MARI Dispatch Instruction Guide

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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

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
Balancing service provider (BSP)	As defined by EB GL art. 2(6)
BMU	Balancing Mechanism Unit

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BOA	Bid Offer Acceptances (A dispatch Instruction issued to a BSP from NG). Used to indicate BM market only instructions
BSP	Balancing Service Provider
Direct activation (DA)	Direct activation can be initiated at any point in time after scheduled optimization has begun for given MTU period
FPN	The Final Physical Notification (FPN) is the generated power profile submitted to NGESO for a ½ hour period before gate closure.
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
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,

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	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.
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.
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 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.

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

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.

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.

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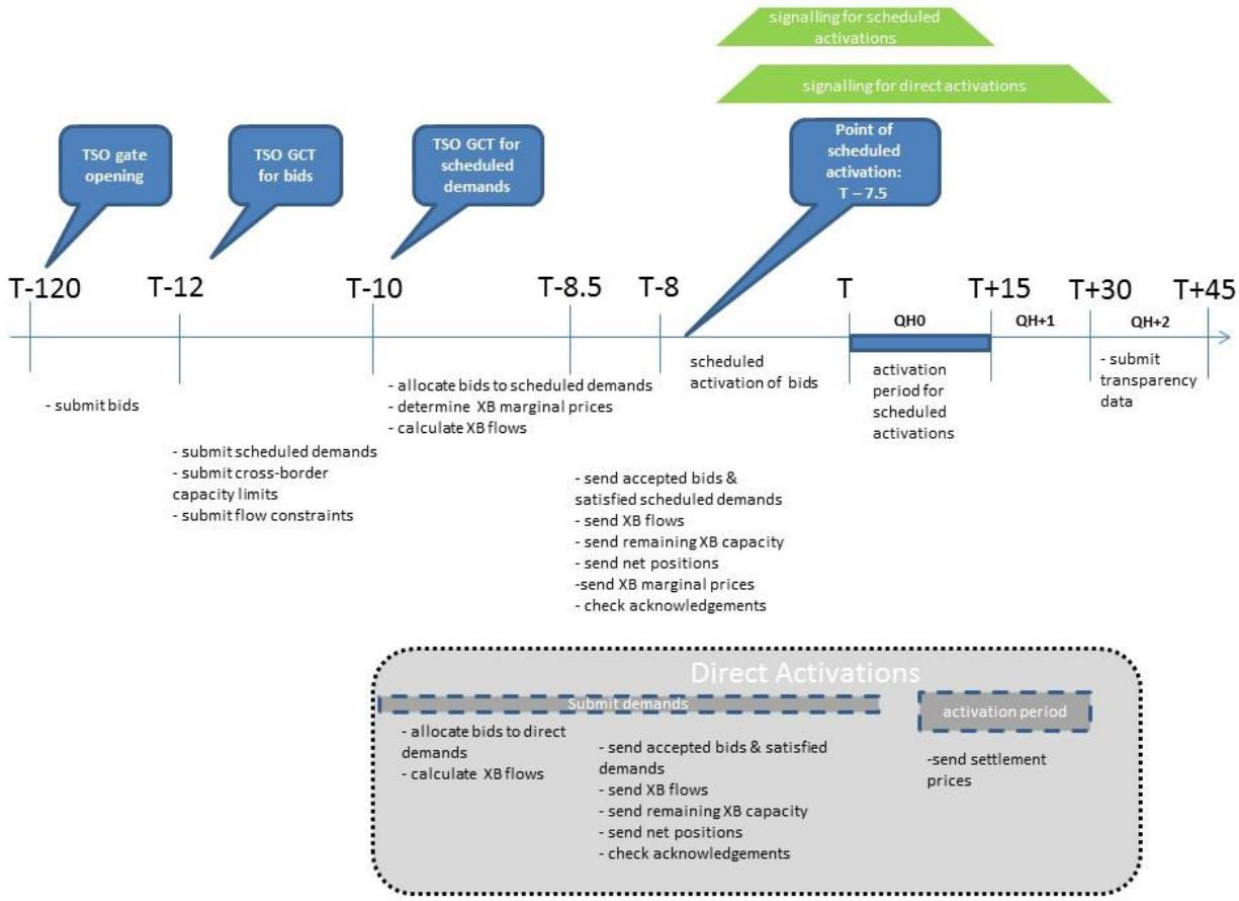

Figure 1: Manual frequency restoration reserve process in common platform – overview.

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).

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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. Product Shape and Ramp Incentives

3.1 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. There are also standard mFRR bid characteristics (see figure 3 below).

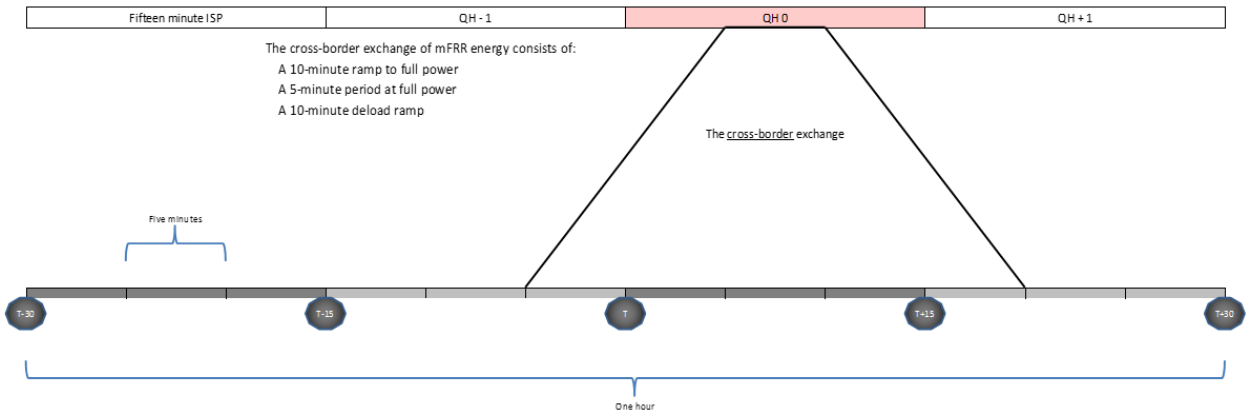

Figure 2 – mFRR standard product shape

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).

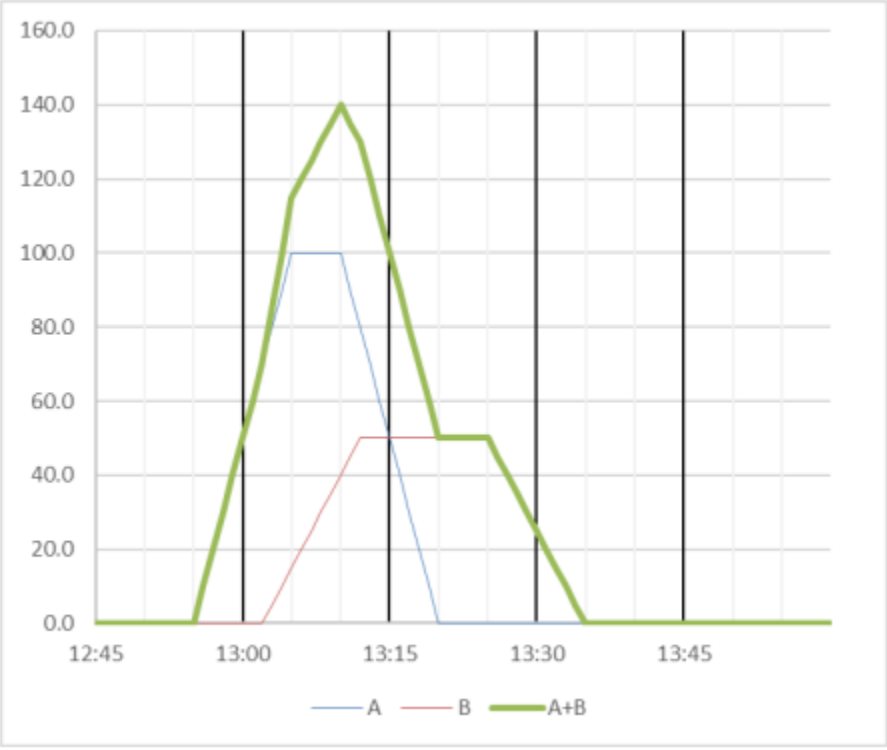

Figure 4 – Example SA versus DA activation & resulting net position in MTU period 1300-1315.

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).

3.2 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.

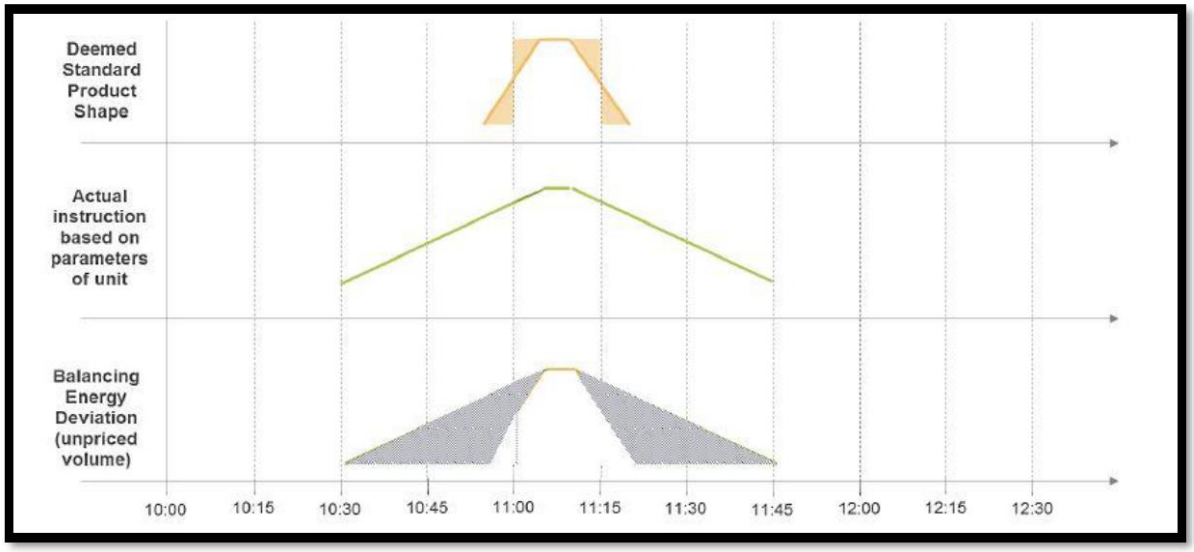

Figure 5 - Standard Product Shape for TERRE – the same incentivization principles will apply for mFRR

4. Dispatch Principles Underlying mFRR processing

4.1 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.

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

4.2 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 ramps rates used will be the run-up and run-down rates as submitted by the BSP at the time of generating the mFRR instruction.

4.3 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.

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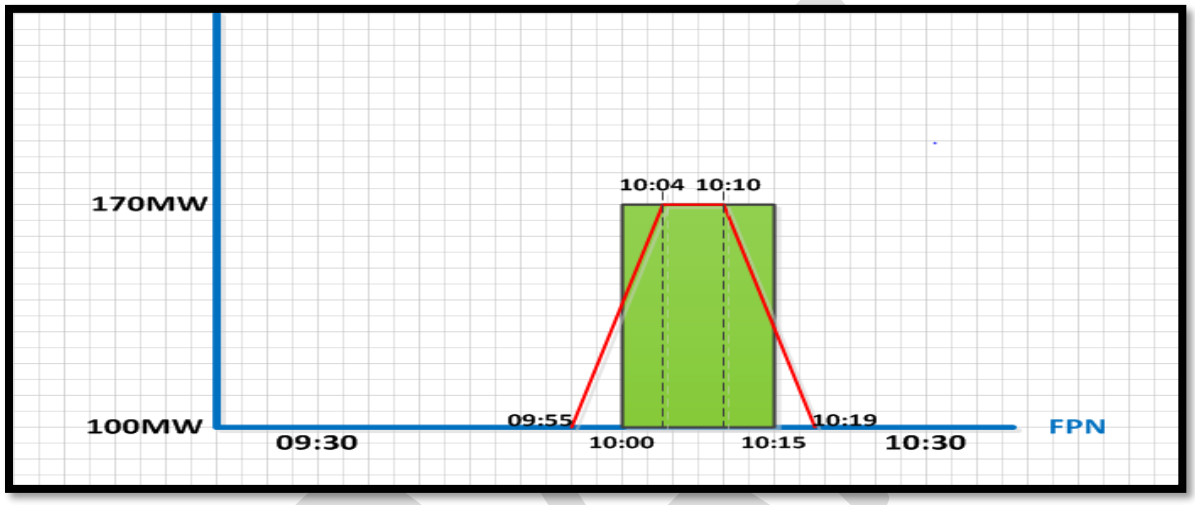
4.4 Nonsymmetrical PmFRRCL

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.

4.5 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.

4.6 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.

4.7 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.

5. Generating mFRR Instructions and Product Stacking

5.1 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).

5.2 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.

5.3 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:

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	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 PmFRRCL target MW is less than or equal to the existing BOA/RRI	Scheduled Activation	mFRR instruction is not sent
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	Direct Activation	Send mFRR instruction.

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	the BMU in the same mFRR auction period		
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).

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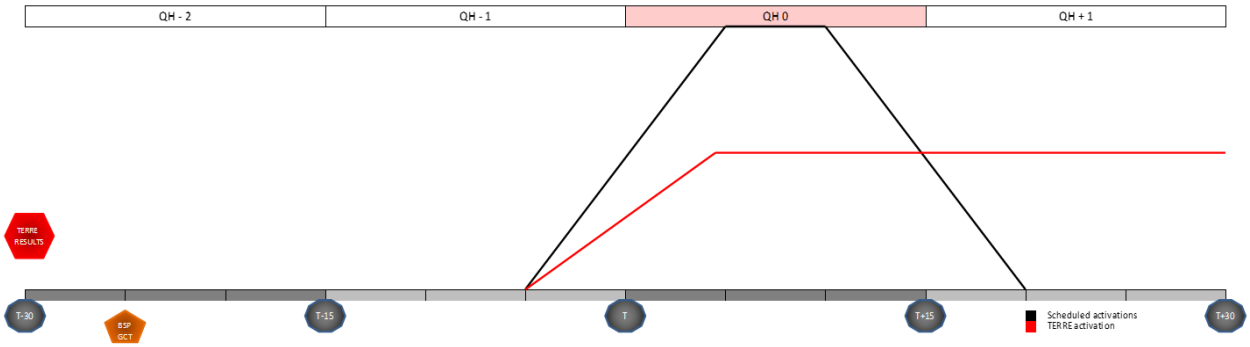
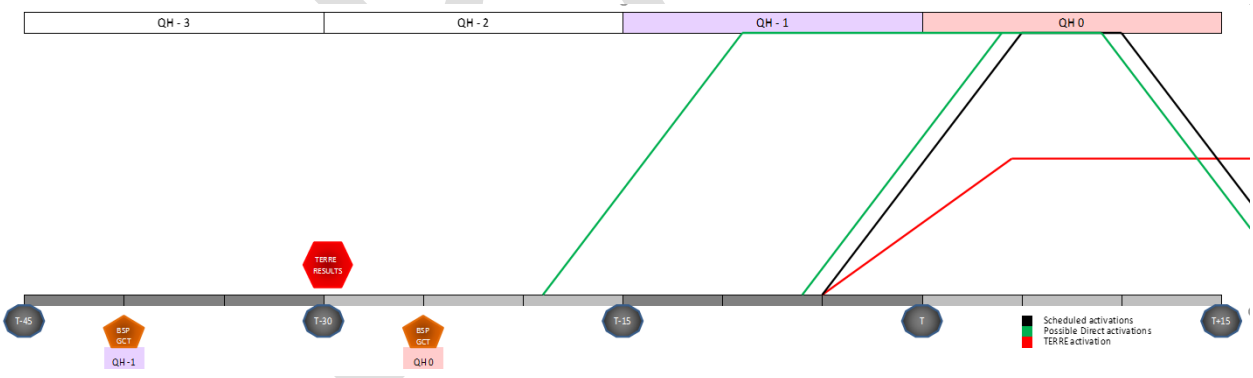
Scenario 2 - A BM BOA or RRI has already been issued to the BMU prior to the receipt of the results for the prevailing auction period, the BOA/RRI is in the same direction and auction period, and the PmFRRCL target MW is greater than the existing BOA/RRI



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.

6. 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 include information on types of bids (e.g. linked bids, conditional bids, elastic, inelastic). This will be added to the dispatch principles document once there is further clarity from the central project.
- 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.

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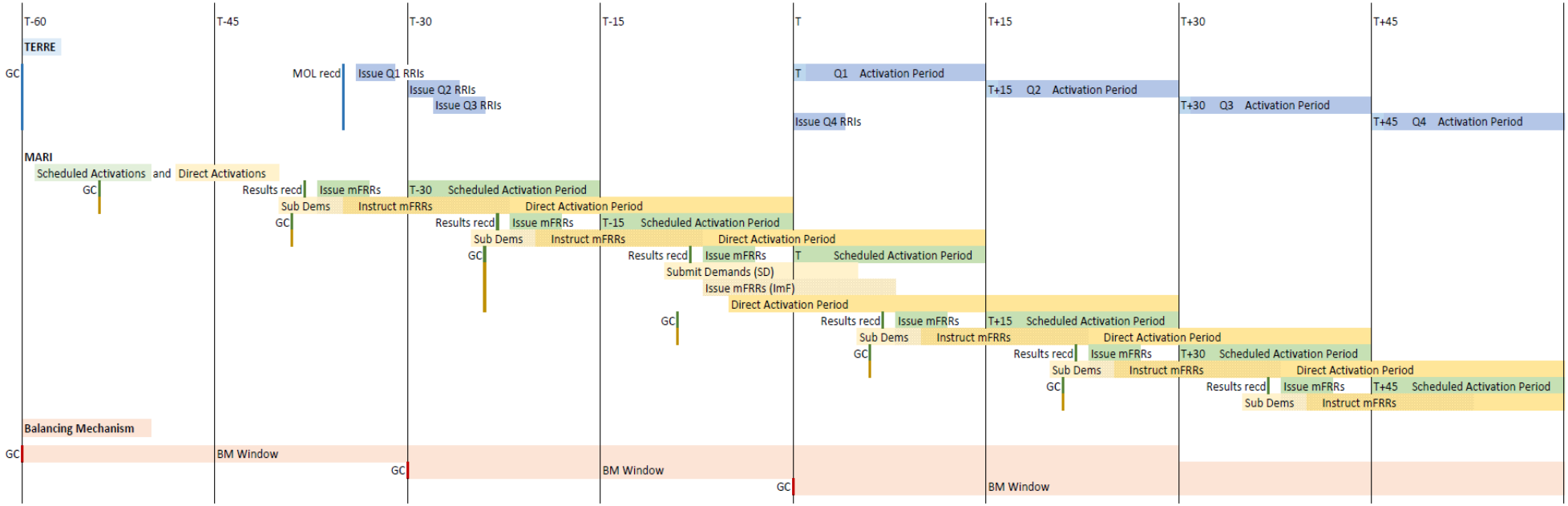
Appendix I – Timeline of interaction between mFRR, RR and the BM