGL, all participating TSOs shall implement and make operational the MARI platform and they shall use it to submit and exchange all balancing energy bids from all mFRR standard products in order to fulfil their needs for mFRR balancing energy.

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

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

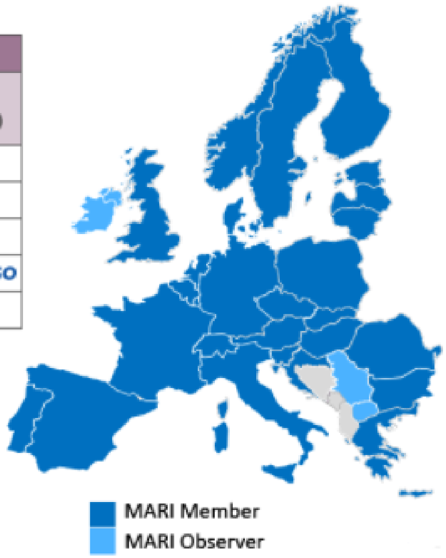

Figure 1[1]: MARI implementation project

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 MARI platform for two years from the legal go-live date (July 24, 2022). Participation in the MARI 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 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.

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

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

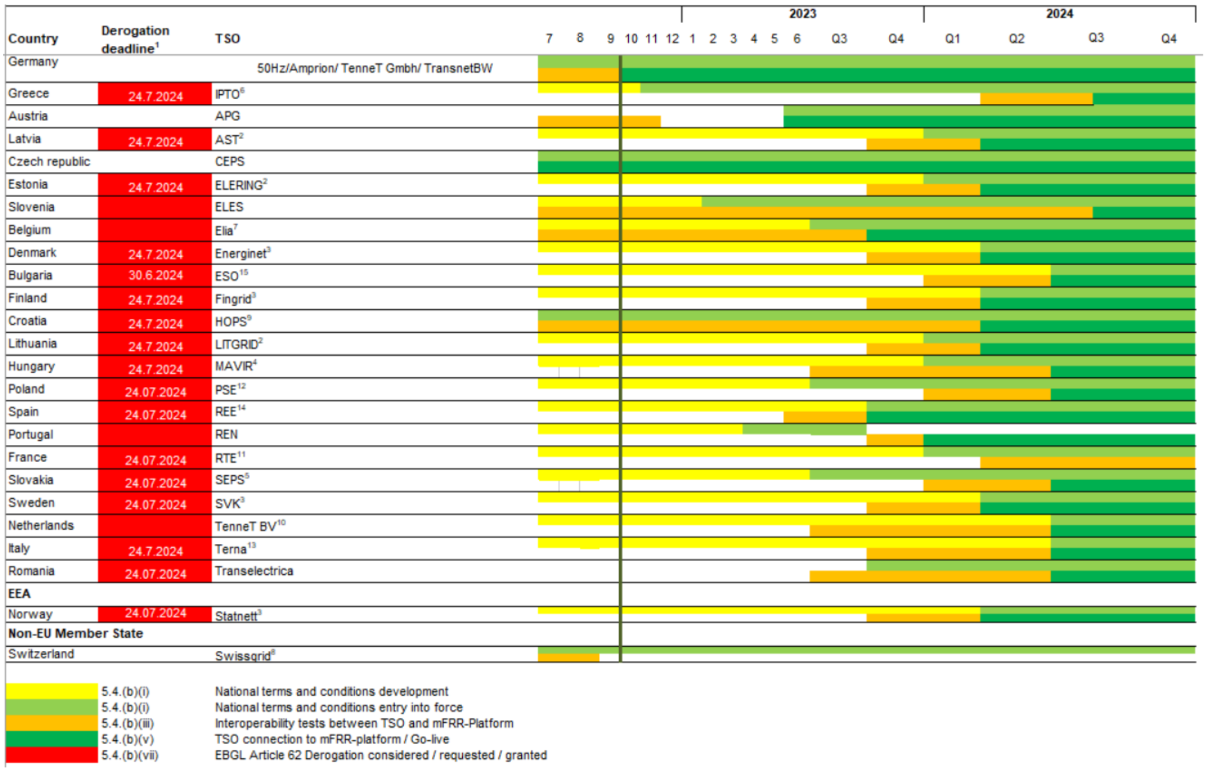

Figure 2[2]: mFRR-Platform Accession roadmap

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] https://eepublicdownloads.blob.core.windows.net/public-cdn-container/clean-documents/Network%20codes%20documents/NC%20EB/2022/MARI_Accession_roadmap_October_2022_Update_Final.pdf

3. MARI platform process overview

3.1. High level description of mFRR platform

The mFRR platform, operated by TSOs, applies a TSO-TSO model with common merit order lists to exchange all balancing energy bids from standard products for mFRR, except for unavailable bids pursuant to art. 29(14) of EBGL. The MARI platform enables TSOs to activate the most cost-efficient set of mFRR bids to meet their needs, while considering constraints linked to the availability of networks to exchange these reserve products.

Pursuant to art. 20(2) of EBGL, the mFRR platform shall be based on common governance principles and business processes, and shall consist of at least the activation optimisation function (AOF) and TSO-TSO settlement function.

In the following figure, the process overview of the mFRR platform is presented.

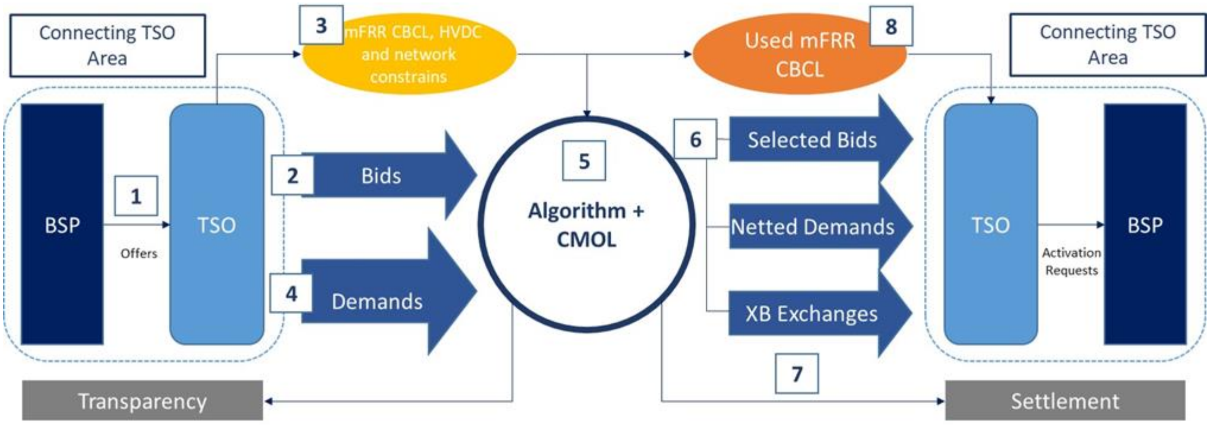

Figure 3[3]: Overview of BSP-TSO and TSO-mFRR platform flows

Platform process steps:

1. TSOs receive bids from BSPs in their local market.
2. If required, TSOs transform bids received from BSPs into standard mFRR balancing energy bids by applying a central dispatch model.
3. TSOs forward standard mFRR balancing energy bids to the mFRR platform.
4. TSOs communicate the available cross border capacity limits (CBCLs), network constraints as well as HVDC constraints.
5. TSOs communicate their energy balancing demands (mFRR needs).
6. Activation Optimization Function (AOF): The clearing of the mFRR balancing demands against BSPs bids is performed.
7. Communication of the AOF results: Accepted bids, satisfied demands, prices to the local TSOs as well as the resulting Cross Border schedules.

[3] Source: MARI Activation Optimization Function Public Description

8. Calculation of the commercial flows between imbalance areas and settlement of the expenditure and revenues between TSOs.
9. Remaining mFRR CBCLs are sent to the relevant TSOs.

According to art. 11 of the mFRR IF, the AOF's first priority when selecting the best set of bids to cover TSOs' mFRR demands is to maximise the economic surplus for a given set of standard mFRR balancing energy bids and mFRR balancing energy needs while its second priority is to minimise the amount of mFRR power exchange on each mFRR balancing border.

In the context of balancing markets, the economic surplus is the total surplus of all TSOs obtained from satisfying their demands and the total surplus of BSPs resulting from the activation of their associated bids, as illustrated in the following figure.

On one hand, the curve consisting of positive TSO demands and downward BSP bids constitutes the consumer curve, and therefore indicates the maximum price consumers (TSOs and BSPs) are prepared to pay for consuming mFRR balancing energy. On the other hand, the curve consisting of negative TSO demands and upward BSP bids constitutes the producer curve, and therefore shows the minimum price they are prepared to receive for supplying mFRR balancing energy.

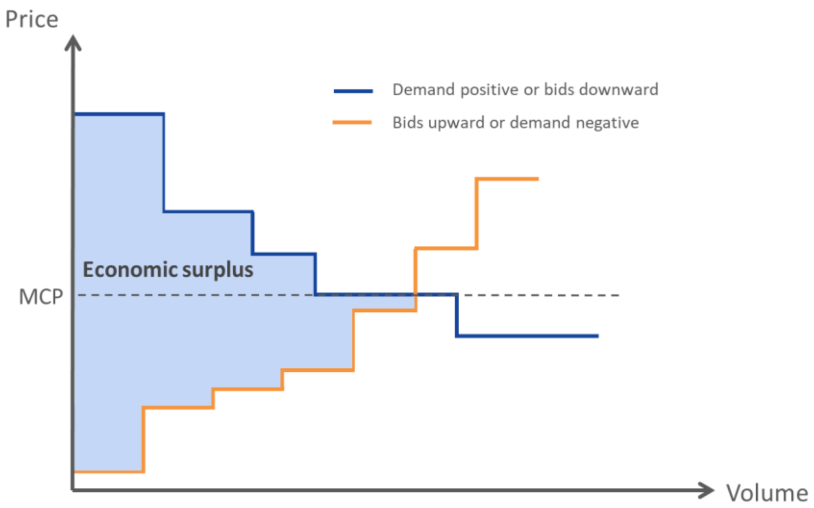

Figure 4[3]: Economic Surplus

3.2. MARI platform activation clearings phases

As previously stated, the MARI platform organizes and optimizes the exchange of mFRR balancing energy activations between TSOs. The optimization algorithm (MARI AOF) searches for a solution that maximizes economic surplus while minimizing the use of cross-border capacity for mFRR energy exchanges.

MARI AOF consists of two different activation clearing phases for each MTU, the Scheduled Activation (SA) clearing which optimizes scheduled balancing energy activations and the Direct Activation (DA) clearing phase(s) which optimizes direct balancing energy activations. Both scheduled and direct clearing phases uses the same MARI AOF algorithm but differ slightly in the processes (GOT, GCT, inputs etc). Once the AOF has completed processing the common merit order list (CMOL), the resulting activations and demand satisfaction, amongst others, are sent back to the relevant TSOs. Resulting activations and demand satisfaction are communicated seperately for scheduled and direct activations.

Scheduled activations are typically used to handle forecasted imbalances proactively or to de-saturate activated aFRR bids. Direct activations are required to perform further activations when imbalances occur between two scheduled activations. Direct activations allow for the activation of mFRR bids at any point in time when an unexpected imbalance occurs.

The Scheduled Activation is the first process and is run for each MTU period. All available bids and demands in both directions that have been received by the MARI platform are taken into account during the Scheduled Activation clearing phase. SA clearing selects bids to satisfy the demands for scheduled activations, determines the cross-border marginal prices and calculates the cross-border flows. Upward and downward bids and positive and negative demands are included in the SA clearing. The balancing energy bids can be exchanged between scheduling areas provided there is enough Cross Zonal Capacity (CZC) to allow for such exchanges to materialize. If enough cross-border capacity is available, the netting of simultaneous demands in opposite directions can also be executed in SA.

Direct activation clearing is run after the SA clearing for the same MTU period. There may be zero, one or many cycles of direct activations for a given MTU period within a specific timeline. DA clearing phase selects bids to satisfy the demands for direct activations, determines the cross-border marginal prices and calculates the cross-border flows. TSO demand from only one direction as well as the remaining bids, available for DA in the same direction are considered per direct activation.

During each optimization process, the market is cleared considering the available bids and the TSOs demands. Since the allocated time between the data collection and the activation time is short (less than 2 minutes for the SA processes and less than 1 minute for DA processes), the MARI platform is required to perform the relevant processes extremely efficiently.

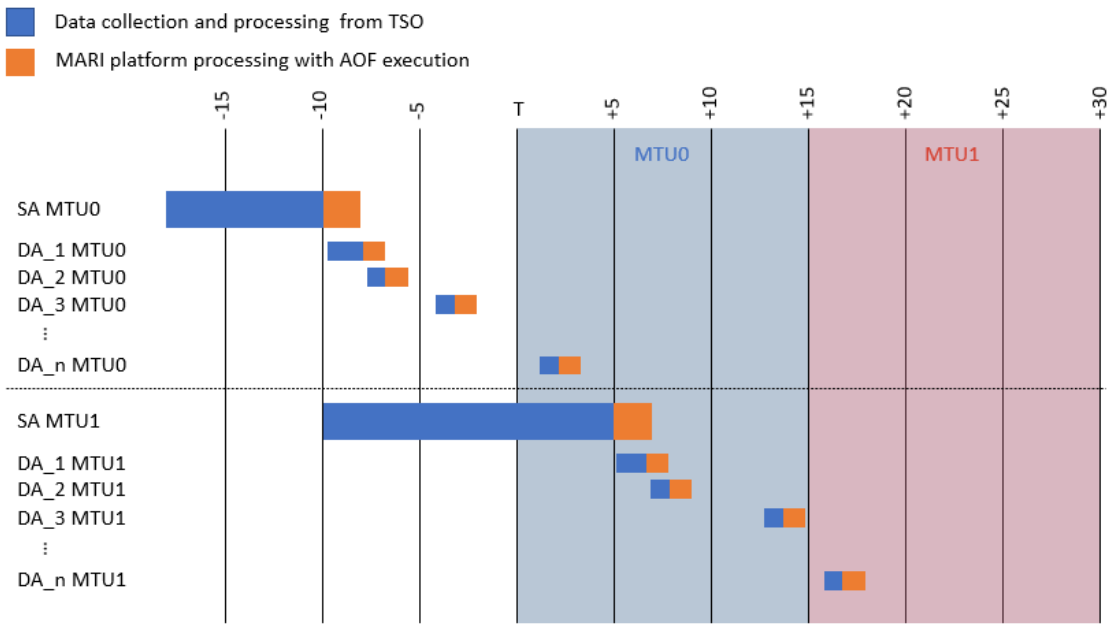

Figure 5[3]: Example of MARI execution

In the following figure common platform's operational phases are outlined which exhibit the timing in order to satisfy a fifteen-minute scheduled activation period starting at T and ending at T+15 and the timing andactivation of a bid for a direct activation. Alltimes are expressed in minutes and are relative to the start of the MTU for which activations are optimised by the platform.

The timings for SA clearing are the following:

- T-12': Each TSO must share the mFRR energy bids received from the BSPs with the mFRR-Platform at the latest 12 minutes before QH(t0).
- T-10': Each TSO must submit to the mFRR-Platform the mFRR demands for Scheduled Activation for QH(t0) at the latest 10 minutes before QH(t0). After this point in time, the mFRR-Platform will start the optimization for scheduled activation and no new information can be taken into consideration.
- Between T-10' and T-8,5': The clearing of SA activation run is triggered. The mFRR platform with its AOF selects bids to satisfy the demands for scheduled activations, determines the cross-border marginal prices and calculates the cross-border flows. The market clearing execution is performed within 60 seconds. Half a minute is allocated to pre-processing of input data and the communication from the platform to the TSOs. After the execution, the results are communicated to the TSOs together with cross-border marginal prices and the bids selected for activation and the satisfied demands. The selected bids for activation by the AOF are communicated by each TSO to their respective BSPs.
- The market clearing information is then transferred to BSPs at T-7.5' and scheduled activation is initiated on T-7,5'. Between T-5' and T+20' balancing energy for scheduled activations is delivered.

According to the mFRR IF, the Balancing Energy Gate Closure Time for BSPs to submit the mFFR bids to their TSOs (BSP mFRR GCT) is 25 minutes before the start of the relevant quarter-hour, i.e. T-25’. However, this timing is only applicable to TSOs applying a self-dispatching model. Due to time constraints related to the conversion of mFRR bids by IPTO (refer to section 5) this timing may not feasible. Therefore IPTO may propose a different mFRR GCT for BSPs.

The timings for DA clearing are presented in the following figure. After T-10’ and up to 5 minutes after the start of QH(t0), TSOs may submit a demand to trigger one Direct Activation where all bids eligible for DA and not activated in the previous activation run of the same MTU period can be used. Processing of such demands will have to wait until the AOF completes the scheduled activations. Likewise, if the AOF is already busy processing one or several demands for direct activations, any subsequently arriving direct demands will have to wait until the AOF completes the running process.

The DA market clearing excecution is performed within 15 seconds. Depending on the timing of the DA process, information is transferred to BSPs between T-7.5’ min and T+7.5’, and the delivery of the requested MW lasts until the end of the SA run of the next MTU period (QH(t+1)), i.e., the delivery will always end at T+35’.

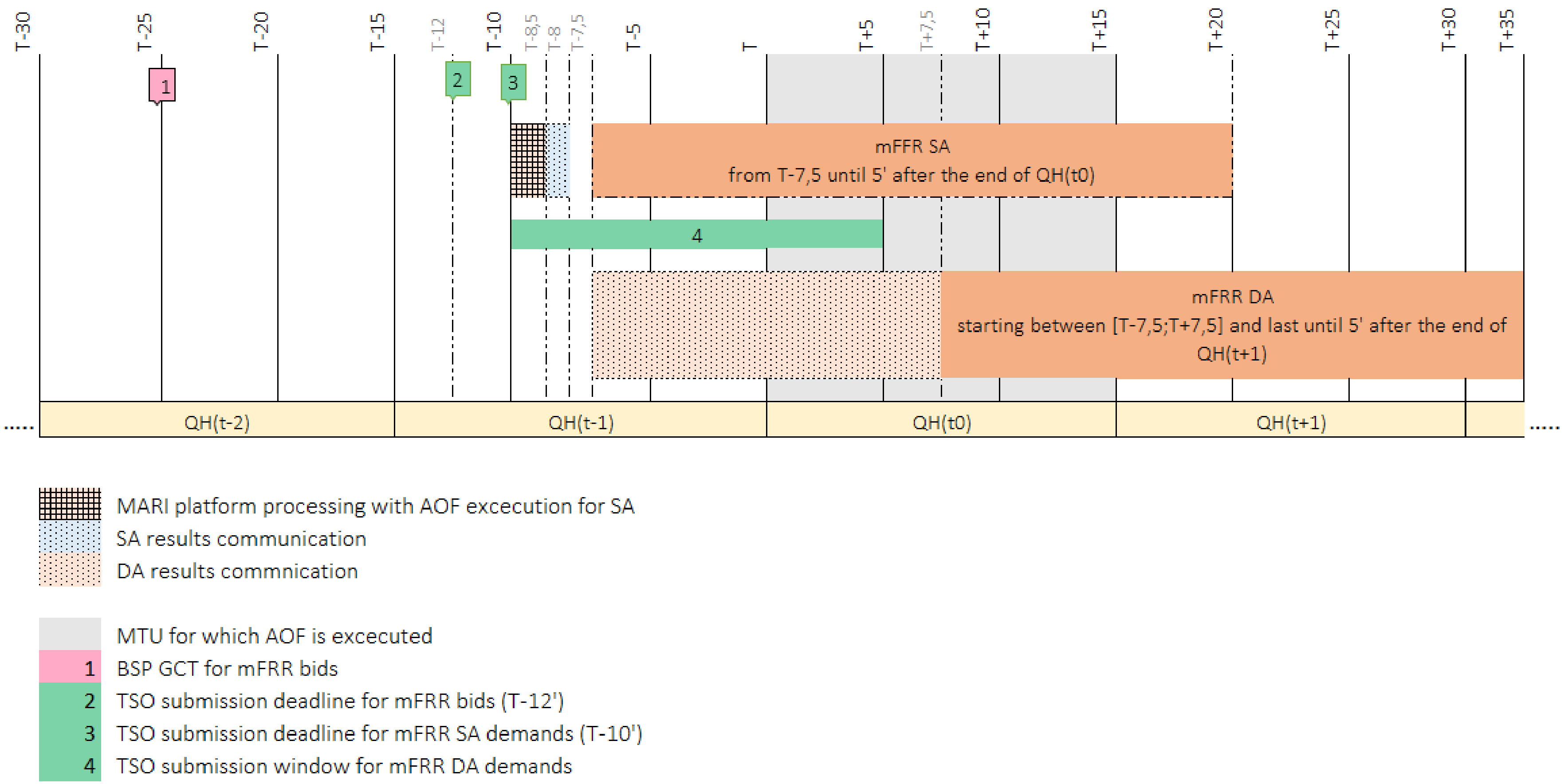

Figure 6[3]: mFRR platform operational phases and timings overview

3.3. Market areas used in mFRR platform AOF

Different types of areas are considered in the MARI AOF as presented in the following topology example.

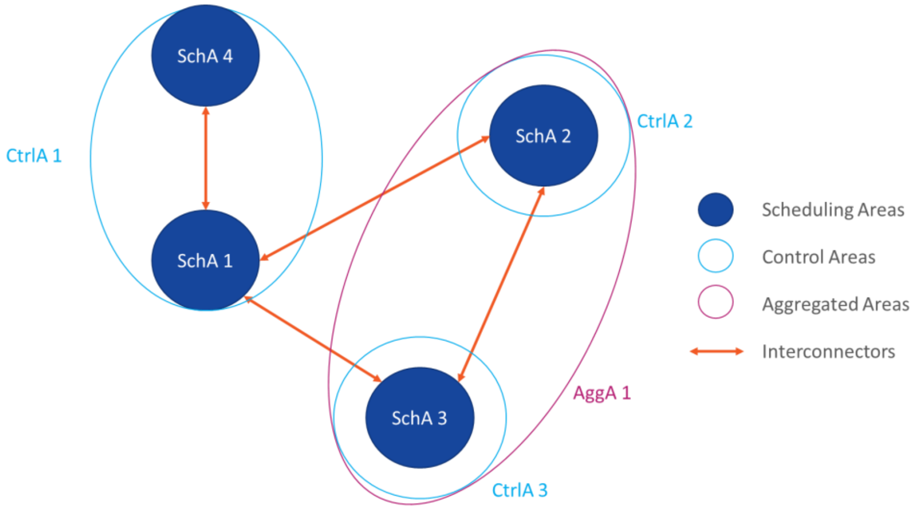

Figure 7[3]: Topology example

Scheduling Areas

A scheduling area is the area level where the different bids and most of the demands are submitted. Scheduling areas cannot include any other areas, whatever their types; they are the most elementary zones modelled in MARI. The interconnectors allow exchange of mFRR energy, coupling the different scheduling areas of the network. The cross-border maginal price (CBMP) will be defined at the end of the activation optimization process for each of the scheduling areas. Each scheduling area is included in at most one control area.

Control Areas

A control area is defined as a set of scheduling areas operated by a single system operator (TSO). Itcan therefore include one or several scheduling areas. In MARI's AOF, the control areas are not directly interconnected with one another, as the interconnections are defined at the level of scheduling areas.

Aggregated Areas

An aggregated area is a set of scheduling areas that can have specific mFRR demand requirements. They include at least 2 scheduling areas. Aggregated areas differ from control areas in the sense that they do not necessarily represent an area controlled by a single TSOTSO (one aggregated area can include several scheduling areas from different control areas). Demands can be submitted at the aggregated area level and are called aggregated demands.

3.4. Market modes used in mFRR platform AOF

The MARI AOF is able to perform the following market modes of optimization in parallel:

a) Coupled optimization: In this market mode, optimization of the resulting cross-border energy flows is permitted up to the CBCLs.
b) Decoupled optimization: In this market mode, all areas are optimized in isolation, with CBCL set to zero on borders between them.

3.5. Contingency measures

3.5.1. Decoupling/Disconnection

Each TSO can request decoupling for its control area. Decoupling means that the control area is treated like an island. On the borders, cross border capacities will be deemed zero in both directions. Bids and demands originating from the decoupled control area will be matched against each other by the MARI platform, without consideration of bids and demands from other control areas. In this scenario, TSOs effectively do not have full access to the common CMOL.

Each TSO can also request disconnection for its control area. Disconnection means that no data submissions will be expected from the TSO, not even bids and demands. Cross border capacities will be deemed zero on the borders of the TSO’s control area(s) and no optimization on the TSOs control areas will be carried out by the MARI platform.

3.5.2. Local fallback and complementary measures

The mFRR process will be carried out locally by each TSO for matching bids and demands within its control area(s) in situations where there is a failure in any data exchange between the TSO’s system and the MARI platform, or within the MARI platform itself. Hence, each TSO must disconnect and perform its own complementary fallback measures. On these grounds IPTO will appropriately amend the current mFRR algorithm and process. For more details see chapter 5.3. In addition, in cases that MARI platform does not satisfy all inelastic/elastic demands, each TSO must use its own complementary measures. In any case, the results of the MARI platform are firm and cannot be rejected by TSOs on the grounds of non-satisfaction of demand.

4. mFRR balancing energy bids

TSOs must use the standard mFRR balancing energy products, as defined in the relevant European regulatory framework in order to connect to the mFRR-Platform. As defined in the mFRR IF, each standard mFRR balancing energy product shall fulfil some characteristics, while other may be defined in the Terms and Conditions of each TSO. The use of specific products is allowed, but only if justified and approved by the National Regulatory Authority. More details are presented in section 4.1.

The mFRR balancing energy bids may have different bid characteristics to reflect the conditions for activation as explained in sections 4.1 - 4.5. The characteristics of the mFRR balancing energy product will be determined by IPTO based on integrated scheduling process bids submitted by BSPs following the rules for converting bids of a central dispatching model into standard mFRR balancing energy product bids pursuant to Article 27 of the EB Regulation, as explained in section 5.

4.1. Standard mFRR balancing energy product

4.1.1. Characteristics of standard mFRR energy bids

The characteristics of the standard mFRR balancing energy product are defined in art. 7 of the mFRR IF. Regarding central dispatching models, some of the characteristics may be determined by the connecting TSO based on integrated scheduling process bids submitted by BSPs following the rules for converting bids into standard mFRR balancing energy product bids pursuant to art. 27 of the EB Regulation.

In the following table the characteristics of the standard mFRR balancing energy product are presented, according to art. 7(1) and 7(2)(a) of the mFRR IF, in comparison to the current local mFRR balancing energy product.

	local mFRR product as of today	mFRR standard product
Mode of activation	manual	manual
Activation type	Scheduled or direct	Scheduled or direct
FAT	7,5 min	12,5 min
Minimum quantity	1 MW	1 MW
Bid granularity	0,1 MW	1 MW
Maximum quantity	n/a	9.999 MW
Minimum duration of delivery period	7,5 min	5 min
Price resolution	0,01 €/MWh	0,01 €/MWh
Validity period	The scheduled activation can take place at the point of scheduled activation only.	The scheduled activation can take place at the point of scheduled activation only.

	A direct activation can take place at any time during 7,5 miinutes after the point of scheduled activation.	A direct activation can take place at any time during 15 minutes after the point of scheduled activation.
Price	€/MWh	€/MWh
Location	At least the smallest of LFC area or bidding zone	At least the smallest of LFC area or bidding zone
Bid divisibility	Fully divisible for generating units . Both divisible and invisible bids are allowed for demand response.	Divisible bids with an activation granularity of 1 MW. Indivisible bids based on national terms and conditions.
Linking between bids and complex bids	multipart bids	Technical and conditional linking between bids submitted in consecutive quarter hours. Complex bids.

Every bid will be assigned an activation type by IPTO. The activation type, can be one of the following three:

- 'Scheduled only' means a bid which can be activated at the point of scheduled activation only;
- 'Direct' means a bid that can be activated at the point of scheduled activation and anytime during the 15 minutes after the point of scheduled activation;
- 'Direct only' means a bid that is eligible for direct activation only, i.e., anytime during the 15 minutes after the point of scheduled activation. This is theimplementation of the "guaranteed volume" concept. More details are provided in section 4.1.2.

The activation type will be determined before the bid gets submitted to the mFRR platform but may be updated subsequently (also refer to section 4.4). Moreover, a bid will always be associated with exactly one direction, which may be either upward (positive) or downward (negative). Each bid will be associated with exactly one scheduling area.

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.The 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 defined in EBGL, the maximum and minimum price 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.

The bid parameters of the standard mFRR balancing energy product, as defined in article 7(3) of the mFRR IF, are presented below.

‘divisible bid’ means a standard mFRR balancing energy product bid, which can be activated partially in terms of power activation according to the bid activation granularity pursuant to Article 6(5);

‘indivisible bid’ means a standard mFRR balancing energy product bid, which cannot be activated partially in terms of power activation according to the bid activation granularity pursuant to Article 7(2). Therefore, the volume of an indivisible bid is always activated altogether;

'complex bids’ means complex bid structures of a BSP with the purpose of economic optimization, allowing BSPs to offer more flexibility, to reflect efficiently their underlying cost structure in their offered bids, and to maximize the opportunity of being activated;

‘exclusive groups’ are a type of complex bids, consisting of a group of bids, where only one bid can be activated from the list of bids part of the exclusive group;

‘multipart bids’ are a type of complex bids, consisting of a group of bids, where individual upward energy bids can only be activated according to increasing price, or individual downward energy bids can only be activated according to decreasing price;

'technical linking’ means links between bids of a BSP in consecutive quarter hours, needed to avoid the underlying asset performing infeasible activations;

'conditional linking’ means links between bids of a BSP in up to three consecutive quarter hours, needed to represent technical restrictions and cost structure of the underlying assets, due to the unavailability of information on the activation of bids from previous quarter hours at the balancing energy gate closure time.

4.1.1.1 Simple bids

As described previously, divisible (partially or fully) and indivisible bids are allowed. Divisible bids have an activation granularity of 1 MW and the bid size may not be smaller than 1 MW. The maximum size of indivisible bids shall be defined in the national terms and conditions for balancing and shall not be higher than the largest technical minimum production or consumption of the pre-qualified generation or load unit of the BSP.

Divisible bids may be activated in incremental steps of 1 MW, from the minimum offered quantity up to the maximum offered quantity. For example, a bid with a minimum offered quantity of 8 MW and a maximum offered quantity of 10 MW may be activated with 8, 9 or 10 MW. Bids must be submitted with integer volumes only. Any remaining quantity of a partially accepted bid will be deemed as unavailable for subsequent activations.

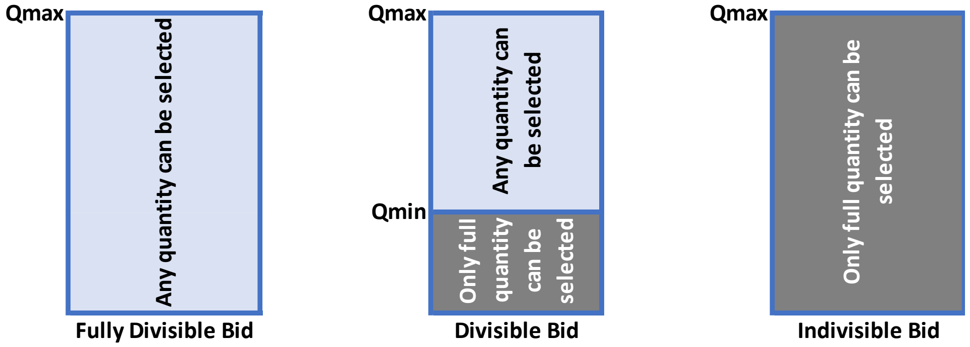

Figure 8: Representation of a fully divisible bid, divisible bid and indivisible bid

In the current local mFRR balancing market design, only fully divisible bids are allowed for generating units. On the other hand both, divisible and invisible bids are allowed for demand response and pumping units. This design option will remain unchanged.

4.1.1.2 Complex bids

Complex Bids consist of groups or families of simple bids, which have specific acceptance behaviors. Two types of complex bids exist, exclusive groups and multi-part bids. In the current local mFRR balancing market only multi-part bids are allowed.

Exclusive groups are families of bids in the same scheduling area where at most one bid can be accepted (even partially). When submitting mFRR Energy Bids in an exclusive group, the following rules must be respected:

- An mFRR bid may only be part of one exclusive group for the concerned quarter-hour.
- mFRR bids in an exclusive group must have the same activation type.
- mFRR Bids in an exclusive group may not be subject to quarter-hour linking.
- Some mFRR bids can be upward while others downward.
- mFRR Bids can be either fully divisible, divisible or indivisible.

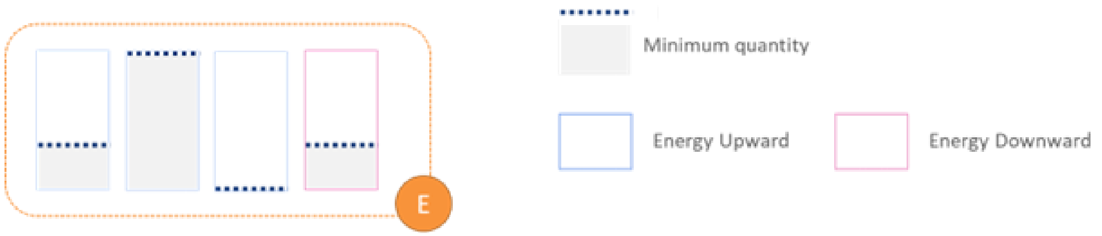

Figure 9[3]: Exclusive bid group

Multipart groups are sets of bids in the same scheduling area, ordered by their price, where their acceptance must follow a price hierarchy deepening on its direction, i.e., acceptance of one bid in the family requires that all preceding bids are accepted. For upward multi-part bids, whenever a bid is accepted, all associated bids with lower prices must be first fully accepted. For downward multi-part bids, whenever a bid is accepted, all associated bids with higher prices must be first fully accepted. Bids in the multi part family must have the same direction, and different prices, but can vary in quantities. In addition, if at least one bid is activated in SA, the remaining volume of the multipart bid is no longer available for DA. Likewise, if at least one bid is activated for DA, the remaining bids are no longer available for any subsequent DA optimizations.

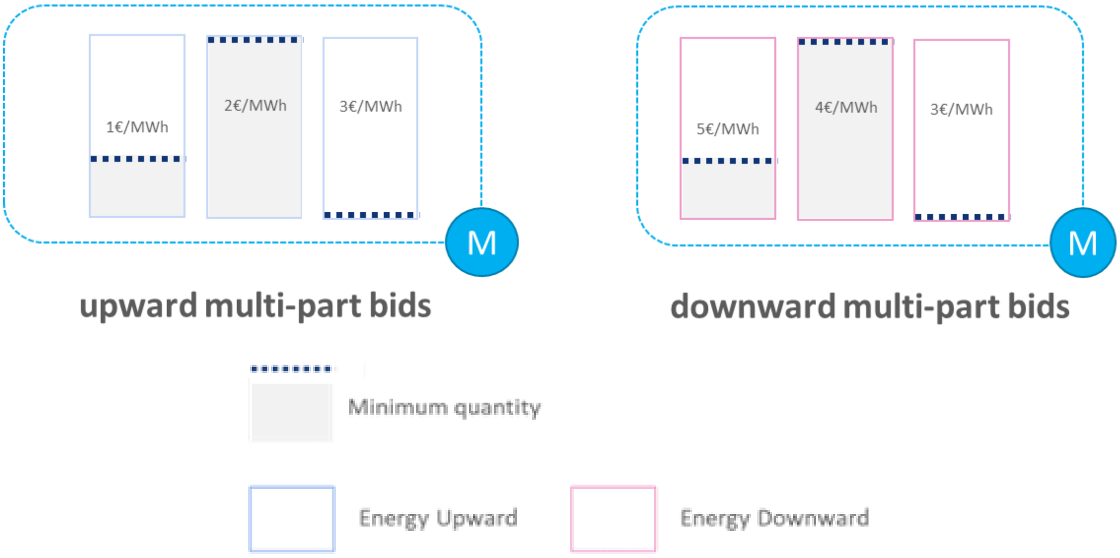

Figure 10[3]: Multipart bid group

4.1.1.3 Linked bids

There may be links between bids in different MTU periods. Bids that are linked must originate from the same scheduling area. Two different types of links are supported; technical and conditional. Technical and conditional links affects the availability of a bid in QH(t0) based on the outcome of the linked bid(s) in earlier, already optimised, quarter hours. The principle of the linking is to switch the availability status of the bids from available to unavailable (or vice-versa) to avoid infeasible activations.

TSOs and BSPs will not be aware of all activations in the preceding quarter-hours at the time of bid submission. More specifically, at BSP mFRR GCT for QH(t0), it is possible that scheduled activations for QH(t-1) and direct activations for QH(t-1) and QH(t-2) may still be requested. For this not to happen, linking can be used to indicate that the bid is no longer available if already activated in the quarter-hour(s) before, or alternatively, that a bid only becomes available in case of an activation in the preceding quarter-hour(s).

BSPs have the responsibility to link the bids together to avoid infeasible activations but each TSO may facilitate BSPs based on information of underlying assets, the technical constraints of such assets, etc. It is at the discretion of the BSP to choose between technical and conditional linking or combination thereof to achieve the bidding objectives.Linking of bids, for example, may be useful in case of BSEs with energy limitations, for demand response with limitations on duration or frequency of activations, for ramping limitations or a technical constraint between positive and negative mFRR energy bids by the same BSE, if the switch between upward and downward activations is not technically feasible from one quarter-hour to another, etc.

In the following figure, infeasible activations related to ramping violations are presented. The example concerns a single asset with the same maximum ramp rate (MW/min) both for upward and downward directions. An upward SA bid for a quantity equal to the maximum MW allowed by the maximum ramp rate, and a downward SA bid for the same MW is submitted to the mFRR Platform for Qh2 and Qh3 respectively.

The upward SA bid is fully activated in Qh2. At the end of Qh2 the bid is deactivated pursuant to the standard product characteristics. For Qh3, the downward SA bid is also fully activated. The deactivation of the upward bid in Qh2 and the simultaneous activation of the downward bid in Qh3 will lead to a down regulation over 10 minutes, with a higher gradient than its maximum allowable ramp rate, because both bids are deactivated/activated at the same time (T+7.5).

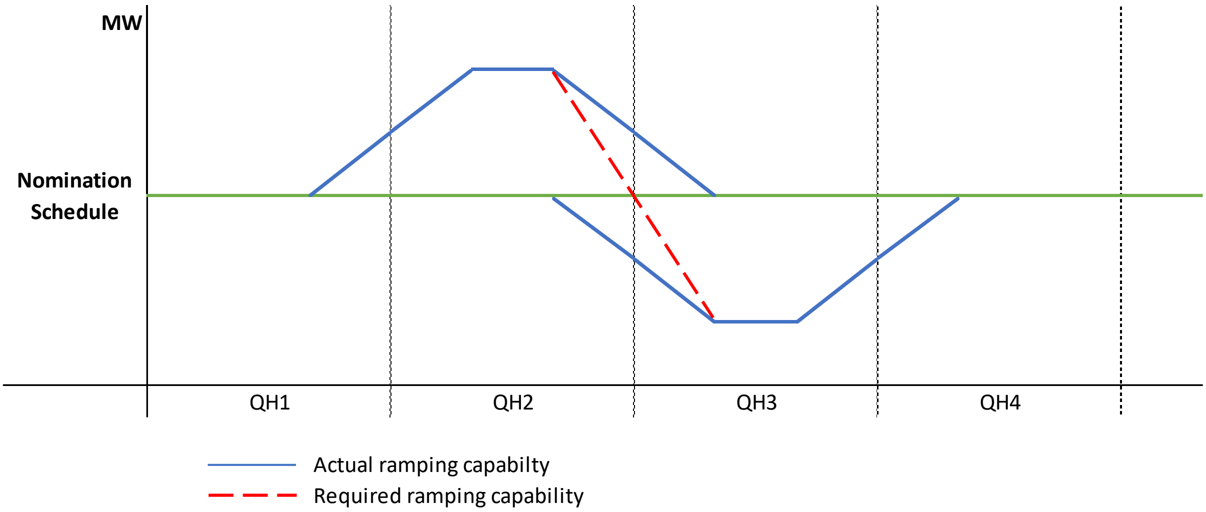

Figure 11: Example of infeasible activation owning to ramping constraints

Technical linking between two bids (simple or complex) in two subsequent quarter hours is possible. Each of the bids within the linked bid must be associated with a unique quarter hour. These links indicate the allowed combinations of direct and scheduled activations of the bids and ensures that a bid that underwent direct activation in QH(t-1) (i.e., for the preceding quarter hour) is not available in QH(t0), neither for scheduled nor for direct activation. This is important in order not to activate the same balancing resource twice**.**

In the following figure an example of technical linking is presented.

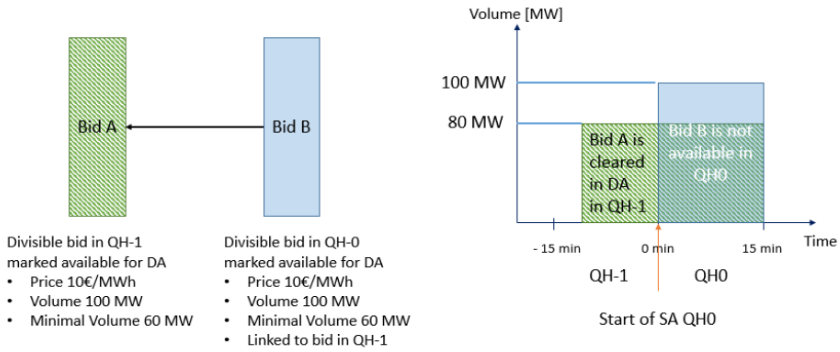

Figure 12[4]: Example of technical linking

[4] Source: MARI-Bid Structure and Linking

Conditonal linking between simple bids in two or three adjacent quarter hours is possible. A given conditional bid in QH(t0) will by default be either available or not available. It may have up to three links to bids in QH(t-1) and/or up to three links to bids in QH(t-2). A bid in QH(t0) that is declared as available by default becomes either completely unavailable for both SA and DA or unavailable for DA when at least one of those links indicate unavailability. A bid in QH(t0) that is declared as unavailable by default, becomes either available or available for DA when at least one of those links indicate availability.

The following types of links are supported:

- Bid initially available:
  a) Bid unavailable if linked bid is activated for either SA or DA.
  b) Bid unavailable if bid is not activated.
  c) Bid unavailable for DA if linked bid is activated for SA.
  d) Bid unavailable for DA if linked bid is activated for DA.
- Bid initially unavailable:
  a) Bid available if linked bid is activated for either SA or DA.
  b) Bid available if bid is not activated.
  c) Bid available for DA if linked bid is activated for SA.
  d) Bid available for DA if linked bid is activated for DA.

In the following figure an example of conditional linking is presented.

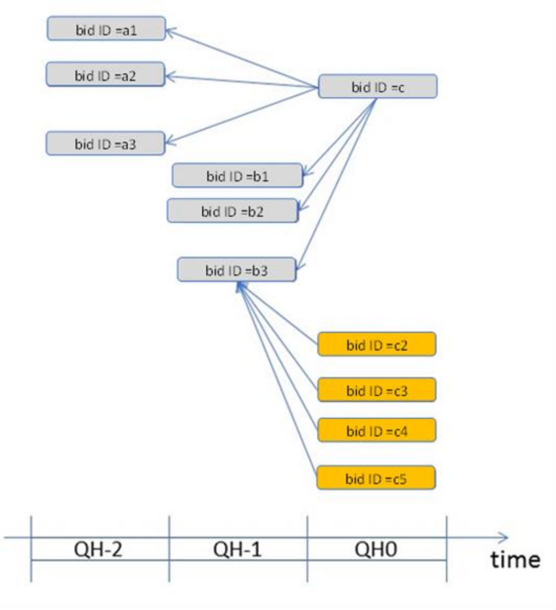

Figure 13[4]: Example of conditional linking

4.1.1.4 mFRR energy bids availability

mFRR IF – Article 2. Definitions
(a) 'availability status' means the condition of a bid being available or unavailable for cross-border activation pursuant to Article 29(9) and (14) of the EB Regulation;

TSOs must send all mFRR energy bids submitted by the BSPs to the mFRR-Platform. However, in accordance with EBGL and the mFRR IF (article 9), each TSO may declare the balancing energy bids submitted to the AOF unavailable for activation via the MARI-platform because they are restricted due to internal congestions or due to operational security constraints within the TSO's scheduling area. The unavailability may be general or apply to a particular activation type (schedule or direct). Unavailability for the mFRR-Platform does not necessarily mean that the bid is unavailable for local activation. In such cases, TSOs are obliged to transparently report on such bid unavailability.

IPTO can declare an mFRR energy bid as unavailable for selection by AOF for different reasons such as:

1. **Intraday total unavailability of entity due to technical reasons (e.g., trip)**
   The bid is unavailable both locally and in the MARI platform.
2. **Restrictions due to internal congestion**
   The bid is unavailable both locally and in the MARI platform.
3. **Internal congestion management.**
   The bid is available locally but unavailable in the MARI platform.
4. **Execution of Dispatch Instructions for mFRR testing.**
   The bid is available locally but unavailable in the MARI platform.
5. **Commissiong Schedules.**
   The bid is unavailable both locally and in the MARI platform.
6. **Guaranteed volumes.**
   The bid is available only for DA activation in the MARI platform.

In addition, bids from entities that that are not scheduled to be synchronized based on ISP results and cannot be activated within the FAT, for example bids from generation units with a synchronization and soak time larger than 12,5 minutes, or bids from generation units that are fully or partially unavailable due to technical reasons (e.g. trip) will not be sent to the MARI platform. For more details please refer to section 5.

Note also that complex bids must have the same availability status for the mFRR-platform. Therefore, if IPTO declares one of the associated bids as unavailable, then the associated bids will also have to be declared as unavailable.

4.1.2. Guaranteed Volume (GV)

When unforeseen incidents or unexpected demands occur in real time, TSOs might need to have access to a certain volume of "direct activatable bids" to perform the Frequency Restoration Process within the Time To Restore Frequency (TTRF). The risks of direct activatable bids' scarcity in a LFC control area during a quarter-hour, is avoided by the 'Guaranteed Volume' concept. TSOs can retain a certain volume of bids eligible for DA by marking some DA bids as not available for activation in SA clearing. For the above reasons, TSOs need to identify locally how much volume of upward and downward direct bids they want to guarantee in their Local Merit Order List (LMOL). In any case, the overall volume that can be marked as "unavailable for GV" shall not exceed the dimensioning of the relevant reserves by the TSO.

Once TSOs have identified the volume to be guaranteed (in each direction), they shall identify in their LMOL the bids that need to be marked unavailable for SA (for GV purpose). In order to ensure a better economic efficiency, TSOs can mark as unavailable only the most expensive direct bids of the relevant LMOL. For more details refer to section 5.

Bids that are marked as unavailable with the purpose to guarantee the access to a sufficient amount of direct activatable bids, will always be forwarded to the CMOLs of the mFRR-Platform but can only be activated through the Platform during the DA process. From the the mFRR energy bids, only those available for both scheduled and direct activation can be marked as guaranteed volume.

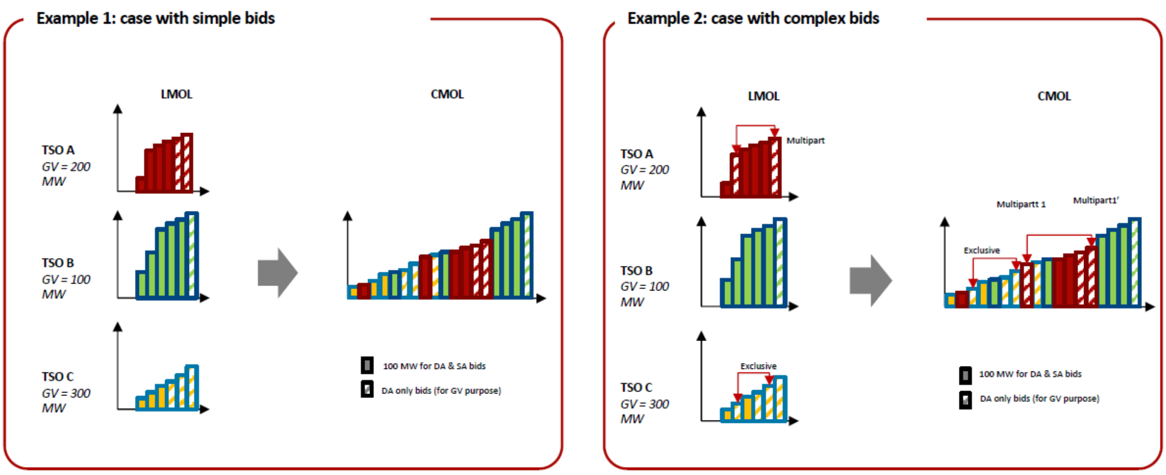

Figure 14[5]: Example of Guaranteed Volume

5 https://eepublicdownloads.azureedge.net/webinars/20201218_Stakeholder_Workshop_Final_APPROVED.pdf

4.2. TSO-TSO standard mFRR balancing exchanged shape

In accordance with the definitions in the mFRR IF and EBGL, mFRR energy offered in standard mFRR energy products must comply with the following characteristics:

- The **preparation period** is the period between the activation request sent by the TSO to the BSP and the start of the ramping period. The preparation period is 2,5 minutes.
- The **ramping period** is the period for linear ramping up to the point of full delivery, during which the input and/or output of active power will be increased or decreased. The ramping period is 10 minutes.
- The **full activation time** (FAT) is 12,5 minutes. FAT is defined as the period between the activation request sent by the TSO to the BSP and the corresponding full delivery. FAT consists of the preparation period and the ramping period. Setting the full activation time for mFRR to 12.5 minutes ensures sufficient time for restoring frequency in accordance with Annex III of the SOGL, which suggests that any frequency incidents have to be dealt with within that 15-minute period.
- The **minimum delivery period** is equal to 5 minutes. During the delivery period, the BSP delivers the full requested change of power (in positive or negative direction).
- The **maximum duration of delivery period** is the period of time during which the BSP delivers the full requested change of power in-feed to/withdrawal from the system. As stated in the previous section, the mFRR IF defines a standardised minimum duration of delivery period of 5 minutes but there are no harmonized conditions set for the maximum duration of the delivery period due to the non-harmonisation of the preparation period, ramping period and the deactivation period.
- The **deactivation period** is subsequent to the delivery period and is the period for ramping from full delivery to a set point, or from full withdrawal back to a set point. The deactivation period will start after the notification of the scheduled auction results for the next quarter hour (QH+1) to the activated BSP taking place at T+7.5. This will allow the BSPs not to deactivate if they are selected again for delivery in the next quarter. For the direct activation, the deactivation will occur around the end of QH+1, regardless of when the activation was initiated. The deactivation period is equal to 10 minutes.

The TSO-TSO energy exchange profile for the Scheduled Activations for a specific quarter-hour has a specific shape (trapezoid), presented in the following figure. Specifically, the preparation period starts on T-7,5, i.e., 7,5 minutes before the beginning of the quarter-hour QH(t0) and the deactivation period ends on T+20, i.e., by 5 minutes after the end of QH(t0), where ‘T’ is the beginning of the quarter-hour and is considered as the ‘point of scheduled activation’.

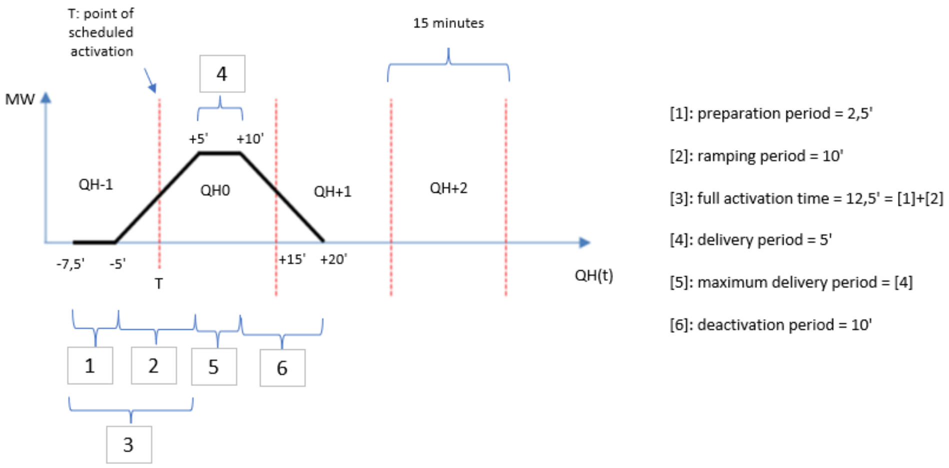

Figure 15[3,4]: Scheduled Activation: TSO-TSO exchanged shape and timings

The delivery of balancing energy for Direct Activations, including ramping, may start at any point in time between T-5 and T+10, depending on when demand(s) arrived on the platform. The delivery will always end at T+35. A Direct Activation (DA) for a specific quarter-hour can be requested by the TSO at any moment after the point of scheduled activation for that specific quarter-hour. Therefore, a direct activation may last at minimum 27,5 minutes and at maximum 42,5 minutes (including FAT). The TSO-TSO energy exchange profile for Direct Activations for a specific quarter-hour has a specific shape (trapezoid), presented in the following figure:

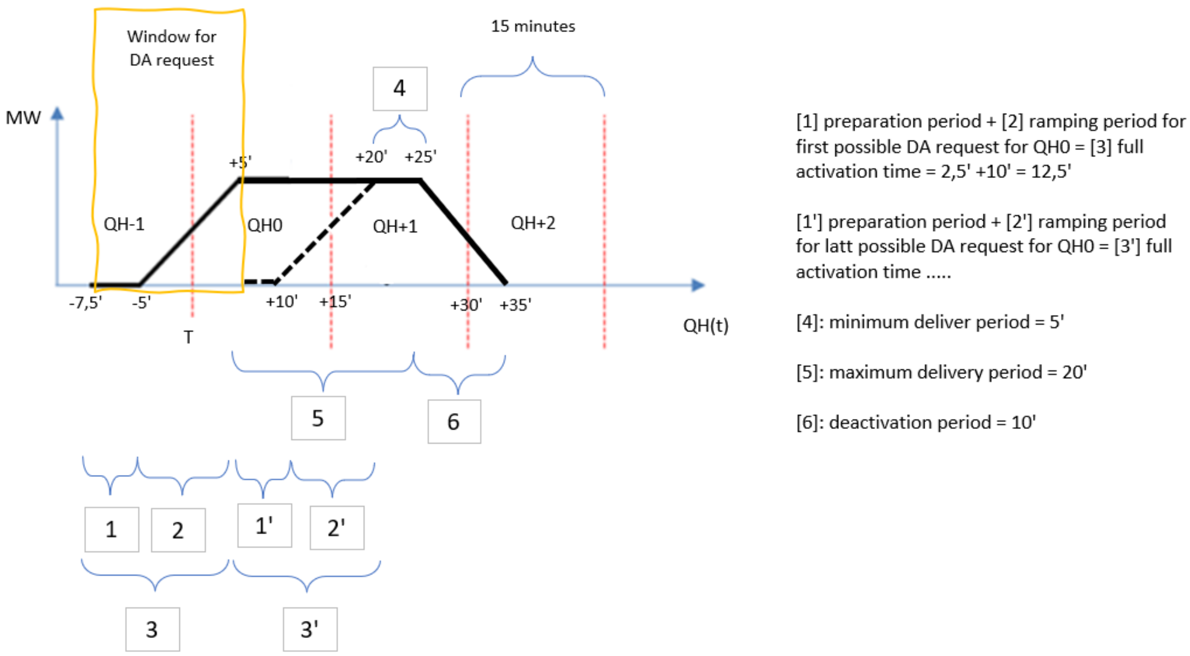

Figure 16[3,4]: Direct Activation: TSO-TSO profile and timings

It is noted that for directly activated bids, the period when energy is actually delivered will stretch until the end of the following MTU period. The start of this period, referred to as activation period, is determined with a configurable precision, initially set to 1 minute, and will coincide with the point in time when the AOF finishes processing the demand(s) that triggered the activation of the bid, plus a configurable allowance (set to 7.5 minutes) for data exchange and ramping.

4.3. Local mFRR balancing energy product characteristics

Following participation in MARI, local mFRR bids' characteristics submitted in the LMOL are expected to be harmonised with the mFRR standard product characteristics (see section 4.1). However, in order to take into account the differences between the various local markets, some mFRR product bid characteristics may be decided on a national level in the terms and conditions for BSPs. This is foreseen so as to ensure TSOs can securely manage the system while, at the same time, guaranteeing liquidity for the mFRR-Platform.

As stated in section 4.1, each bid shall indicate its location (the smallest between the LFC area or the bidding zone). However, more detailed locational information may be required in order to safely manage the system (for example, this information might be needed for solving congestions by filtering bids located in a congested location).

The preparation period, the ramping period, the deactivation period and the maximum duration of the delivery period, desribed in section 4.2, are dependent on the tolerated deviation between the TSO-TSO exchanged shape as described in section 4.2 and the BSP-TSO delivered shape, which is defined individually by each TSO in accordance with their terms and conditions for BSPs.

In the following figure the TSO-TSO exchanged shape (yellow trapezoidal shape) is presented, as well as some indicative TSO-BSP delivered shapes.

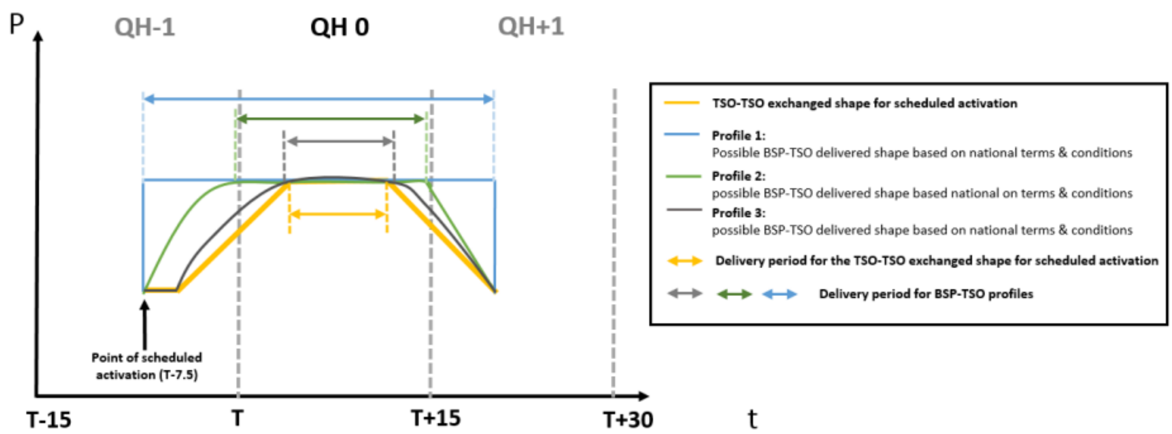

Figure 17[6]: Illustration of different BSP-TSO delivered shapes and their influence on the duration of the delivery period in the case of a schedule activation.

BSPs should follow the activation profile of the TSO-TSO exchanged shape for the requested activations as closely as possible, within a tolerance band. The stricter the tolerance on the deviation between the TSO-TSO exchanged shape and the BSP-TSO delivered shape, the less

[6] Source: MARI Implementation Framework Explanatory Document

the imbalances that will occur. IPTO may set a tolerance band around the TSO-TSO exchanged shape and perform random checks in order to monitor that the delivered BSP profile is within the prespecified tolarance band.

4.4. Submission of mFRR energy bids

TSOs submit to the common platform all balancing energy bids for the standard mFRR product. Bids may be updated up until the TSO mFRR GCT for balancing energy bids at T-12.

After this GCT, mFRR energy bids are considered firm and can no longer be modified by the BSPs. However, in exceptional circumstances the TSO (not the BSP) is permitted to modify the volume, activation type and/or availability status of bids as outlined in article 9 of the mFRR IF. More specifically, TSOs shall be able to submit updates concerning the availability of bids, in response to network outages or system constraints, changes to the volume and the activation type until T+5. No other modifications are foreseen. Due to the design of the AOF, updates to bids after TSO mFRR GCT for demands (at T-10) will not be reflected in the CMOL for scheduled activations. The update will be taken into account by the CMOL for any subsequent direct activations.

The BSP mFRR GCT for the submission of mFRR energy bids to the RTBM will be modified to be in line with the MARI process. As already mentioned in previous sections, according to mFRR IF, the GCT for BSPs to submit the mFFR balancing energy bids to their TSOs is 25 minutes before the start of the concerned quarter-hour, i.e. T-25. However, due to time constraints related to the conversion of mFRR bids by IPTO this timing is not feasible. The BSP mFRR GCT for the Greek market will depend on the time required for the conversion of bids.

The format of the bids also depends on the market design option that will be selected regarding unit commitment, reserve procurement and redispatching.

5. Conversion to standard mFRR energy products

Article 27 of EBGL sets out the requirements for TSOs using a central dispatching model. Article 27(2) of EBGL requires that each TSO applying a central dispatching model uses "[…] the integrated scheduling process bids available for the real time management of the system to provide balancing services to other TSOs, while respecting operational security constraints" and, in accordance with Article 27(3) of EBGL converts "as far as possible the integrated scheduling process bids pursuant to paragraph 2 into standard products taking into account operational security". Moreover, Article 27(3) of EBGL mentions boundary conditions for the conversion rules which must be "fair, transparent and non-discriminatory", shall "not create barriers for the exchange of balancing services" and shall "ensure the financial neutrality of TSOs".

Therefore, pursuant to EBGL, IPTO will convert the bids received by BSPs into standard products using a dedicated conversion platform. The rules for converting the balancing energy bids into mFRR standard products will inter alia respect the following:

- the mFRR standard products characteristics,
- the technical characteristics of the balancing service entities,
- the system constraints for operational security, including reserves.

5.1. Balancing energy bids conversion rules

The rules for converting balancing energy bids into mFRR standard products are indicatevely described below.

- The conversion process will consider bids that can be activated within a quarter-hour from:
  - (a) Entities that are online but not in startup or shut down phase (synchronization, soak and de-synchronization phases) or transitioning phase.
  - (b) Entities that are not in commissioning or testing operation.
  - (c) Entities that have been allocated non-spinning mFRR capacity. This is applicable to Dispatchable Generating Units, Dispatchable RES Units Portofolios and Dispatchable Load Portfolios with zero synchronization time and soak time.
- The conversion process will consider bids that can be activated within a quarter-hour from entintities taking into account:
  - (a) the technical constraints of the entities that are included in the Declared Characteristics such as Technical Minimum Generation, Maximum Net Capacity, synchronization time, soak time, de-synchronization time, soak profile output, minimum up/down time constraints, transition times, ramp rates etc.
  - (b) Non-availability declarations.
  - (c) allocated FCR and aFRR balancing capacity and AGC limits (min/max entity's capacity constraints).

(d) any restrictions on mandatory injections.

(e) Nominated Schedules.

(f) minimum acceptance ratio of the bids.

(g) System constaints.

More specifically, both upward and downward balancing energy bids of a BSE which is contrained by a System constraint will be capped up to the applied limit. Upward and downward balancing energy bids of BSEs for which a group generic constraint applies (System constaint relevant for a group of BSEs) will first be sorted in a merit order list, ascending for upward bids and descending for downward bids, taking also into account the technical constraints of these BSEs and their Nomination Schedules. From the merit order above, the most economic bids will be selected. Bids to shutdown units will be selected last, irrespective of their economic ranking. The bids not selected with the above process will be forwarded to the mFRR-platform but will marked as unavailable both locally and in the MARI platform due to internal congestion (refer to section 4.1).

If indivisible bids exist, then those bids will be excluded, even if they are more economic, in cases where the economic selection violates their indivisibility. As an example, let's assume a group generic constraint applied to three BSEs for a maximum generation limit of 800MW for a certain quarter-hour. The balancing energy bids of each Entity are presented below. Entities B and C sumbit an indivisible bid step (3B and 4C accrordingly). After applying the aforementioned rules the available steps to be submitted to the mFRR-Platform are those from the sum of the Nomination Schedules of all entities up to the maximum generation limit (red window), excluding bid 4C even though it has a lower price.

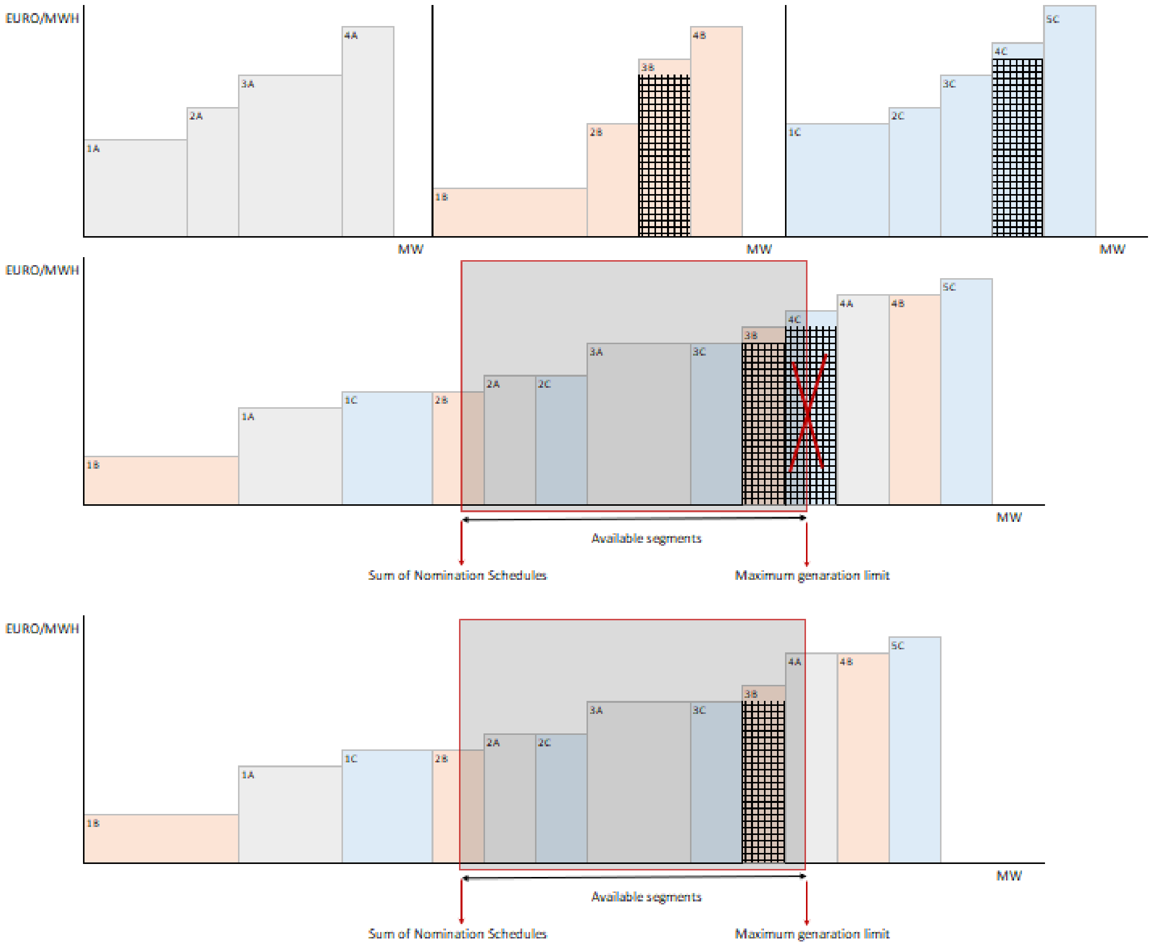

Figure 18: Example of handling indivisible bids.

5.2. Local merit order list to be submitted to MARI platform

The output of the conversion process will be two local merit order lists, LMOLs, one in the upward direction and one for the downward direction. This set of bids will be sorted according to their price, ascending for upward bids and descending for downward bids. If the prices of two or more balancing energy bids for the same Dispatch Period are identical then the following order of priority shall be applied for upward bids: (a) Dispatchable Load Portfolio, (b) Dispatchable RES Units Portfolio, (c) Dispatchable hydro Generating Units, and (d) Dispatchable thermal Generating Units, and the reverse for the downward bids.

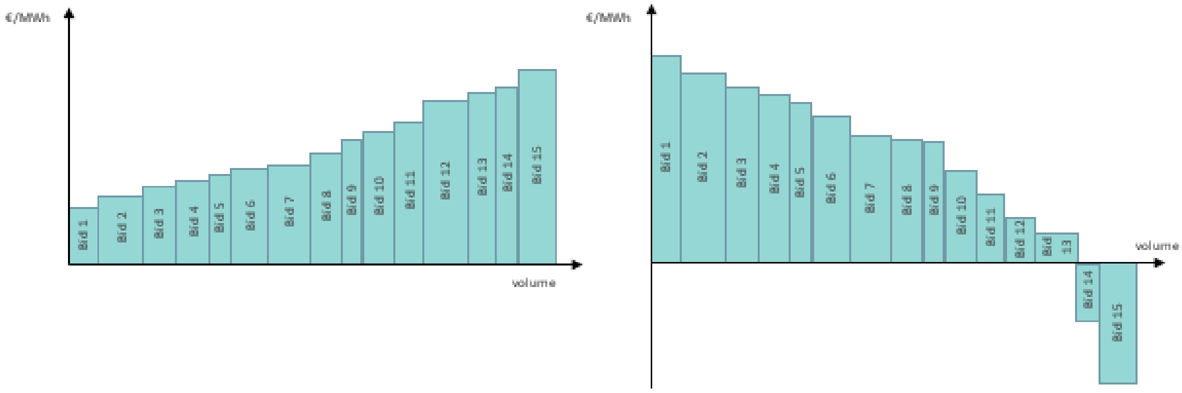

Figure 19: Example of positive and negative merit order list.

After the creation of the two local MOLs, the volume that has been identified by IPTO to be guaranteed (in each direction), will be matched to the most expensive direct bids of the MOL and will be marked unavailable in SA activation (guaranteed volume). If one bid that is part of a multipart group or an exclusive group is selected for guaranteed volume, all associated bids are also selected for guaranteed volume. In such cases the following rules apply:

- The entire volume of the bids in the multipart group is considered as guaranteed volume.
- The largest volume of the bids in an exclusive group is considered as guaranteed volume.

5.3. Local merit order list when disconnected from the MARI platform

In cases where IPTO is disconnected, or local fallback procedures are invoked, the same local merit order will be used by the local mFRR process, RTBM. Therefore RTBM will need to be modified. For more details refer to section 6.2.

6. Activation of mFRR balancing energy bids

6.1. Dispatch instructions

As described in section 4.3, if the mFRR profile delivered by the BSP deviates significantly from the cross-border exchange schedule (TSO-TSO exchanged shape), this may result in additional imbalances for the connecting TSO. Therefore, it is important that the delivered mFRR balancing energy is consistent with the cross-border exchange schedule to limit the impact on the local imbalances. Under and over-delivery should be avoided to the extent possible as this additional imbalance may result in an increased use of short-term products, mostly aFRR, which is expected to have higher procurement costs and lower liquidity. Therefore, it is proposed that entities are incentivized to deliver the TSO-TSO exchanged shape.

For each selected SA mFRR Energy Bid from the MARI platform, IPTO will transform the selected bid into Dispatch Instructions which will be sent to BSEs as a single setpoint (in MW or in MWh). The BSP must reach the setpoint by the end of the FAT and must automatically deactivate the bid according to the figure below. The BSP must follow the activation profile of scheduled activation as described in sections 4.2 and 4.3.

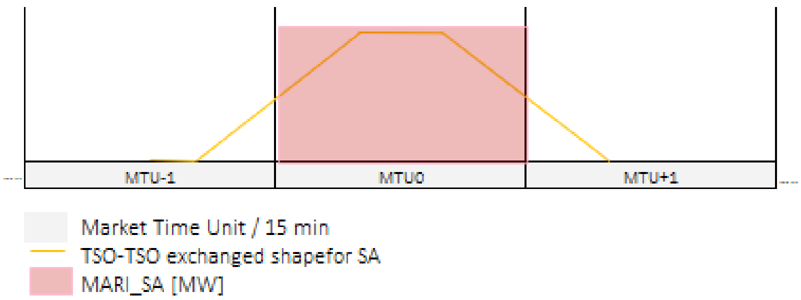

Figure 20: Example of SA Dispatch Instruction.

Likewise, for each selected DA mFRR Energy Bid from the MARI platform, IPTO will transform the selected bid into Dispatch Instructions which will be sent to BSEs as a single setpoint (in MW or in MWh). The BSP must reach the setpoint by the end of the FAT and must automatically deactivate the bid according to the figure below.

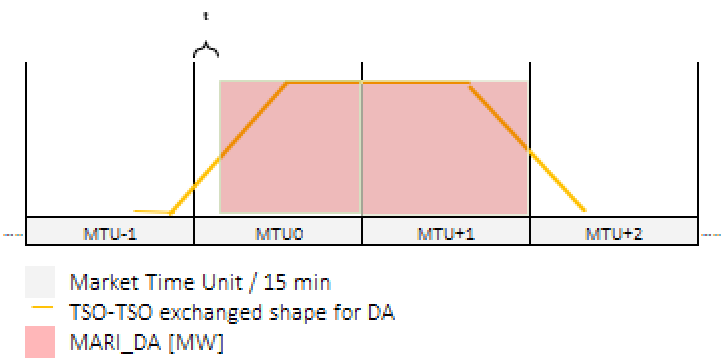

Figure 21: Example of DA Dispatch Instruction.

6.2. Local activation principles

After connecting to the MARI platform, the mFRR energy bids submitted by IPTO can be activated by the MARI platform based on the European common merit order and the MARI AOF. As described in section 3.5, in situations where the MARI platform is not available for any reason, IPTO must disconnect and activate mFRR energy bids using local selection principles for the fallback procedure. IPTO will need to appropriately amend the current mFRR algorithm and RTBM process to address these situations.

7. mFRR balancing energy demands

IPTO will submit to the common platform the mFRR demands for balancing energy for scheduled and direct activations, respectively, referring to a specific MTU period. While all demands for scheduled activations have to be submitted by the TSO gate closure at T-10 (relevant to the beginning of the specific MTU period), the demands for direct activations may subsequently be submitted at any point in time up until T+5 (relevant to the beginning of the specific MTU period). Updating of demands, including cancellation, is permitted up to the point in time when the AOF starts processing the submitted demand.

7.1. Characteristics' of mFRR demands

A demand is always associated with exactly one direction, which may be either upward (positive) or downward (negative). The location of the demand is associated with a given scheduling area. All demands are considered to be divisible. Similar to bids, the activation type must be declared and is either for scheduled activation or direct activation.

The mFRR demands may be either inelastic (price dependent) or elastic (price independent). An 'elastic mFRR demand' is a TSO demand for activation of standard mFRR balancing energy product bid of which the satisfaction depends on the price of standard mFRR balancing energy product bids. An 'inelastic mFRR demand' is a TSO demand for activation of standard mFRR balancing energy product bid, which needs to be satisfied irrespectively of the price of the activation of standard mFRR balancing energy product and therefore the price limit is set to the value of the technical price limit defined in the methodology pursuant to Article 30(1) of the EB Regulation; In other words, an inelastic demand does not have a price and corresponds to a demand that must be satisfied at all costs.

TSO demands have also the following features:

- Quantity [MW]
- Price [€/MWh]
- Location of demand
- Purpose: balancing purpose or system constraint activation purpose. The demands for "Balancing purpose" have a higher priority for MARI AOF than the demands for "system constraints purpose".

7.2. Calculation of mFRR demands

IPTO will calculate mFRR demands for scheduled or direct activation. In order to to compute the mFRR demands for scheduled activation per quarter hour, IPTO will estimate the zonal imbalances and take into account the required de-saturation of the already used aFRR balancing capacity.

For the computation of the mFRR demands for direct activation, IPTO will take into account incidents or unforseen imbalances. In addition, IPTO will also take into account the volumes of mFRR demand not fully satisfied by the MARI platform.

7.3. Satisfied demands

After execution of the AOF for scheduled and direct activations respectively, the MARI platform will send the satisfied demands. When processing the LMOL document with the accepted bids and satisfied demands, IPTO may detect that demands are not entirely satisfied. IPTO may have to perform local supplementary measures to address this situation above (refer to section 3.5.2).

8. Settlement of mFRR energy and imbalances

8.1. mFRR energy settlement prices

The mFRR energy clearing prices are determined by the mFRR-Platform per uncongested area and are called the “Cross-Border Marginal Prices” (CBMP). The CBMP is the price of the last bid of the mFRR standard product which has been activated to cover the energy need for balancing purposes within an uncongested area. In MARI AOF, a set of scheduling areas interconnected by uncongested interconnectors define an uncongested area and a price zone. Within a price zone, all areas are coupled and the price must be the same for all scheduling areas of a given price zone.If there is a congestion on an interconnector connecting two scheduling areas, then there is no price convergence, and price in these two scheduling areas can diverge.

The optimization of the scheduled activations produces a single CBMP per MTU and uncongested area for both upward and downward balancing energy whereas the optimization of the direct activations produces two different settlement prices, one for upward and one for downward balancing energy. After completion of the optimization of scheduled activations, the common platform provides the clearing prices (CBMPs) to the TSOs and after completion of the optimization of scheduled activations for the following quarter hour, the common platform distributes to TSOs the clearing prices for direct activations.

The methodology to determine prices for mFRR balancing energy is based on marginal pricing. Generally, the marginal price represents the price of the last bid of a standard product that has been selected by the mFRR-Platform to cover the energy need (demand) for balancing purposes within a specified area. Given that there may be various optimizations for each quarter-hour, i.e., mFRR with scheduled activation and mFRR with direct activation, multiple mFRR energy clearing prices can be determined. More specifically:

- one for mFRR SA for both positive and negative directions,
- none or more for mFRR DA for positive direction, and
- none or more for mFRR DA for negative direction.

8.1.1. mFRR energy clearing price for Scheduled Activation

For mFRR SA there is only one time point of Scheduled Activation for each quarter-hour. This results in a list of mFRR energy bids to be activated, both in positive and negative directions, and in one clearing price that satisfies the conditions of all selected bids. This clearing price is applicable for the determination of the energy remuneration of all mFRR energy bids selected for Scheduled Activation with delivery in the QH(t).

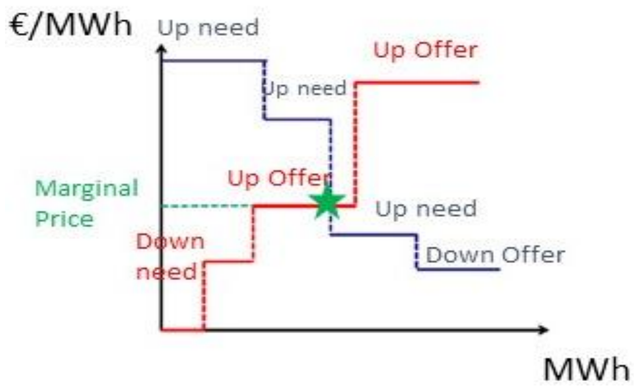

Figure 22: SA clearing example

8.1.2. mFRR energy clearing price for Direct Activation

For mFRR DA, there can be multiple moments of Direct Activations for each quarter-hour. Every DA activation results in two lists of mFRR energy bids to be activated, one in positive and one in negative direction, and accordingly one clearing price that satisfies the conditions of all selected bids for positive direction and one clearing price that satisfies the conditions of all selected bids for negative direction.

Of the selected bids in the DA clearing phase, the one with the highest price sets the marginal bids price for all the bids selected for Direct Activation in positive direction whereas the one with the lowest price sets the marginal bids price for all the bids selected for Direct Activation in negative direction.

Given that Direct Activations may require delivery in the concerned quarter-hour Qh(t) as well as the next quarter-hour Qh(t+1), the energy delivered for direct activation is remunerated differently depending on the quarter-hour of delivery and the relevant clearing price for scheduled activation. More specifically, the price used to remunerate positive energy in response of a direct activation, is the maximum between the 'Clearing Price for SA' and the 'Marginal bid for DA positive direction' of the same quarter-hour of delivery. Accordingly, the marginal price used to remunerate negative energy in response of a direct activation, is the minimum between the 'Clearing Price for SA' and the 'Marginal bid for DA negative direction' of the same quarter-hour of delivery.

Consequently, the energy delivered in the first quarter-hour of a Direct Activation may be remunerated differently from the energy delivered in the second quarter-hour.

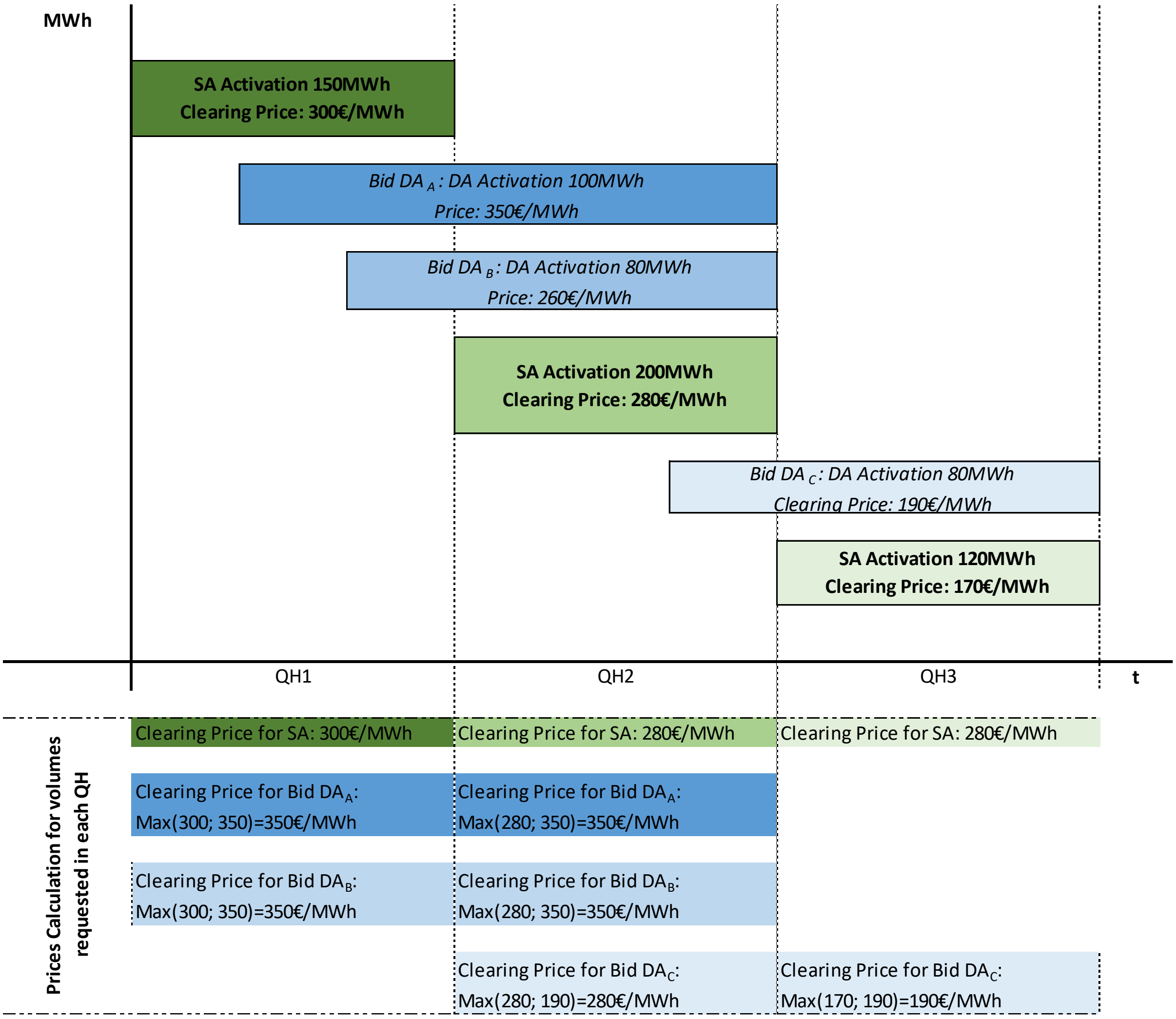

Figure 23: Example of mFRR energy prices determination

8.1.3. mFRR energy prices in congested areas

As explained previously, in case of cross-zonal capacity limitations between adjacent areas, a price split can occur. This means that in each uncongested area the highest selected bid sets the marginal price for the respective area.

The uncongested areas can be different among the different balancing processes. For example, the uncongested areas for mFRR activations can be different from the uncongested areas for aFRR activation. Moreover, as mFRR with direct activation and aFRR are continuous processes, the definition of the uncongested areas for this process may change at any point in time, also within an Imbalance Settlement Period or the quarter of an hour for which the bid is submitted.

8.2. mFRR energy and imbalances calculation

For each entity, e, the selected mFRR energy bids for activation via the mFRR-Platform are remunerated based on the clearing prices for the relevant quarter-hour as follows:

mFRR Energy Remuneration(e,t) =

mFRR Energy Requested(e,t) ∗ *mFRR Energy Clearing Price(e,t)*

Scheduled Activation

The mFRR Energy Requested (MWh) for the relevant quarter-hour corresponds to the expected balancing energy provision for the net selected bids by MARI of a specific entinty for the concerned QH(t) in MW for SA, $MARI\_SA_{\mathrm{MW}}^{Up-Dn}$. If the Dispatch Instruction is received at the point of scheduled activation (i.e. a Scheduled Activation), then the mFRR Energy Requested is remunerated for the red area and the yellow areas correspond to imbalances as depicted in the following figure.

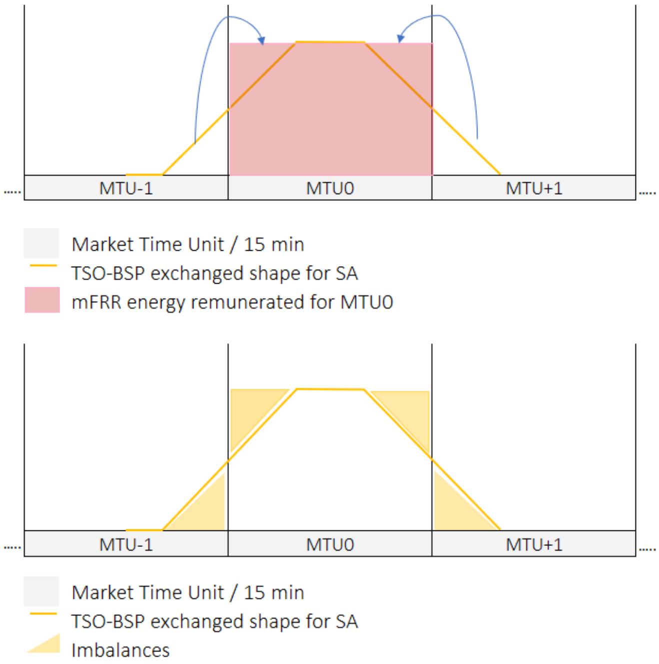

Figure 24: Renumerated volume settlement for SA

For QH(t0) mFRR Energy remunerated is equal to:

$MARI\_SA_{\mathrm{MWh}}^{Up-Dn}$ = $MARI\_SA_{\mathrm{MW}}^{Up-Dn}$ * *1/4 *15/15 [MWh]*

Direct Activation

If the Dispatch Instruction is received before the point of scheduled activation (i.e. a Direct Activation was requested for the previous quarter-hour), then the mFRR Energy Requested (MWh) for the concerned quarter-hour is reduced in proportion to the delay of the activation request in relation to the point of scheduled activation, as depicted in the green area in the following diagram. The mFRR Energy Requested (MWh) corresponds to the expected balancing enegy provision for the net selected bids by MARI of a specific entinty for the concerned QH(t) in MW for DA, $MARI\_DA_{\mathrm{MW}}^{Up-Dn}$. The mFRR Energy Requested is remunerated for the green and red area and the the yellow areas correspond to imbalances as depicted in the following figure.

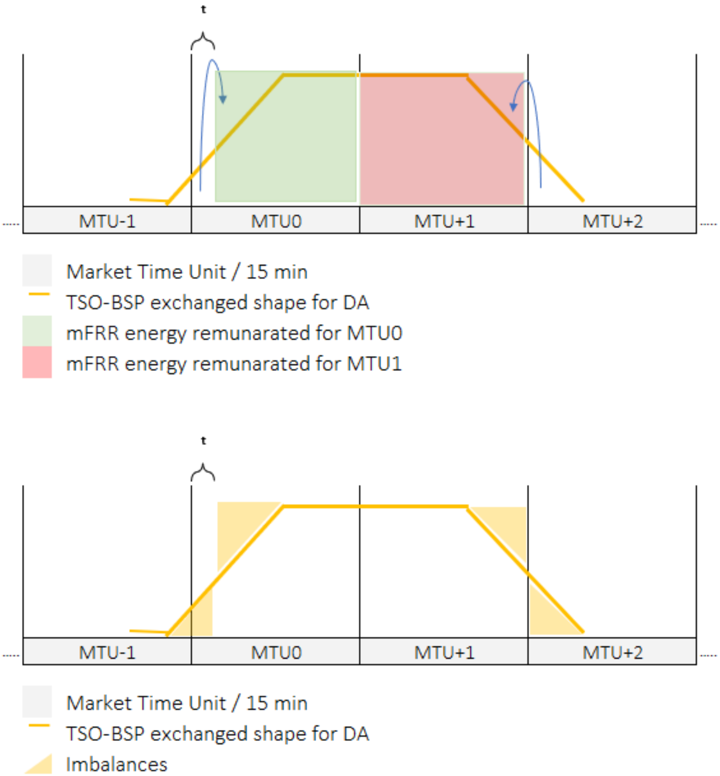

Figure 25: Renumerated volume settlement for DA

For QH(t0) mFRR Energy remunerated is equal to:

$MARI\_DA_{\mathrm{MWh}}^{Up-Dn}$ = $MARI\_DA_{\mathrm{MW}}^{Up-Dn}$ * 1/4 * (15-t)/15 [MWh]

where **t** is the time delay between point of scheduled activation and the time of the direct activation request.

For QH(t+1) mFRR Energy remunerated is equal to:

$MARI\_DA_{\mathrm{MWh}}^{Up-Dn}$ = $MARI\_DA_{\mathrm{MW}}^{Up-Dn}$ * 1/4 *15/15 [MWh]

Instructed Energy

The Instructed Energy for an Imbalance Settlement Period *t* will be calculated as follows:

$$\mathrm{INST\ [MWh]} = \mathrm{NS}_{MWh} + MARI\_SA_{\mathrm{MWh}}^{Up-Dn} + MARI\_DA_{\mathrm{MWh}}^{Up-Dn} + Local\_SA_{\mathrm{MWh}}^{Up-Dn} + Local\_DA_{\mathrm{MWh}}^{Up-Dn}$$

Where,

NS_{MWh}: corresponds to the Nomination Schedule of the entity (in MWh), i.e., the nominated energy schedule resulting from the entity's participation in the previous markets that is technically feasible according to the technical characteristics of the asset and the nominated Balancing Capacity.

$MARI\_SA_{\mathrm{MWh}}^{Up-Dn}$: corresponds to the expected balancing energy provision for the selected bids for SA, by the MARI platform, of a specific entity, for the concerned QH(t), in MWh (mFRR Energy Requested).

$Local\_SA_{\mathrm{MWh}}^{Up-Dn}$: corresponds to the expected energy provision for the selected bids for SA, by the local mFRR-Platform, of a specific entity, for the concerned QH(t) in MWh.

$MARI\_DA_{\mathrm{MWh}}^{Up-Dn}$: corresponds to the expected balancing energy provision for the selected bids for DA, by the MARI platform, of a specific entity, for the concerned QH(t), in MWh.

$Local\_DA_{\mathrm{MWh}}^{Up-Dn}$: corresponds to the expected energy provision for the selected bids for DA, by the local mFRR-Platform, of a specific entity, for the concerned QH(t), in MWh.

8.3. Imbalance price calculation

No changes are expected in the imbalance price calculation. Specifically, the imbalance price for an Imbalance Settlement Period shall be calculated as the weighted average of the prices of the activated Balancing Energy, via the MARI Platform and via local mFRR process, in the predominant direction (upward or downward) for manual and automatic FRR.

If there has been no activation of balancing energy, the imbalance price ia calculated as the value of avoided balancing energy activation.

8.4. Financial settlement

8.4.1. Price formation

If there is no congestion on the borders between the various scheduling areas then the highest activated bid price defines the price for the TSO-TSO settlement as well as the price for the TSO-BSP settlement for all scheduling areas. Every BSP receives the same price for the activated balancing energy from the connecting TSO and every TSO pays/receives the same marginal price for imported/exported (cross-border) balancing energy.

If a congestion occurs on some borders, the capability of exchanging balancing energy is limited and less energy than economically optimal can be exchanged. This leads to the dermination of various uncongested areas, which are defined as a set of scheduling areas interconnected by uncongested interconnectors. Different prices are set in each uncongested area. Specifically, the highest activated bid in each uncongested area sets the marginal price of that specific uncongested area. The price difference due to the congestion on the border creates a congestion income, which is handled in a way that guaranties financial neutrality of both TSOs.

8.4.2. Financial Settlement timeline

The TSO-TSO settlement is performed monthly by a Billing Agent who sends invoices to the TSOs before the end of the 5th working day of the month M+1, where M refers to the delivery month for which the settlement is performed. The payments by the TSOs to the Billing Agent are performed no later than thirty (30) calendar days after the date of issuance of the invoice and the payments by the Billing Agent to the TSOs are performed no later than thirty-two (32) calendar days after the date of issuance of the invoice. Finally, the correction of invoices is possible up to thirty-six months after the month of delivery.

The aforementioned timeline affects the timeline of the local balancing market settlement as performed today. Two options have been identified. The first is to switch to monthly local settlement cycles in order to take into account MARI settlement results in the initial settlement. This option increases the risk for the Clearing House and will increase the required guarantees by the BSPs, but reduces the need for corrective settlements. The second option is to continue with weekly local settlement cycles. In this case, financial exchanges with other TSOs will initially (on the weekly local settlement) be credited/debited to the Uplift Account 3 (Financial Neutrality Account) and will be corrected with a local corrective settlement performed after the finalization of the TSO-TSO settlement. This could create large variations in the cost of Uplift Account 3 depending on the direction of the energy flows by the MARI platform. The monthly settlement cycle of MARI also affects corrective settlement timing which is now performed in week W+6 and will have to be performed after the receipt of the monthly MARI settlement statement. Moreover, the local Final Settlement will also have to be performed after the finalization of the MARI settlement which may performed up to thirty-six months after the month of delivery.