NGESO MARI REFERENCE DOCUMENT

Contents

1. Introduction

1.1 Document Change History

Version	Issued Date	Changes	Comments
1.0	28/10/2020	Issued for External Distribution	Please note, this is a draft document and subject to change/evolve over time as NGESO gathers more information from the central project and receives feedback both internally and externally
2.0	25/11/2020	Widened scope of document	Section on types of bids, impacts to interconnectors and frameworks added (based on internal and external feedback)
3.0	08/12/2020	Updates to the definitions, feasibility of bids and multipart bids.	Changes made to reflect workgroup 6 and 7 feedback

1.2 Background

Manual Frequency Restoration Reserve (mFRR) is an energy product defined within the Electricity Balancing Guideline (EBGL). The product will be traded across different Transmission System Operators (TSO) control regions, with a central European platform (Libra), responsible for activation of the product (both scheduled and direct activations) and resultant energy flows across TSO boundaries.

P407 BSC and GC0145 Grid Code modification were raised within Great Britain (GB) to facilitate the energy transactional changes arising from the EBGL within Great Britain.

National Grid ESO as the Transmission System Operator in Great Britain will as part of its obligations under the above-mentioned legislations, manage the mFRR bids, Libra accepted bids and issue resultant instructions to Balancing Service Providers (BSPs) without compromising the integrity of the UK energy grid and transmission systems.

1.3 Glossary of Terms / Abbreviations

Term	Definition
AOF	Activation Optimisation Function; as defined by EB GL article 2(39)
Activation period	For the mFRR standard product, the activation period starts in the middle of ramp-up and ends in the middle of ramp-down. For scheduled activations the activation period is equal to 15 minutes and coincides with the MTU period that is being optimized by the AOF. For direct activations the activation period may have a duration from 15 minutes up to 30 minutes, starting during the MTU period being optimized by the AOF and ending with the following MTU period.
Area	Unless explicitly specified, area may refer to either a scheduling area, LFC area, control

	area, LFC control block or an aggregation thereof.
ATC	Available Transmission Capacity – this is the transfer capacity remaining available between two interconnected areas for further commercial activity over and above already committed utilisation of the transmission networks.
Balancing service provider (BSP)	As defined by EB GL art. 2(6)
BMU	Balancing Mechanism Unit
BOA	Bid Offer Acceptances (A dispatch Instruction issued to a BSP from NG). Used to indicate BM market only instructions
BSP	Balancing Service Provider
CBCL	Cross-border capacity limits
Desired Flow Range	In addition to the capacity limits, constraints on the resulting minimum and maximum flows may be submitted for the purpose of interconnector controllability, due to operational constraints or countertrading. Such constraints are permitted for AC links as well as for HVDC links. Such constraints are referred to as desired flow ranges.
Direct activation (DA)	Direct activation can be initiated at any point in time after scheduled optimization has begun for given MTU period
Full Activation Time	Full Activation Time is the maximum time that a BSP has available to deliver full power. In MARI, the FAT is 12.5 minutes. The 12.5 minutes comprises of 2.5 mins for BSP preparation plus a 10 min ramp.
FPN	The Final Physical Notification (FPN) is the generation or consumption profile of the BMU for each settlement period (30 mins) of the day.
Gate Closure	Gate Closure is a point one hour prior to the start of a Settlement Period. This is the point by which BSC parties must submit information to National Grid regarding their planned production or consumption in a Settlement Period
GCT	Gate closure time
HVDC	High voltage direct current
ICRP	Interconnector Reference Program
IF	Implementation Framework
MEL	Maximum export limit
mFRR	Manual frequency restoration reserves; active power reserves that may be manually activated, available to restore system frequency to the nominal frequency and, for a synchronous area consisting of more than one

	LFC area, to restore power balance to the scheduled value.
MTU	Market Time Unit
PN	Physical Notification
PRCL	Used for TERRE - Post Reserve Committed Level - the proposed new level for the one hour period covering the results of the Libra auction including the addition of ramps. In calculating this variable no BOAs are included.
PmFRRCL	Used for MARI (term subject to change) - The post mFRR committed level (PmFRRCL) is the proposed new level for the mFRR auction period (15 mins) covering the results of the Libra auction including the addition of ramps. It is the unit's new level when the participants submitted MEL/MIL and import/export run up and down ramps rates have been applied to the PmFRRL.
PmFRRL	Used for MARI (term subject to change) –The post mFRR level (PmFRRL) is the summation of the PRCL and mFRR averaged across the activation period.
PRRL	Used for TERRE - Post Replacement Reserve Level = FPN (Final Physical Notification) + RRA averaged across each Quarter. For the avoidance of doubt, MEL/MIL and ramps are not applied at this stage. The PRRL will have discontinuities if the RRAs for given 15 minute periods are at different levels. In calculating this variable no BOAs are included.
QH	QH is the quarter hour corresponding to the delivery of the balancing energy bid.
RR	Replacement Reserve. Replacement Reserve is a harmonised service across participating European TSOs for the provision of both an increase and decrease of active power.
RRA	Used for TERRE - Replacement Reserve Acceptance: The volume activated by Libra after optimisation for each Market Participant against each activation period.
Scheduled activation (SA)	scheduled activation can be initiated only at a specific point in time in relation to given MTU period
Settlement period	A period of 30 minutes ending on the hour and half-hour in each hour during a day.
Social Welfare	'social welfare' means in the context of activation optimisation function, the total surplus of the participating TSOs that is obtained from satisfying their mFRR demand submitted to the mFRR Platform and the total

	surplus of balancing service providers (“BSPs”) resulting from the activation of their associated submitted standard mFRR balancing energy product bids. The curve consisting of the positive TSO mFRR demand and the downward BSP standard mFRR balancing energy product bids submitted to the mFRR-Platform constitutes the consumer curve, and therefore indicates the maximum price consumers (TSOs and BSPs) are willing to pay for consuming mFRR balancing energy.
TSO	Transmission System Operator

1.4 Document objective and scope

This purpose of this document is to provide guidance to the wider industry on the mFRR process, the product shape, the dispatch principles underlying mFRR processing and finally mFRR interaction with other products (e.g. BM and RR).

Please note, this is a draft document and subject to change/evolve over time as NGESO gathers more information from the central project and receives feedback both internally and externally, thus ensuring the mFRR process is fit for purpose.

2. Brief Process Overview

2.1 Operational Context

The MARI platform has several operational phases, summarised below:

Tendering phase – The gate opens for BSP bid/offer submissions at T-120. Bids may be freely updated up until the BSP GCT at T-25, this will give NGESO time to validate[1] and submit bids to the central platform (T-12). NGESO will then submit the bids and demands, available cross-border capacity limits and, where applicable, desired flow constraints and HVDC interconnector schedules, to the MARI platform.

NB - For NGESO to be able to submit the cross-border capacity limits, we need to receive the ICRPs in time to calculate the ATC. For TERRE, we will be receiving ICRPs every hour and then an updated ICRP is expected after the TERRE results are issued. We can use the updated ICRP to calculate the ATC for MARI. In addition to the capacity limits mentioned above, constraints on the resulting minimum and maximum flows may be submitted for the purpose of interconnector controllability, due to operational constraints or countertrading. Such constraints are referred to as desired flow ranges.

As part of the tendering phase, each bid is assigned an activation type, which must be exactly one if the following:

[1] NGESO will validate and reject bids deemed infeasible before submitting to the platform

1) '*Scheduled only'* means a bid which can be activated at the point of scheduled activation only. This point is currently set at T-7.5, meaning 7.5 minutes before the beginning of the quarter hour for which the bid was submitted;
2) '*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, currently set to between T-7.5 and T+7.5, meaning 7.5 minutes before and after the beginning of the quarter hour for which the bid was submitted;
3) '*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. Only TSOs are permitted to mark a bid with activation type 'Direct only'. This activation type cannot be submitted by market participants.

The activation type is determined before the bid gets submitted to the mFRR platform but may be updated subsequently. For GB, only NGESO is permitted to mark a bid with activation type '*direct only*', as NGESO may want to avoid a situation where bids eligible for DA become exhausted during SA, leaving NGESO with limited reserves. Therefore, NGESO can retain a minimum volume of bids eligible for DA also after SA, by marking some bids as eligible for DA only.

NGESO then submits the requirement (referred to as a 'demand' in the central project) to the common platform. See the mFRR timings section below for more detail.

NB - the availability of bids must be indicated, distinguishing between availability and unavailability (i.e. cannot be activated by the AOF). Under the mFRR IF, TSOs are permitted to modify the availability and the volume of the bid at any time up until T+5. EB GL article 29.14 contemplates two possible reasons for declaring a bid as unavailable; internal congestion or operational security constraints.

Clearing phase – the optimization module is executed on the MARI platform which allocates bids to demands, determines clearing prices and calculates the cross-border flows. After the clearing phase for scheduled activations, NGESO can submit a demand for direct activations, which will be processed as soon as possible.

Results verification phase - the resulting local merit order list with the satisfied needs and accepted bids is sent to NGESO, along with the cross-border flows, the remaining ATC, clearing prices and the net position. For scheduled activations, the results shall apply for the entire QH0 while for direct activations they apply for a fraction of QH0 (size of which depends on when the AOF completed processing the demands) and until end of QH1.

Dispatch and settlement – NGESO is responsible for forwarding the activations to the BSPs upon receiving the results from the MARI platform. No later than T+30 min, the MARI platform will submit the clearing prices, aggregated energy bids and all individual energy bids to the ENTSO-E Transparency Platform, as well as other transparency information required by the mFRR IF. The MARI platform will send financial data to the accounting service provider at the end of the settlement period.

2.2 MFRR Timings

Figure 1 below exhibits the timing in order to satisfy a fifteen-minute scheduled activation period starting at T and ending at T+15 and the direct activation period and starting at T and ending at T+30 for direct activation.

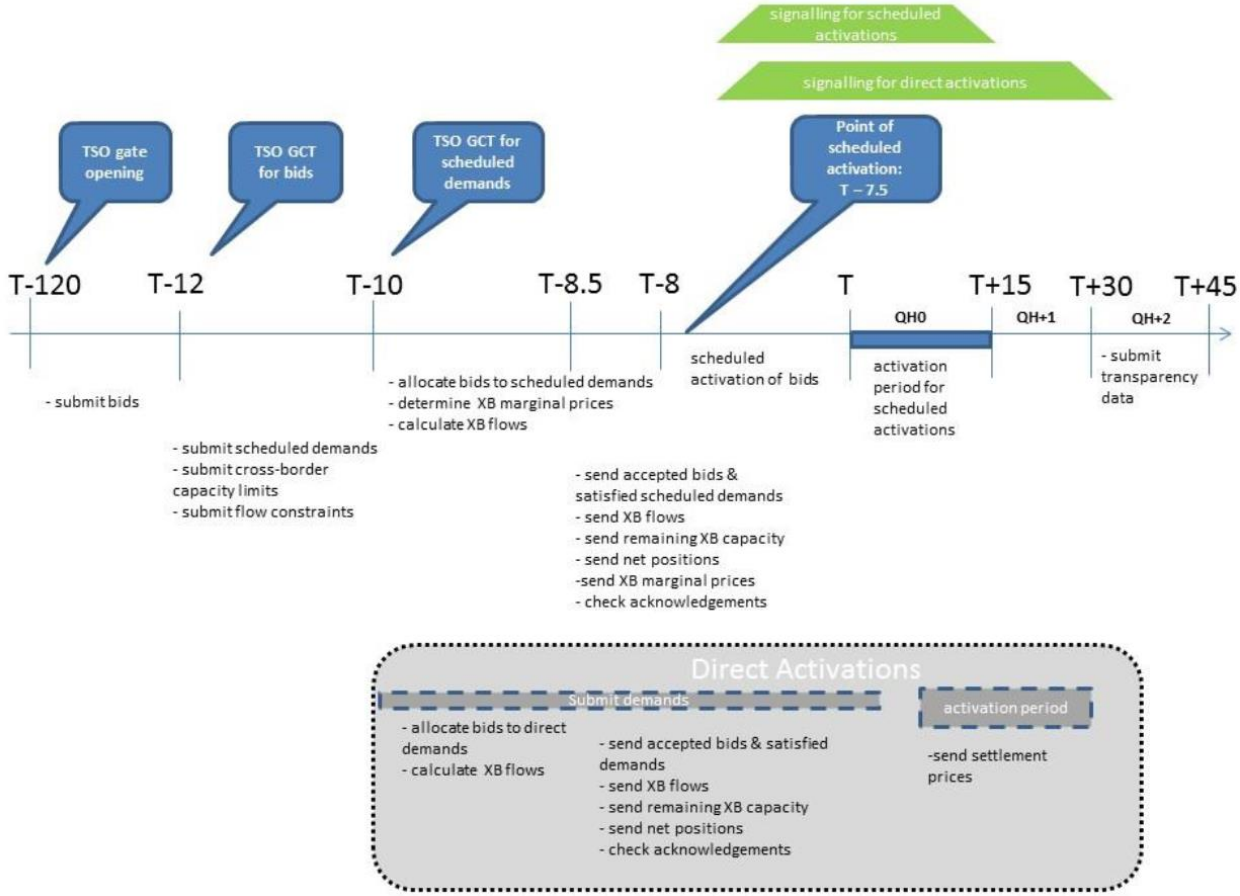


Figure 1: process timeline of the mFRR platform

Timings for Scheduled Activations

Time	Process
T-120	gate opens for submissions of all types of data from the TSO to the mFRR platform, except for demands for direct activations.
T-12	TSOs must submit to the mFRR platform all their bids no later than T-12
T-10	TSOs must submit to the mFRR platform their demands for scheduled activations no later than T-10. NB –changes in availability or in the offered volume of energy bids may be submitted at any time, however if submitted after T-10 such updates will be taken into account during subsequent direct activations only.
Between T-10 and T-8.5	Between T-10 and T-8.5 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.
Between T-8.5 and T-8	the resulting net positions, cross-border flows and remaining capacity are sent to TSOs together with cross-border marginal prices and the bids selected for activation and the satisfied demands.
T-8	the scheduled activation phase begins during which bids selected by the AOF are communicated by each TSO to their respective BSPs. 30 seconds are foreseen to communicate the results from the mFRR platform to the TSOs, followed by an additional 30 seconds for the communication from TSOs to BSPs.
T-7.5	scheduled activation is initiated
Between T-5 and T+20	Delivery of balancing energy for scheduled activations, including ramping, occurs. This is also the time interval during which corresponding signalling will occur.
T+45 the latest	reporting of data to the ENTSO-E central transparency platform shall occur

Timings for Direct Activations

Time	**Process**
T-120	gate opens for submissions of all types of data from the TSO to the mFRR platform, except for demands for direct activations.
T-12	TSOs must submit to the mFRR platform all their bids no later than T-12
T-10 until T+5	TSOs may submit their demands for direct activation. Processing of such demands will have to wait until the AOF completes the SA (or previous DA). 20 seconds are allocated to the platform for executing a direct optimisation, of which 15 seconds are granted to the AOF. This is followed by another 30 seconds for communicating the results to the TSOs.
T-5 and T+10	Delivery of balancing energy for direct activations, including ramping, may start within this timeframe. For direct activation, the activation period stretches until T+30, i.e. until end of following quarter hour. Delivery will always end by T+35 (5 mins ramp after the activation period).
T+7	Settlement prices related to the energy delivered in MTU1 for direct activations submitted for MTU0 can only be determined and distributed to TSO by this timeframe, after the scheduled optimisation for MTU1.

T+35	Delivery will always end by this time. This is also the time interval during which corresponding signalling will occur.
T+40 the latest	TSOs submit the detailed reasons for changes to bid availability
T+45 the latest	reporting of data to the ENTSO-E central transparency platform shall occur

3. Types of bids

NGESO will submit the bids received from BSPs to the mFRR platform. The AOF platform will facilitate different types of bids. These bid types can be divided into three broad categories for BSPs:

1) Simple bids (within one MTU)
2) Complex bids (within one MTU)
3) Linked bids (between MTUs)

It remains the responsibility of BSPs to correctly identify their bids, in order to avoid unfeasible activations (e.g. double activation of the same resources).

3.1 Simple bids

Simple bids are those bids, which are not linked together in any form. Every simple bid is characterized by a unique price. The offered volume determines the size of the bid. Depending on the size of the minimum offered Volume; the following types of bid can be modelled:

3.1.1 Divisible bid

Bids can be 'fully divisible' meaning that any portion of the volume of the bid may be activated. A 100MW fully divisible bid may be activated at anywhere between 1MW and 100MW.

3.1.2 Indivisible bid

An 'indivisible bid' means a standard mFRR balancing energy product bid, which cannot be activated partially in terms of power. Therefore, the volume of an indivisible bid is always activated altogether (i.e. all or nothing).

3.2 Complex bids

A complex bid consists of a group of bids within the same MTU period that are associated with each other. The following two types of complex bids will be supported by the platform: Exclusive and multipart bids.

The bids making up a complex bid must all originate from the same scheduling area.

3.2.1 Exclusive bids

Exclusive bids are mutually exclusive according to the principle "exactly one or none". They may have different prices, directions and volumes. They must have the same activation type and availability status. Exclusive bids always refer to the same MTU period.

3.2.2 Multipart bids

If an upward multipart bid is accepted, then all associated bids with lower prices must also be accepted. If a downward multipart bid is accepted, then all associated bids with a higher price must also be accepted. This is referred to as parent-child linking. In the case of multipart bids, each link

has a parent and a child. Each parent and each child has an associated price[2] and quantity. They must all have the same activation type, availability status, MTU period and have the same direction.

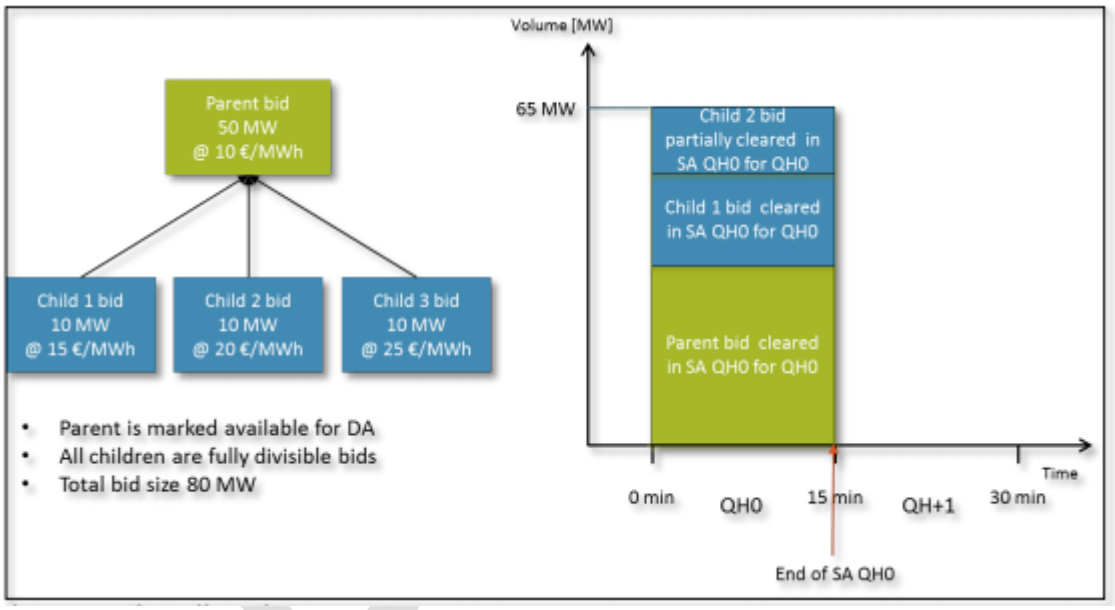
The parent bid will be the cheapest one for the positive direction and the most expensive for the negative direction.

For example, consider the following multipart bid for the quarter hour 03:15-03:30 in upward direction, consisting of the following associated components:

a) 300MW at 10 €/MWh
b) 100MW at 15 €/MWh
c) 50MW at 20 €/MWh

Bid (a) may be activated on its own. Bid (b) may be activated only if also bid (a) is activated. Bid (c) may be activated only if also bids (a) and (b) are activated.

The diagram below also demonstrates the parent-child linking. In this example, 65MW of upwards volume has cleared in scheduled activation. This multipart bid consists of the parent bid which is the cheapest bid at 10 €/MWh, the child 1 bid at 15 €/MWh and partial volume of the child 2 bid at 20 €/MWh.



If any component / any bid in the multi-part bid is accepted in scheduled activation, none of the other components would be available in direct activation.

3.3 Linked bids

There may be links between bids in different MTU periods. Two different types of links are supported; technical and conditional.

The links will apply retrospectively, i.e. the availability of a bid is determined by the outcome for the linked bids in earlier, already optimized MTU periods. While linking allows to determine the availability of a bid based on the outcome of another bid in a previous MTU period, it should be

[2] All bids in the multi-part bid should have different prices.

noted that there is no limit on the continuation of linking into future MTU periods. The bid in MTU0 may subsequently influence the availability of a bid in MTU1 etc.

Technical and conditional bids are 'binary', in the sense that only the availability of the bid in QH0 is affected by the outcome of the bid(s) in earlier quarter hours.

It is possible to have both technical and conditional links between bids, however in such cases the bids must all be simple.

Bids that are linked must originate from the same scheduling area.

3.3.1 Technically linked bids

At gate closing for QH0, the BSP does not know the result of the clearing for DA for QH-1. Therefore, if the bids submitted for QH-1 and QH0 represent the same asset or the same pool the dependencies between those bids must be communicated to the mFRR platform in order to prevent overlapping or unfeasible activations.

Technical linkage is the **linkage of two bids (simple or complex) in two subsequent quarter hours**. Technical linking is typically used to model limitations in the underlying asset that delivers the balancing energy bid. Each of the bids within the linked bid must be associated with a unique quarter hour. From the viewpoint of the platform, these links will indicate the allowed combinations of direct and scheduled activations of the bids. The following rile will be supported:

- *A bid that underwent direct activation in QH-1 (i.e. for the preceding quarter hour) is not available in QH0, neither for scheduled nor for direct activation. This rule shall always be enforced by the AOF.*

3.3.2 Conditional bids

At gate closing for QH0, the BSPs do not have the knowledge, if their bid in QH-2 was activated in DA or if their bid in QH-1 was activated in SA or DA. A bid in QH0 may for example be available / unavailable for clearing if bid in QH-2 was activated in DA or bid in QH-1 was activated in SA.

Conditional linking is a **link between two or three adjacent quarter hours and is only applicable to simple bids** (for day 1 of go live).

A given bid in QHO may have between zero and three conditional links to bids in QH-1 and/or between zero and three conditional links to bids in QH-2. The bid in QH0 becomes either completely unavailable or unavailable for direct activation when at least one of those links indicate unavailability.

The following types of conditionality shall be supported:

- *Bid in QH0 not available if bid in QH-1 is activated/activated in SA/activated in DA*
- *Bid in QH0 not available if bid in QH-1 or QH-2 is rejected*
- *Bid in QH0 not available for DA if bid in QH-1 or QH-2 is activated in SA*
- *Bid in QH0 not available for DA if bid in QH-2 is activated in DA*

All bids subject to conditional linking have an initial availability status: they may be either available or unavailable. The conditional linking will turn the initial availability status of bids to the opposite availability status if the condition materialises.

4. Product Shape and Ramp Incentives

4.1 mFRR product shape

TSO-TSO standard product shape

The 'TSO-TSO' shape is well defined. This is the power profile that is exchanged between TSO control areas – i.e. cross-border exchange. This shape consists of a 10-minute linear ramp to full power, a 5-minute period at full power (for scheduled activation) and a 10-minute deload ramp (see figure 2 below). A 10-minute ramp equals the ramp which is used for scheduled programs of exchange across Continental Europe. Full Activation Time is 12.5 minutes. The 12.5 minutes comprises of 2.5 mins for BSP preparation plus a 10 min ramp. There are also standard mFRR bid characteristics (see figure 3 below).

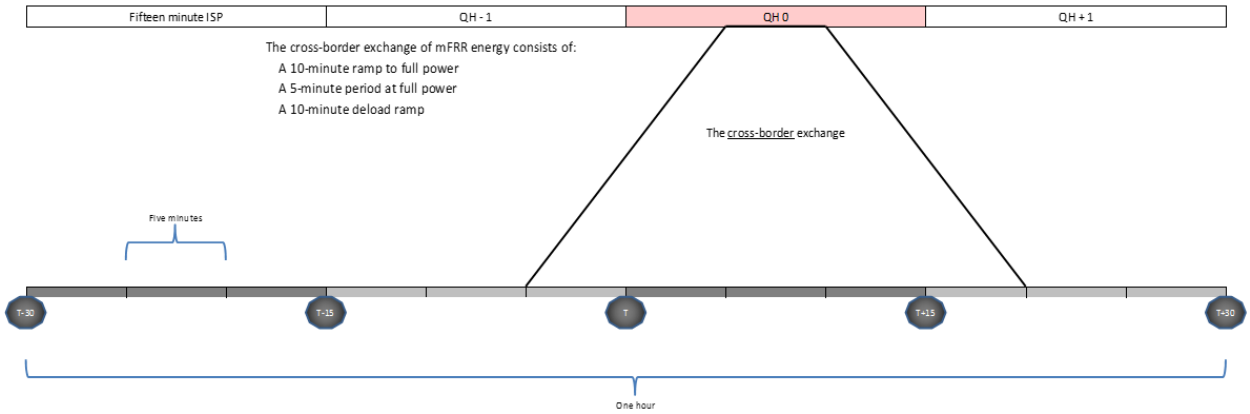


Figure 2 – mFRR standard product shape

Mode of activation	Manual
Activation type	Direct or scheduled
Full activation time ("FAT")	12.5 minutes
Minimum quantity	1 MW
Bid granularity	1 MW
Maximum quantity	9,999 MW
Minimum duration of delivery period	5 minutes
Validity Period	A scheduled activation can take place at the point of scheduled activation only. A direct activation can take place anytime during the 15 minutes after the point of scheduled activation.

Figure 3 - Standard mFRR product bid characteristics

For direct activations, the duration of the delivery period will be dependent on when the bid is activated and on the point of deactivation. Assuming a ramp of 10 minutes and deactivation at the end of the next QH, the duration cannot be longer than 20 minutes. The TSO-TSO shape develops when there are scheduled and subsequent direct activations over a border (see figure 4 below).

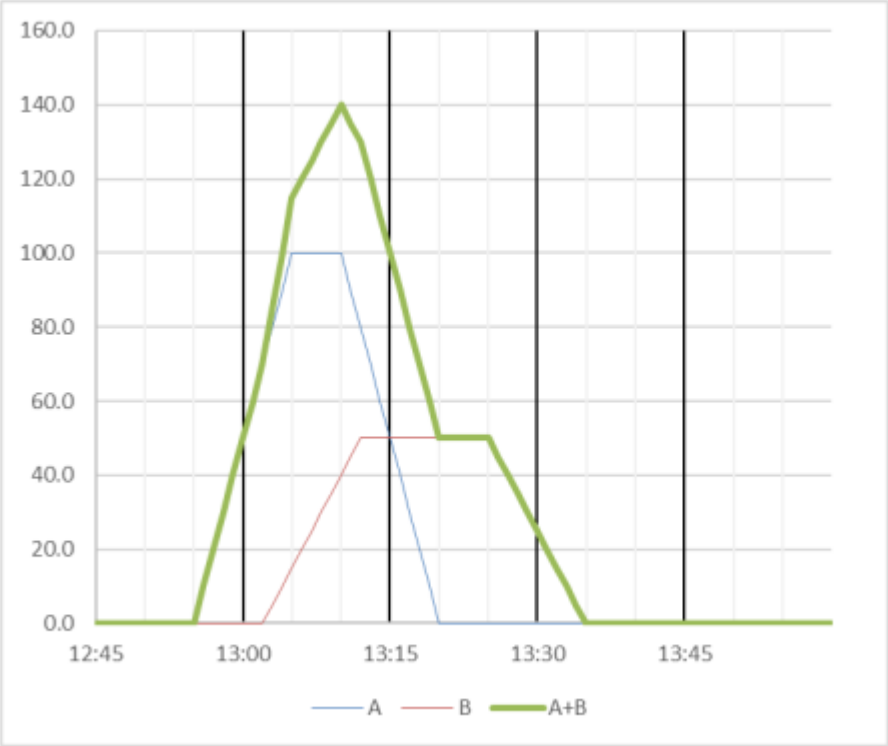


Figure 4 – Example SA versus DA activation & resulting net position in MTU period 1300-1315.

BSP Product Shape

The 'BSP-TSO delivered shape' refers to the actual delivery/withdrawal of certain units. Each TSO can define the BSP shape (e.g. the preparation period, the ramping period, deactivation period, maximum duration of delivery period).

The desired BSP delivered shape should align with the TS0-TSO exchanged shape (to avoid imbalance and frequency deviations for NGESO). Therefore, the BSP-TSO shape is a ramped shape.

For both scheduled and direct activations the ramping will be the same (10 minutes to full power). For scheduled activations the full activation time is 5 minutes. For direct activations the activation period will vary depending on the need (up to T+30).

4.2 Incentivising the BSP Product Shape

The MARI market will pay for any volume delivered within the standard allowable ramping period of 10 minutes, starting from 5 minutes before the activation period and ending 5 minutes after the activation period. This volume aligns with the TSO-TSO shape and TSO-BSP shape.

Any deviation from this shape will be settled at the Balancing Energy Deviation Price (BEDP) which has been (currently) set to zero. Therefore, any volume delivered outside of the standard product shape will not be paid for. For units with longer ramps than the standard product shape, the ramp

will not be paid for. For quicker ramps, as long as the volume is the same as the volume of the standard product shape, the BSP will not be penalised.

These settlement principles align with the TERRE market, and have been set out to encourage BSPs to follow the standard product shape, whilst avoiding barriers to entry. NGESO can change these principles if necessary[3].

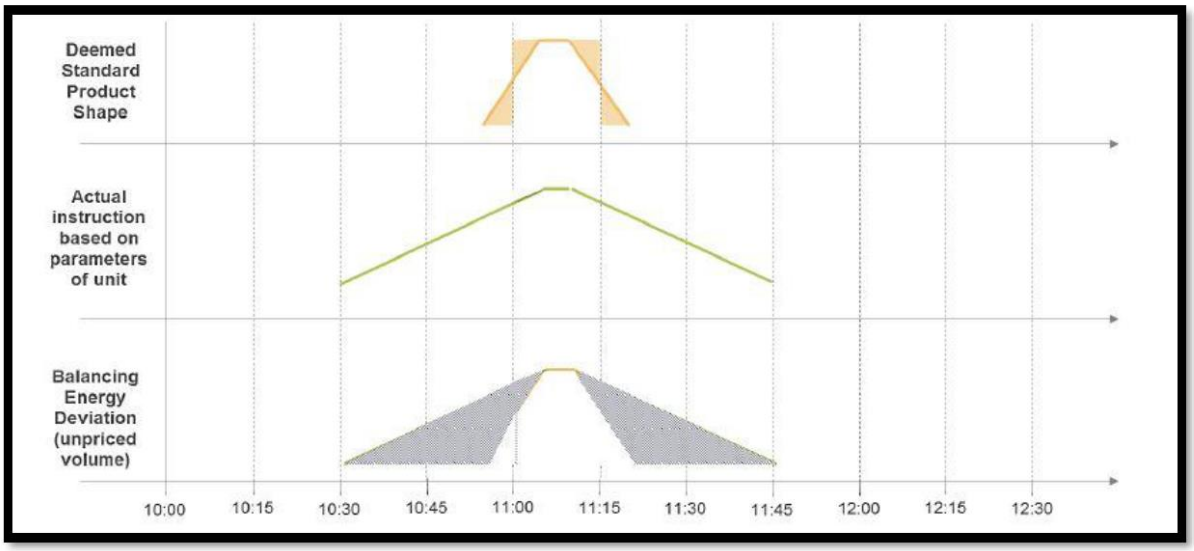


Figure 5 - Standard Product Shape for TERRE – the same incentivization principles will apply for mFRR

5. Impacts to Interconnectors

5.1 How will the AOF determine the cross-border schedule?

The AOF that will be used in the mFRR platform is based on the maximization of social welfare and the minimization of manual frequency restoration power exchange on borders which is effective in case the maximization of the social welfare provides multiple optimal solutions.

The AOF uses as input the common merit order lists (CMOL) with the balancing energy bids submitted by the BSPs, the balancing energy demands submitted by the TSOs, as well as network information, i.e. HVDC constraints. The AOF creates a cost curve consisting of the TSO balancing energy demands and the CMOLs of all bids, and based on this curve as well as on all defined constraints, it provides the optimal social welfare, the satisfied demands, the accepted bids, the XB marginal prices and the XB commercial schedules.

5.2 Cross-border capacity limits

NGESO can provide to the common platform the cross-border capacity limits (CBCLs) as well as any applicable technical profiles or net position limits. This information will be used by the AOF when selecting energy bids to satisfy the demands for scheduled and direct activations.

5.3 Interconnector flow constraints

In addition to the capacity limits mentioned above, constraints on the resulting minimum and maximum flows may be submitted for the purpose of interconnector controllability, due to

[3] Via a BSC modification

operational constraints or countertrading. Such constraints are also referred to as desired flow ranges.

5.4 Multiple interconnectors at one border

As there are multiple interconnectors connected to GB, the AOF will determine the flow on each interconnector. Min/max flow constraints on interconnectors shall be satisfied as far as possible.

If NGESO submits a mFRR demand, and there is capacity available on multiple interconnectors connected to GB, the algorithm shall evenly distribute the resulting flow among the interconnectors configured for that given border, while respecting the applicable CBCLs, interconnector flow constraints and dead zones (for now, the central project has deemed the requirement on dead-zones out of scope).

For example, assuming no interconnector flow constraints and dead zones, a resulting flow of 20MW and three interconnectors with CBCLs set at 5, 10 and 15 respectively, the following flows will be assigned to the interconnectors: 5, 7.5 and 7.5, respectively. As the example indicates, as input to the optimisation, the CBCLs on the three interconnectors are set at 5, 15, 20. The algorithm has determined a flow of 20MW on this border. 15MW is uniformly allocated across the three interconnectors, with 5MW on each. This leaves the first interconnector fully saturated. The remaining 5MW is allocated uniformly between the two interconnectors with remaining capacity, with 2.5MW on each. The resulting flow on the fist interconnector is 5MW, and 5 + 2.5 = 7.5 MW on the remaining interconnectors. NB – weights are not applied in this example.

The algorithm can consider weights that may be applied on certain borders. This is entirely optional and to be confirmed for GB.

5.5 Cross-border flows

The common platform informs NGESO of the cross-border flows resulting from scheduled and direct activations, respectively. In some cases, the resulting cross-border flows may be sent to the regional nomination platform or operator of the interconnector. It is entirely configurable and at the discretion of the TSOs to decide what party or parties shall receive the output files. For TERRE, Libra will send the cross-border schedule directly to the ICs. NGESO will adopt the same data exchange approach for MARI.

Subject to configuration in the common platform, the resulting cross-border flows may be communicated in an EDI document, a signal, or a combination of both.

5.6 Cross-border shape stacking

The TSO-TSO shape develops when there are scheduled and subsequent direct activations over a border (see section 4 above). NGESO and the interconnector operators need to manage the aggregated flows. Provided the ATC submitted by NGESO is feasible, ensuring the interconnectors can ramp at their set ramp rate, the interconnector schedules will also be feasible.

6. Dispatch Principles Underlying mFRR processing

6.1 mFRR Acceptance

For scheduled activation, between T-8.5 and T-8, NGESO will have the resulting net positions, cross-border flows, remaining capacity, cross-border marginal prices and the bids selected for activation and the satisfied demands. At T-8, NGESO will communicate the instruction to respective BSPs. At T-7.5, scheduled activation is initiated.

For direct activation, processing of demands submitted by NGESO will have to wait until the AOF completes optimisation of the scheduled activation. Likewise, if the AOF is already busy processing one or several demands for direct activations, any subsequent arriving demands for direct activations will have to wait until the AOF finishes. As soon as the AOF has finished processing a set of demands for direct activations, the cross-border flows, remaining capacity and net positions are sent to TSOs together with the selected bids and satisfied demands. 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 the demand(s) arrived on the platform. The delivery will always end at T+35.

To ensure feasibility of bids, it is expected that BSPs will submit operating parameters that will meet any energy generation/demand obligations arising from Libra results. See section above for the TSO-TSO and TSO-BSP standard product shape.

6.2 Post mFRR level (PMRRL) and Post mFRR Committed Level (PmFRRCL)

In TERRE, the PRRL is derived by adding the RRA to the FPN and averaging across the quarter. Ramps and possible capping (owing to MEL/MIL) are then applied to give the PRCL.

In MARI, the post mFRR level (PmFRRL) is the summation of the PRCL and mFRR averaged across the activation period. The PmFRRCL is the unit's new level when the participants submitted MEL/MIL and import/export run up and down ramps rates have been applied to the PmFRRL. The PmFRRCL is essential as it forms the basis upon which the mFRR profile is created.

Within each activation period, the MEL/MIL may indicate that it is not possible to achieve the level indicated by the post mFRR level.

NGESO will adopt a "feasible" ramping methodology and will allow a maximum run up/down period of 10 minutes for mFRR activations.

The ramp data will be part of the dynamic data set that NGESO requires, which can be updated on an ad hoc basis for each settlement period. NGESO hold a set of ramp rates for each BMU which we use to construct BOAs. The intention is the same for TERRE when constructing RRIs. When a participant submits a different set of ramp rates, these replace the rates we have and are then used for all subsequent BOAs and RRIs. The same principles will apply for MARI.

6.3 Interaction Between Adjacent Auction Periods

If two consecutive mFRR activations have been received for a BMU for adjacent auction periods, then the ramp for the first delivery period could impact the amount of energy delivered in the later activation periods, as the first ramp may need to intersect with the prevailing PmFRRCL.

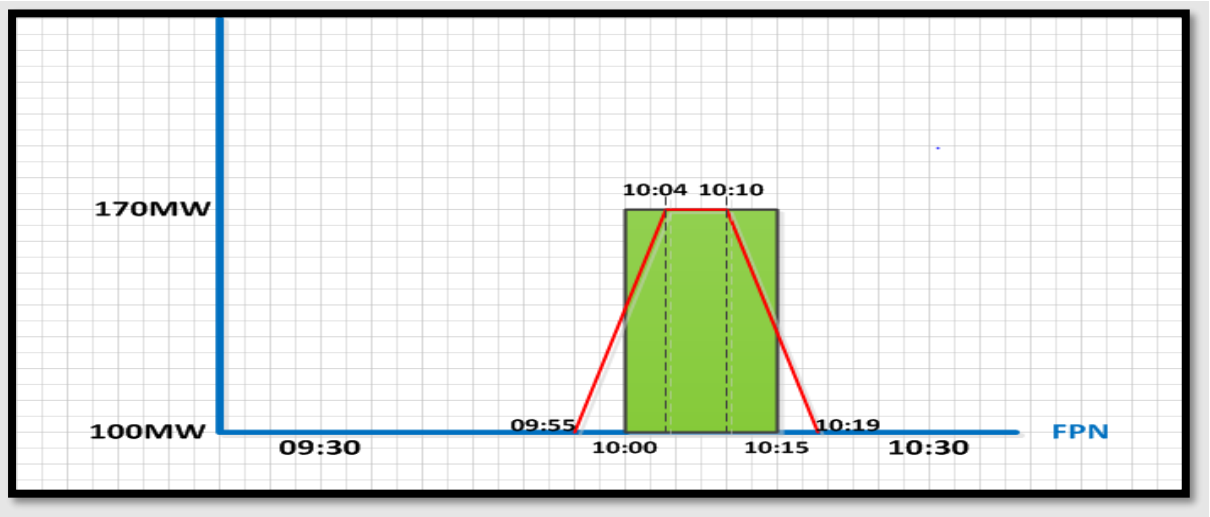
For two consecutive auction periods and where the prevailing ramp down rate is not sufficient to achieve a 5 minute' 'flat top', NGESO's BM system will create a PmFRRCL that allows a 5 minute 'stable' period at a point higher than the PmFRRRL.

6.4 Nonsymmetrical PmFRRCL

The BM constructs instructions with points on whole minutes and power levels at integer MWs. We need a rule to position instructions that are asymmetric due to their ramping times.

If the combined ramp up and ramp down time is an odd number less than 10 minutes (e.g. 9 minutes) then this will lead to time at which the PmFRRCL is reached also being an odd number of minutes. In such instances, the PmFRRCL shall be constructed such that the start of the PmFRRCL is positioned

closer to the start of the PmFRRL. The figure below, shows an example of a BMU with a ramp time of 9 minutes from FPN to full load.



If the time to ramp to the PmFRRL is less than 10 minutes, the stable period of the PmFRRCL may exceed 5 minutes so long as the total energy generated during ramp and within the PmFRRL is equal to a 15- minute block of energy as illustrated in the area under the curve.

The PmFRRCL will be adjusted so the start and end times of the ramping periods achieve the best possible symmetry within -5/+5 minutes (e.g. -4/+4 minutes, -3/+3 minutes, -2/+2 minutes and -1/+1 minute) if the ramping duration is an even number less than 10 minutes.

6.5 Insufficient ramp capacity

If it is infeasible to derive a PmFRRCL that meets the post mFRR level, either the first PRRL or ramping between consecutive periods, allowing for the BMUs submitted ramp rates and the 10-minute ramp period rule, then the closest possible PmFRRCL will be generated.

6.6 Varying FPN within an Activation Period

If a BMU's PRRL fluctuates within an activation period, the PmFRRL will be derived by averaging the PRRL + mFRR across the whole of the activation period. This way, the effect of the dynamic nature of the PRRL is minimised while also ensuring minimal deviation from overall delivered volume implied by the mFRR value.

6.7 Delivery Periods with mFRR of Zero MW (0MW)

If the time between two delivery periods is not sufficient for a complete ramp down and ramp up for the next delivery period, NG's BM system will create a PmFRRCL that allows a 'stable' level (preferably 5 minutes') between the ramp down and ramp up period.

7. Generating mFRR Instructions and Product Stacking

7.1 When will mFRR be used?

In the event of energy imbalance between generation and consumption, NGESO may activate mFRR. The mFRR timescale of use is much closer to real time than RR (replacement reserve), so it is expected the standard product RR will be used in the first instance, and then mFRR will be requested to resolve any remaining imbalance (where economic and efficient to do so).

7.2 What are mFRR instructions?

Satisfied demands and bids to be activated will be sent from the central platform to NGESO via a MOL document (a Merit Order List document). NGESO will then send mFRR instructions to the relevant BSP's who have been successful in the auction. mFRR instructions are BOA like instructions. Refer to Section BC2.7.1 of the Grid Code for details of the content of a BOA.

7.3 mFRR instruction dependencies

NGESO will use mFRR in conjunction with RR. However, there will be times were standard European products (RR and mFRR) and specific GB products (the BM) interact because BSP's can participate in all three markets (see Appendix I).

TERRE results are published at T-35 and concern the delivery period T to T+60. As the MARI gate closure time for BSPs (for QH0) is at T-25 for scheduled activations, there appears to be enough time for a BSP to update their position following a TERRE instruction and the two products will stack. This will allow BSP's to ensure their submitted bids and offers align with the dynamic parameters for scheduled activation. Therefore, the interaction between mFRR Scheduled Activation and RR volume is feasible (see scenario 2 figure below).

The use of mFRR direct activation with RR and post gate closure BOA's is more complicated. NGESO only foresee to use direct activation when there is an unforeseen shift in the market position close to real time (e.g. a change in renewable generation output) and after the platform algorithm has completed the scheduled activation process for the relevant auction period. NGESO therefore would plan to use scheduled activation first, and then if required, submit a direct activation request. The demand for direct activation must always be inelastic (i.e not priced - the volume is absolutely required by the TSO). In such circumstances, it foreseen that direct activation would only be used when there is either no or limited market-based alternatives to manage the system.

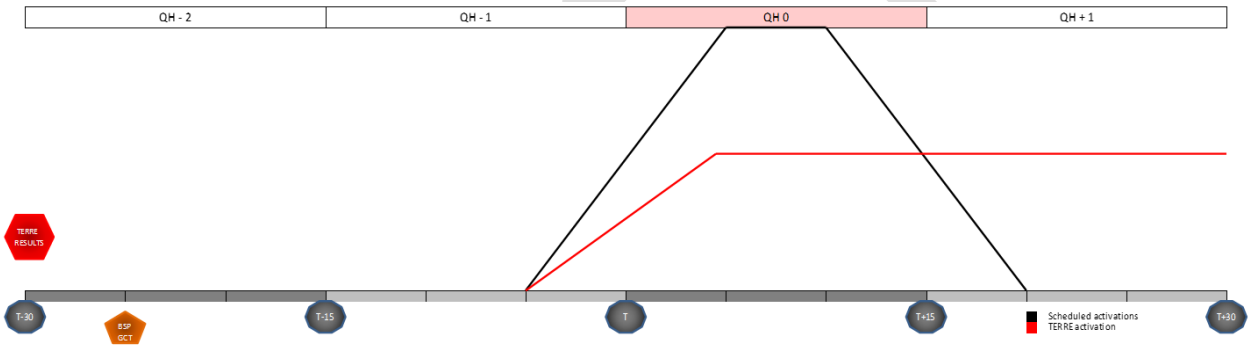
As a result of this interaction, and due to the complexity of the GB market, NGESO will hold the right not to instruct all mFRR activations. Appropriate mFRR instructions will be sent depending on the conditions mentioned below:

	Scenario	Activation Type	Action
1	No BM BOA (post gate closure BOA) or RRI has been issued to the BMU in the mFRR auction period	Scheduled Activation	mFRR instruction sent
2	A BM BOA (post gate closure BOA) or RRI has already been issued to the BMU in the mFRR auction period, the BOA/RRI is in the same direction as the requested mFRR and the PmFRRCL target MW is greater than the existing BOA/RRI	Scheduled Activation	mFRR instruction sent and the products will stack (see scenario 2 figure below)
3	A BM BOA (post gate closure BOA) or RRI has already been issued to the BMU in the mFRR auction period, the BOA/RRI is in the same direction as the requested mFRR, and the	Scheduled Activation	mFRR instruction is not sent

	PmFRRCL target MW is less than or equal to the existing BOA/RRI		
4	A BM BOA (post gate closure BOA) or RRI has already been issued to the BMU in the mFRR auction period, the BOA/RRI is in the opposite direction to the mFRR requested volume, but the mFRR activation is required	Scheduled Activation	If an 'opposite action' is required to amend the position, then the mFRR instruction will be sent to adjust the output of the BMU (where it is economic to do so i.e. price of mFRR compared to price of unwinding BOA or BOA on a different BMU and technically feasible) *NB – although this is the ideal solution, this is subject to change. NGESO needs to further analyse what is feasible within the mFRR timescales (NGESO has 30 seconds for the communication from TSOs to BSPs)*
5	A BM BOA (post gate closure BOA) or RRI has already been issued to the BMU in the mFRR auction period, the BOA/RRI is in the opposite direction to the mFRR requested volume, but the mFRR activation is not required	Scheduled Activation	mFRR instruction is not sent *NB – although this is the ideal solution, this is subject to change. NGESO needs to further analyse what is feasible within the mFRR timescales (NGESO has 30 seconds for the communication from TSOs to BSPs)*
6	No BM BOA (post gate closure BOA) or RRI has been issued to the BMU in the same mFRR auction period	Direct Activation	Send mFRR instruction.
7	A DA for QH-1 has been requested along with RR volume for QH0 (either in the same or opposite direction)	Direct Activation	Send mFRR instruction. There is an overlap that could occur. The TERRE activation should be signaled to the BSP at T-30 but this is after the MARI gate closure time for QH-1 which occurs at T-40. In such circumstances, NGESO would instruct the mFRR direct activation and not instruct the RRI. (see scenario 7 figure below for overlap). It is the responsibility of the BSP to ensure that if they are participating in multiple markets (especially as there can be a risk of overlap) that they enter volume that is feasible and volume that they can commit to in each market. NGESO will also endeavor to carry out 'bid cleansing' before bids are sent to the platform.

			Therefore, it is unlikely that this overlap scenario will happen. In the unlikely event where there is an overlap and the BSP cannot instruct the TERRE and MARI volume, the Direct Activation will take priority and the BSP would be subject to the RR imbalance (the RR would not be instructed).

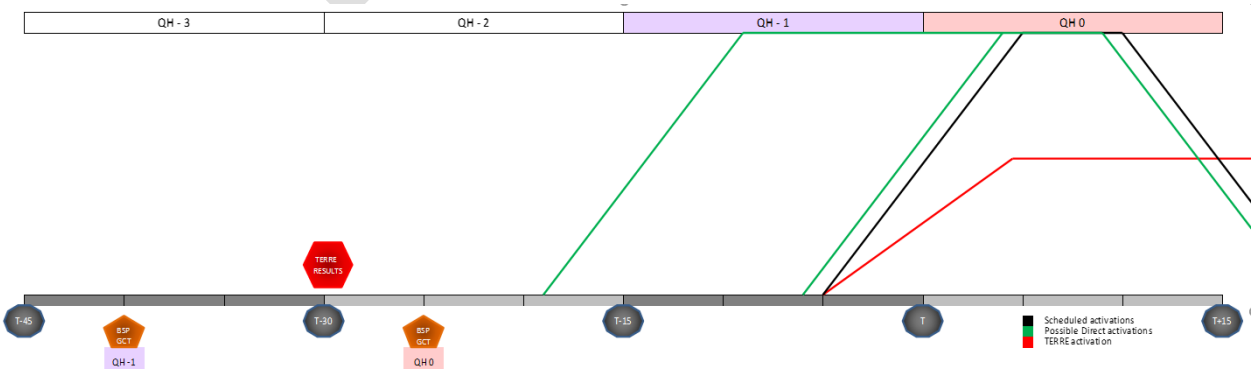
Scenario 2 - A BM BOA or RRI has already been issued to the BMU prior to the receipt of the results for the prevailing auction period, the BOA/RRI is in the same direction and auction period, and the PmFRRCL target MW is greater than the existing BOA/RRI



TERRE results are published at T-35 and concern the delivery period T to T+60. As the MARI gate closure time for BSPs (for QH0) is at T-25 for scheduled activations, then there appears to be enough time for a BSP to update their position following a TERRE instruction and the two products will stack.

NB - The T mentioned here is the start of an hour for TERRE auction period. This must not be confused with the mFRR auction period, of which there are four in 15-minute blocks.

Scenario 7 – pre-existing TERRE activation with Direct Activation. A DA for QH-1 has been requested along with RR volume for QH0 (either in the same or opposite direction)



If we consider mFRR direct activation with a preexisting TERRE activation there is a problem. The MARI BSP gate closure for QH-1 is at T-40 (where T is the start of QH0). If the BSP receives a DA for QH-1 and a TERRE activation for QH0 there is an overlap that could occur. The TERRE activation would be signaled to the BSP at T-30 but this is after the MARI gate closure time for QH-1 which occurs at T-40. The BSP does not have the opportunity to update their bid availability following the TERRE results.

8. Frameworks

mFRR Information Required	Where will it be covered?	Key Contact within NGESO
Interconnector settlement process	The Balancing and Ancillary Services Agreement – (BASA)	Tom Ireland
Interconnector operational process - an overview of the mFRR process and information flows	The Operational Protocol (OP)	Neil Sutton
Interconnector deviation from the TSO-TSO cross border shape	The System-to-System Flow Methodology (+BASA & OP)	Tom Ireland
Requirements placed upon participants - this information will allow participants to comply with the requirements for participation, submission of data and the prequalification criteria.	The Grid Code - namely Balancing Code 6 (BC6) and review of Balancing Code 5 (BC5) for prequalification requirements.	Louise Trodden
Dispatch Principles - provide guidance to the wider industry on the mFRR process, the product shape, the dispatch principles underlying mFRR processing and the mFRR interaction with other products	MARI reference document for NGESO	Camille Gilsenan

9. Further analysis required

- NGESO needs to define clearer terminology for the 'Post mFRR level' (PmFRRL) and 'Post mFRR Committed Level' (PmFRRCL) to avoid confusion with TERRE.
- NGESO needs to further analyse the BM/mFRR and RR timeline and interaction between these products
- Time to communicate mFRR volumes to BSP's may be a challenge for NGESO. NGESO needs to ensure we can do this efficiently.
- Scheduled and direct activation stacking will impact the feasibility of interconnector schedules. Provided the ATC submitted by NGESO is feasible, ensuring the interconnectors can ramp at their set ramp rate, it is assumed that the interconnector schedules will also be feasible. However, further impact assessments are required to ensure this feasibility.
- Feasibility of inelastic bids (i.e not priced - the volume is absolutely required by the TSO) with regards to the National Grid Procurement Guidelines.

Appendix I – Timeline of interaction between mFRR, RR and the BM