Public

Response Stacking Guidance

Guidance for splitting Response Services with the Balancing Mechanism and other NESO services.

NESO
National Energy System Operator

Contents

Version Control

Version	Date	Notes
V1	Nov 2025	Consolidated documentation on Stacking Response Service

Response and Balancing Mechanism

1. Introduction

Splitting means the simultaneous delivery of two or more services. This chapter explains how NESO and providers can unlock stacking of the Dynamic Frequency Response (DFR) services (Dynamic Containment (DC), Dynamic Moderation (DM) or Dynamic Regulation (DR)) or Static Firm Frequency Response (FFR) with bid-offer acceptances (BOAs) in the Balancing Mechanism (BM).

To participate in service splitting with the BM, a provider will need to adhere to all the necessary system, data and communication requirements outlined in NESO's BMU registration guide[1] and Grid Code.

Existing principles for energy limited providers in the BM

The Balancing Mechanism (BM) system architecture has some limitations in its representation of storage assets. NESO are working towards developing system solutions to factor real time stored energy capacity/capability of energy storage assets within the BM. Until this work is delivered, NESO are operating the principles as outlined previously in the EDL/EDT guidance document[2]. Should there be any conflict with the Grid Code, then the Grid Code will take precedence.

Questions - If you have any questions, please contact the team at: box.futureofbalancingservices@neso.energy

2. Splitting Dynamic Response with the BM

For NESO, DFR services are crucial to operational security so providers of DFR wishing to participate in the BM should ensure that any BM activity does not unintentionally erode or compromise the ability to deliver their DFR obligations.

2.1 General principles

1. **Maximum Export Limit (MEL) and Minimum Import Limit (MIL)** should be used to reflect the availability for BOAs while preserving response delivery as detailed on page 11/12 of the EDL/EDT guidance document.
2. **Bid-Offer Data (BOD)** - If MEL/MIL submissions are not sufficient to inform BM availability while preserving response provision, then pricing data can be used to

[1] https://www.neso.energy/document/290631/download
[2] https://www.neso.energy/document/300231/download

'price out' tranches of capability to indicate that the unit committed that quantity to the DFR service. We believe that this will only apply to Bid or Offer volume in the range from FPN to 0 as MEL/MIL cannot be negative submissions (positive for MIL), and that providers should only use this approach when MEL/MILs are insufficient.

3. **Stable Export Limit (SEL) and Stable Import Limit (SIL)** - these should reflect the physical capability of the unit.
4. **Operational Baseline (OB)** - this should match the Physical Notification.
6. **Baselines (both Operational and Performance)** should accurately represent the natural state of the unit without delivery of Dynamic Response (e.g. assuming frequency is at 50Hz). NESO reserves the right to investigate any differences between Operational and Performance baselines and any suspected unwarranted manipulation of Performance data.
5. **Notice to Deliver Offers (NTO) and Notice to Deliver Bids (NTB)** - as per the Grid Code this must be less than or equal to 2 minutes, we no longer advise a minimum as actual BOA delivery can be added in to the performance baseline and we do not wish to artificially slow units' delivery, but this can remain at the discretion of the providing units.
7. **Run-Up Rate (RUR) and Run-Down Rate (RDR)** - we have updated the service terms to make it clear that the baseline ramp-rate rules will not apply to baselines adjusted by BOAs. So RUR and RDR can remain as technical parameters.
8. **Performance monitoring** will be based on the BM-adjusted baseline - e.g. the PN + any BOA.
9. Any **bid/offer acceptance** does not remove the contractual obligation to deliver DFR.
10. **Unavailability of DFR** should be communicated directly to NESO control room via the methods laid out in the Service Terms.

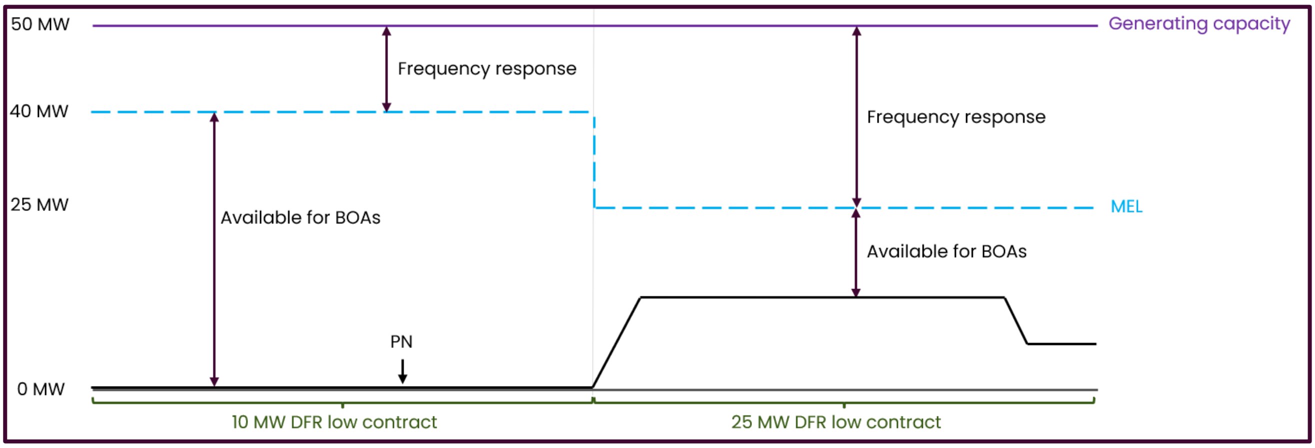
2.2 Worked examples

Example 1

MEL/MIL should be used to indicate the dispatchable power capacity up to the level that could be sustained for at least 30 minutes. When splitting capacity between the BM and response, MEL/MIL should be further used to indicate capacity unavailable due to providing DFR. MEL adjustment is for protecting low frequency response contract capacity, and high frequency contract capacity are protected by MIL adjustments. The following examples all focus on the use of MEL when a unit is holding low frequency contract.

As shown in the example below, a unit initially has a PN of 0 and holds a DFR low contract. The provider submits a MEL lower than the generating capacity, to ensure capacity is protected from BOAs and reserved to be able to deliver the DFR contract.

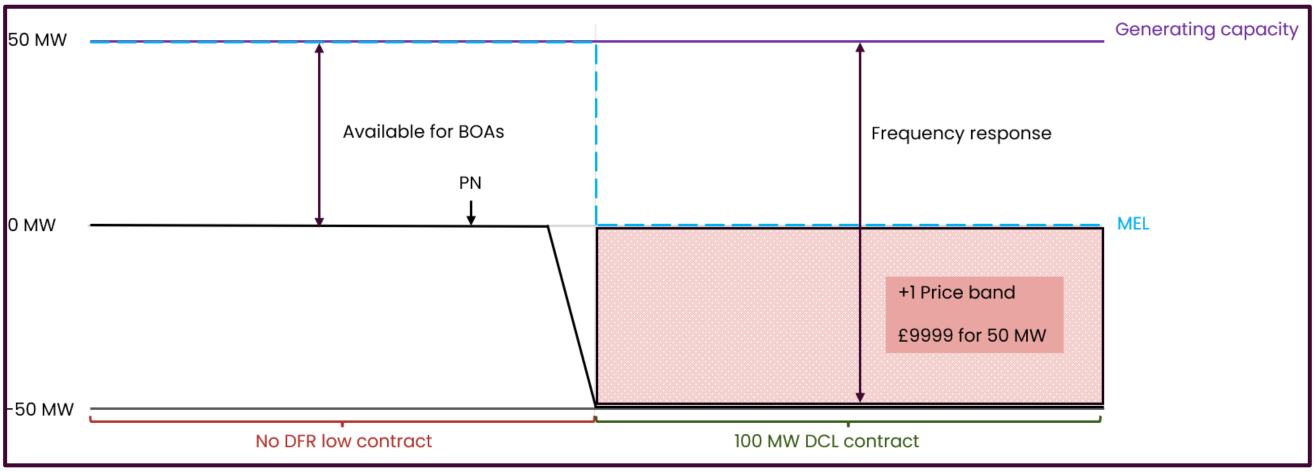
In the following period, the unit has an exporting PN and is holding a DFR low contract for a greater capacity than the first period. The provider lowers the MEL accordingly, ensuring that the unit has dispatchable power capacity that could be sustained for at least 30 minutes whilst continuing to deliver on their DFR contract.



Example 2

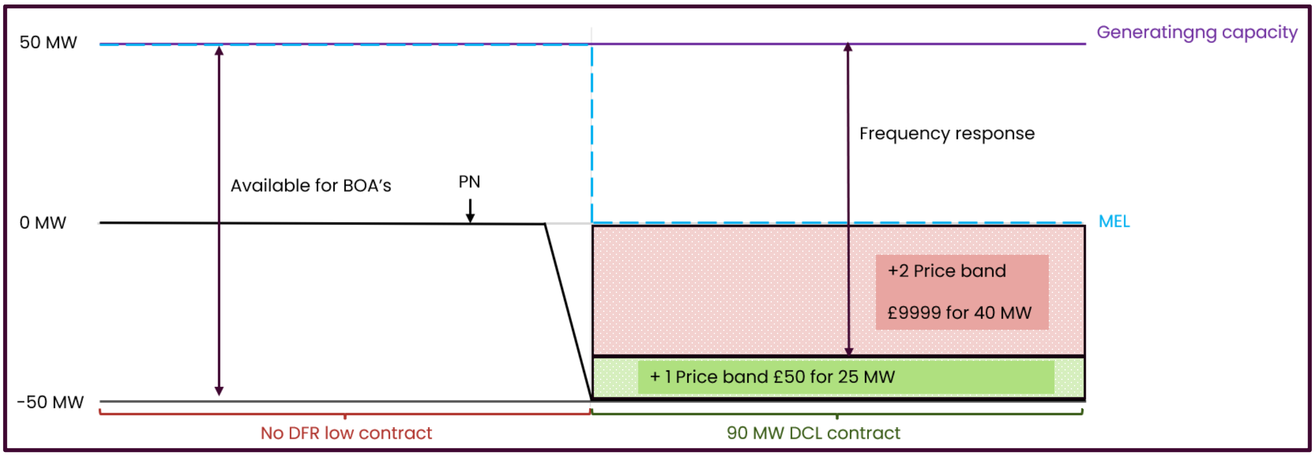
As mentioned, there is a specific set of circumstances where this approach may be insufficient information to avoid a BOA eroding response, and so the following example shows the additional use of Bid Offer Data to solve this issue:

In this case, the unit has a negative Physical Notification of –50MW, and has contracted for 100MW of Dynamic Containment Low. Full delivery of the response service would take the asset from its PN to its full Generation Capacity (GC) of 50MW. As any offer would erode the response capacity, to avoid being sent offers the unit submits a Maximum Export Limit of 0MW, however as MEL cannot be negative this does not prevent an offer being sent from -50MW up to 0MW. In this case, the unit also submits a +1 price band, with 50MW of volume at £9999/MWh. Although a BOA is still possible, the high price means that the BOA is extremely unlikely to be in merit and therefore is very unlikely to be sent. The MEL is still reduced to zero during the period to minimise the volume of expensive price band required. This is expected to be an unusual case, and so we expect MEL/MIL (as shown in Example 1) to be the main method for avoiding response erosion.



Example 3

It may also be the case that there is some flexibility for offers, but that price bands are still needed – in the case below only 90MW of DCL has been contracted and so the +1 price band is a reasonable price, and the +2 band is used to avoid response erosion.



Note, there is no need to submit a price in excess of £9999/MWh for offers (or £-9999/MWh for Bids), as higher prices only increase the risk associated with any rounding of BOAs (to MW and minute) on settlement period boundaries clipping some of a high price band.

2.3 Performance data submissions

Performance data is submitted through an API service as CSV files. The operational baseline needs to reflect the expected output of the unit. Providers should add/subtract the BOA quantity (+ any additional non DFR service quantity) from their original operational baseline.

The table below illustrates how an operational baseline of 0MW may be updated to reflect a BOA acceptance. The unadjusted baseline would normally be flat at 0MW.

Unit	t	f_hz	baseline_mw	p_mw	soe_import_mwh	soe_export_mwh	availability
ABC	2020-08-04T12:29:00.850Z	50.0	0	0	25.0000	25.0000	63
ABC	2020-08-04T12:29:00.900Z	50.0	0	0	25.0000	25.0000	63
ABC	2020-08-04T12:29:00.950Z	50.0	0	0	25.0000	25.0000	63
ABC	2020-08-04T12:30:00.000Z	50.0	0	0	25.0000	25.0000	63
ABC	2020-08-04T12:30:00.050Z	50.0	-0.0208	-0.0208	25.0000	25.0000	63
ABC	2020-08-04T12:30:00.100Z	50.0	-0.0416	-0.0416	25.0000	25.0000	63
ABC	2020-08-04T12:30:00.150Z	50.0	-0.0624	-0.0624	25.0000	25.0000	63
ABC	2020-08-04T12:30:00.200Z	50.0	-0.0832	-0.0832	25.0001	24.9999	63
ABC	2020-08-04T12:30:00.250Z	50.0	-0.1040	-0.1040	25.0001	24.9999	63

Point of instruction

BM BOA instructions are timestamped with a granularity of minutes. However, we acknowledge that units with 0 or 1-minute NDZ can receive a BOA after its point of instruction. E.g. a BOA with an instruction to start at 12:01:00 may be received anywhere up to 12:01:59. For this reason, and to encourage the use of 0 and 1-minute NDZs which provides value to NESO, we propose that providers use their discretion when incorporating the BOA into their baseline. The guiding principle should be that the reported baseline is an accurate representation of what the asset was doing without any response provision.

In the case where a BOA stamped to start at 14:02:00 was received at 14:02:37 (for example), we would accept an operational baseline that included this BOA change at any point between 14:02:00 and 14:03:00 - not constrained only to the minute boundary.

The BOA will be submitted by NESO in-line with the unit's run-up and run-down rate parameters, the adjusted baseline should reflect this. Imbalance arising from not following a BOA will be treated in the normal way - providers may wish to consider this when following a BOA instruction and representing this in their operational baseline. As it stands with regards to performance monitoring, we will not penalise any small differences between the operational baseline and the BOA-adjusted FPN.

Advice for incorporating BOAs and other non DFR services

Providers are permitted to pre-process or clean their Performance Data before submission to NESO. This means that the Performance baseline can and should reflect the actual delivery and deviation from any BOA, not just the BOA instruction.

For example, a unit may experience a lag between the time-stamp of a BOA instruction and the unit's actual change in active power. In this case the actual delivery of the BOA (i.e. including the lag) should be represented in the Performance Data baseline submission to NESO.

Providers should not use pre-processing to artificially increase their apparent performance in delivery of Dynamic Response or mask any underperformance.

2.4 Operational metering & settlement

Operational metering

No change required. ENCC will be able to follow the delivery of the BOA and any DFR response using existing tools.

Settlement

The response energy computation for DFR is unaffected by this change and will continue to be based on accepted MW and system frequency deviation from the target frequency.

Consequently, any BOA will not impact the determination of response energy volume data which is provided to Elexon under the Applicable Balancing Services Volume Data (ABSVD) submission, and an imbalance will arise if the service provider does not supply the tendered level of response.

2.5 Additional Clarifications of the service terms

Providers should always seek to ensure they are following the latest version of the Service Terms. Further clarifications of the Service Terms can be found below.

Submission of baseline, MEL, MIL, SEL & SIL

We would like to clarify that a baseline does not have to be at the same level throughout a settlement period.

3. Splitting Static Firm Frequency Response with BM

The chapter below details how providers can unlock stacking of Static Firm Frequency Response (Static FFR) with bid-offer acceptances (BOAs) in the Balancing Mechanism (BM). Like DFR services, NESO see Static FFR as crucial to operational security, so providers wishing to participate in the BM should ensure that any BM activity does not unintentionally erode or compromise the ability to deliver their Static FFR obligations.

3.1 General principles

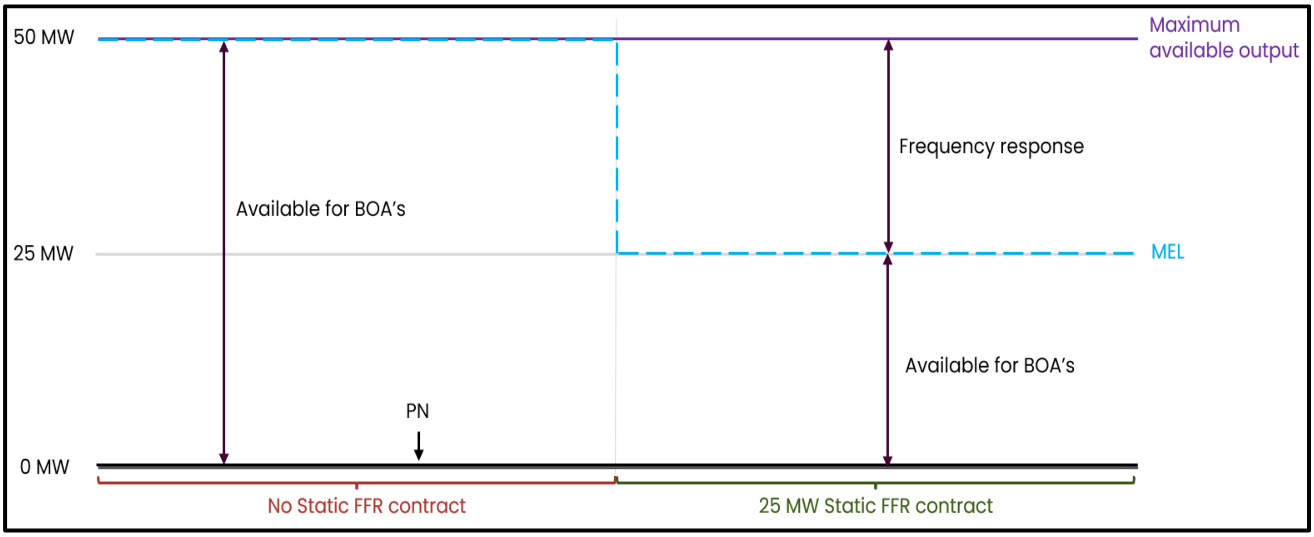
1. **Maximum Export Limit (MEL)** should be used to reflect the availability for BOAs while preserving response delivery as detailed on page 11/12 of the EDL/EDT guidance document.
2. **Bid-Offer Data (BOD)** - If MEL submissions are not sufficient to inform BM availability while preserving response provision, then pricing data can be used to 'price out' tranches of capability to indicate that the unit committed that quantity to the Static FFR service. We believe that this will only apply to Bid or Offer volume in the range from FPN to 0 as MEL cannot be a negative submission, and that providers should only use this approach when MEL is insufficient.
3. **Stable Export Limit (SEL) and Stable Import Limit (SIL)** - these should reflect the physical capability of the unit.
4. **Physical notification (or Operational Baseline)** - should accurately represent the natural state of the unit without delivery of Static FFR (e.g. assuming frequency is at 50Hz).
5. The **performance monitoring process** detailed in the service terms does not change for units that are stacking in the BM.
6. Any **bid/offer acceptance** does not remove the contractual obligation to deliver Static FFR.
7. **Unavailability of Static FFR unit** should be communicated directly to NESO control room via the methods laid out in the Service Terms.

All three types of units (Generation, Demand and Bi-directional) can provide Static FFR whilst operating in the BM. Below looks at each unit type and how providers should adhere to the guiding principles to unlock stacking of Static FFR and BOA's in the BM.

3.2 Worked examples

Generation unit

The same principle that was highlighted earlier in the document for units providing DFR whilst in the BM applies for units providing Static FFR. If contracted for any given period, the MEL should be used to indicate capacity unavailable due to providing Static FFR. In the example below, for the first EFA block the unit isn't contracted for Static FFR. The provider therefore sets MEL as the maximum available output and is available to receive BOAs up to this level. The second EFA is contracted for 25 MW of Static FFR, meaning the MEL has to drop to at least 25 MW below the maximum available output, to reserve capacity to be able to respond if a frequency trigger was breached.



Bi-Directional unit

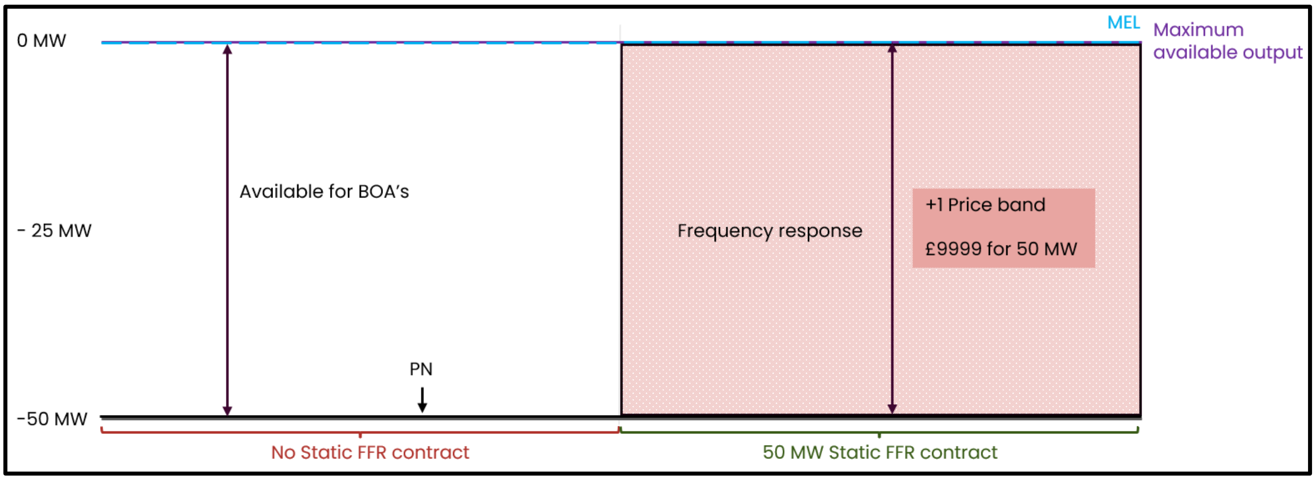
Typically, bi-directional units can follow the same principles as generation units if stacking in the BM. However, this does lead to the same potential issue highlighted in example 2 of stacking DFR with BM if the PN is negative.

In these circumstances, providers should use the same approach with offer price tranches to price themselves out of competition to avoid any erosion of response delivery.

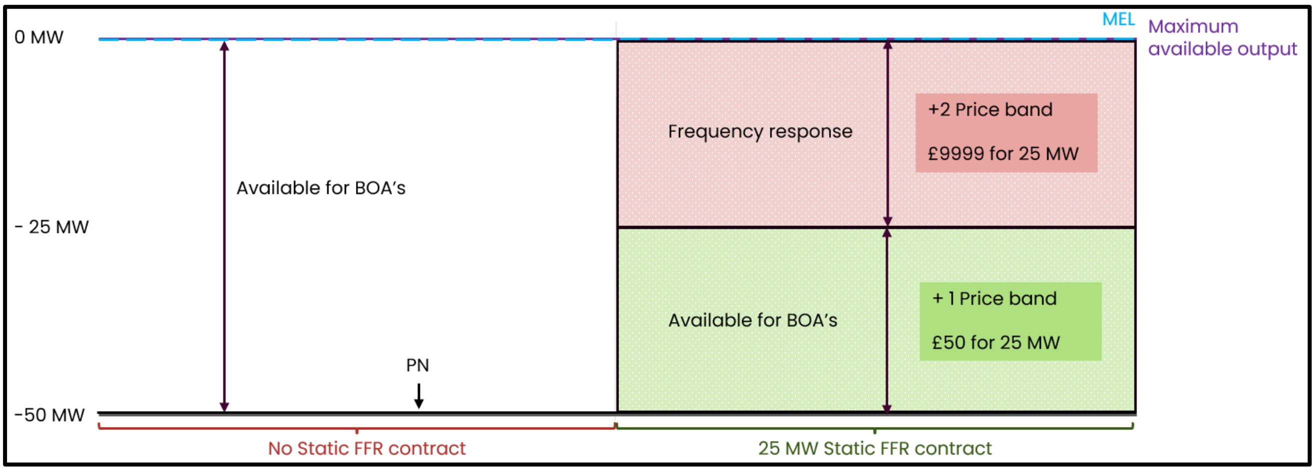
Demand unit

For demand only units, operational parameters cannot be used to ensure a unit doesn't receive a BOA that could erode response capacity. Therefore, providers must use offer price bands to signify what capacity is available for BOAs and what capacity is reserved to stop erosion of response capacity.

Example (No capacity for BOAs example) - Unit contracted for 50 MW with a PN of – 50 MW, provider must submit an offer price band of £9999 for 50MW to ensure the unit doesn't receive any BOAs as this would erode response capacity.



Example (Capacity available for BOAs) - Unit contracted for 25 MW in second EFA with a PN of – 50 MW, provider submits the first offer price band at £50 for 25MW and the second at £9999 for 25MW to ensure it doesn't receive any BOAs that would erode response capacity.



Dynamic Response and Inertia

4. Overview

This chapter sets out the requirements that must be met by users who wish to stack both Stability Services and Frequency Response services. This document specifies the simulations that must be performed to demonstrate the capability of dual service delivery. Also covered in this document is the process for deriving an inertia calculation methodology for the performance monitoring baseline of Dynamic Frequency Response Services that must be agreed and approved before allowing the stacking of inertia and dynamic frequency response.

The provider must complete all the steps covered in this document before being permitted to stack Frequency Response Services with Stability Services. At each stage NESO will aim to provide a response within 15 business days.

The demonstration of the stacking of reserve services does not need to be completed, this owes to the fact that the time response of these services is much slower than for a Frequency response service. In the future, this may be subject to change if the stacking of reserve and response is permitted and an impact on service delivery is identified.

5. Splitting Matrix

The requirements for stacking Stability service with other services are shown below, in Table 1. All services denoted in Table 1 as requiring simulations will need to complete the simulations covered in Section 7 Simulations.

Table 1: Stacking Requirements

Service	Dynamic Containment	Dynamic Moderation	Dynamic Regulation	Mandatory Frequency Response
Simulation Requirements	Yes	Yes	Yes	Yes

6. Process Overview

This section sets out the process that must be followed for the demonstration of capability to stack the services.

Simulation studies are required to be completed to show the capability of the solution to deliver both frequency response and stability services, this must be demonstrated through the simulations set out in Sections 7.1 -7.3. These simulations must be submitted to and subsequently accepted by NESO.

Following the acceptance of these simulations, an inertia calculation methodology with NESO must be agreed. The purpose of this methodology is to determine the contribution of the Inertia service to the overall active power response of a plant during a frequency event.

A flowchart illustrating the process that must be followed is shown in Appendix A.

7. Simulations

All simulations must be carried out for each service being stacked with the Initial Conditions in Table 2 applied. These simulations must be carried out in a verified PSCAD EMT model[3], a copy of the exact model used should be supplied to NESO. The simulation timestep should be in accordance with the Grid Forming Best Practice Guide[4].

[3] The EMT model must be the final verified model that is submitted as per PC.A.9.4 of the Grid Code.
[4] https://www.neso.energy/document/278491/download

Table 2: Initial Conditions for Simulations

Initial Condition	Reactive Power Setpoint	Active Power Setpoint
1	Maximum Leading	0MW
2	Maximum Lagging	0MW

The simulations must be carried out with the following conditions:

- Inertia only
- Inertia and LFSM
- Inertia and the Stacked Frequency Response service

The plant must have both LFSM and Voltage control modes enabled. For plant with multiple modes of Voltage Control (i.e. Voltage Droop and Constant MVAr mode) all modes of voltage control must be demonstrated.

The volume of each service to be demonstrated must be agreed with NESO before the simulations are undertaken.

A summary of the required simulations is shown below in Table 3.

Table 3: Simulation Requirements

Stacked Services	Inertia	Inertia + LFSM	Inertia + Frequency Response + LFSM
Setpoint			
Initial Condition 1	Required	Required	Required
Initial Condition 2	Required	Required	Required

The required simulation events to be simulated are shown in Sections 7.1-7.3

For all simulations, a time-series plot of the results must be included. This data must also be submitted in the form of a raw .csv data file for all study cases. The data should be submitted with a 1ms timestep.

The following data (At the Grid Entry Point) must be provided:

- System Frequency (Hz)
- Rate of Change of Frequency (RoCoF)
- Active Power (MW)
- Reactive Power (MVAr)

- Connection Point Voltage (kV)

7.1 Simulation for 0.5Hz Events

The profile shown in Figure 1 must be simulated to demonstrate the plant behaviour during 0.5Hz events. A description of this simulation requirement is shown in Table 4.

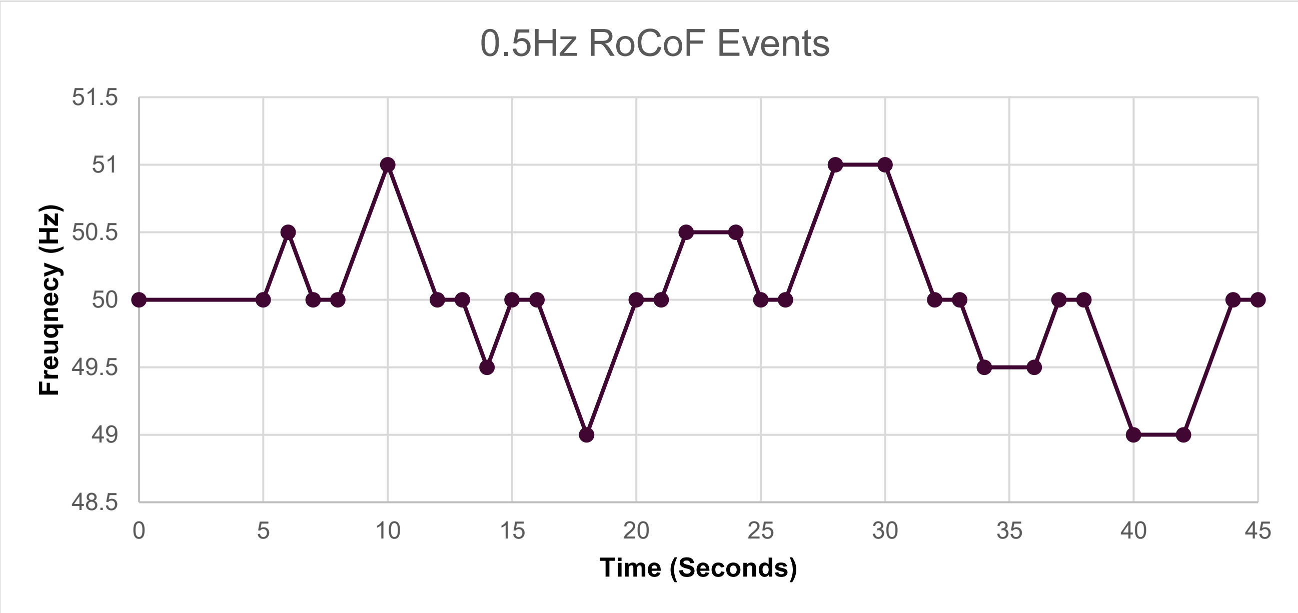


Figure 1: 0.5Hz RoCoF Events

Table 4: 0.5Hz Simulation Steps

Step	Action
1	Ramp from 50Hz to 50.5Hz at 0.5 Hz/s.
2	Ramp from 50.5Hz to 50Hz at 0.5 Hz/s
3	Hold for 1 Second
4	Ramp from 50Hz to 51Hz at 0.5 Hz/s
5	Ramp from 51Hz to 50Hz at 0.5 Hz/s
6	Hold for 1 Second
7	Ramp from 50Hz to 49.5Hz at 0.5 Hz/s
8	Ramp from 49.5Hz to 50Hz at 0.5 Hz/s
9	Hold for 1 Second
10	Ramp from 50Hz to 49Hz at 0.5Hz/s

11	Ramp from 49Hz to 50Hz at 0.5Hz/s
12	Hold for 1 Second
13	Ramp from 50Hz to 50.5Hz at 0.5 Hz/s.
14	Hold for 2 Seconds
15	Ramp from 50.5Hz to 50Hz at 0.5 Hz/s
16	Hold for 1 Second
17	Ramp from 50Hz to 51Hz at 0.5 Hz/s
18	Hold for 2 Seconds
19	Ramp from 51Hz to 50Hz at 0.5 Hz/s
20	Hold for 1 Second
21	Ramp from 50Hz to 49.5Hz at 0.5 Hz/s
22	Hold for 2 Seconds
23	Ramp from 49.5Hz to 50Hz at 0.5 Hz/s
24	Hold for 1 Second
25	Ramp from 50Hz to 49Hz at 0.5 Hz/s
26	Hold for 2 Seconds
27	Ramp from 49Hz to 50Hz at 0.5 Hz/s
28	Hold for 1 Second

7.2 Simulation for 1Hz Events

The profile shown in Figure 2 must be simulated to demonstrate the plant behaviour during 1Hz events. A description of this simulation requirement is shown in Table 5.

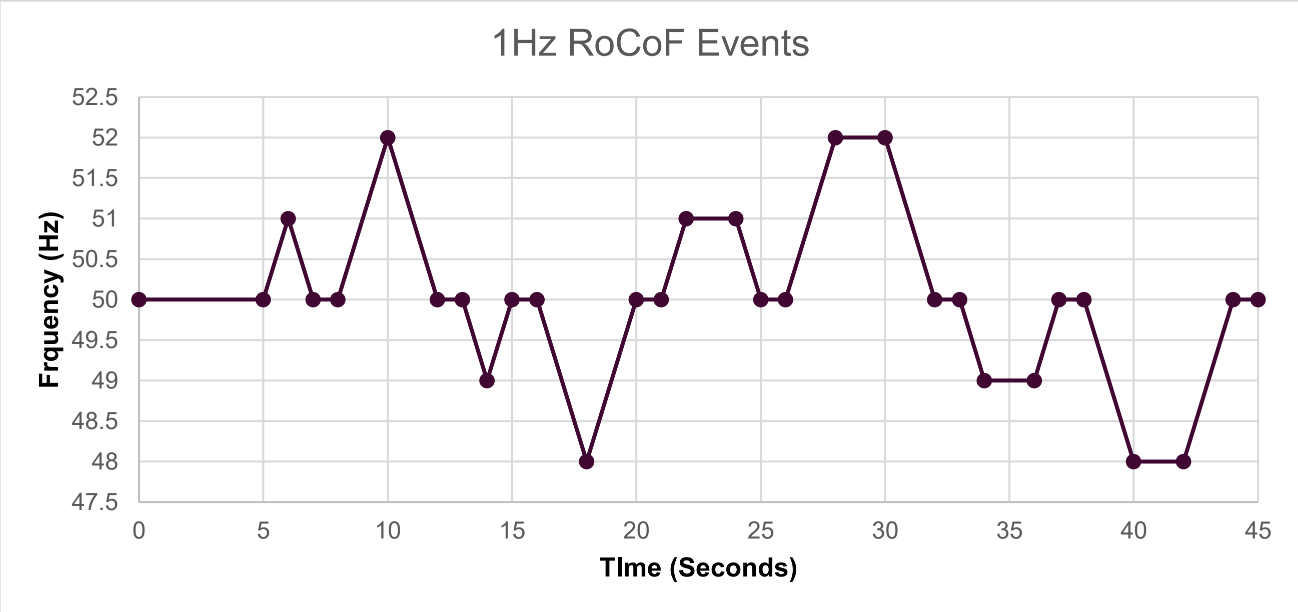


Figure 2: 1Hz RoCoF Events

Table 5: 1Hz Simulation Steps

Step	Action
1	Ramp from 50Hz to 51Hz at 1 Hz/s.
2	Ramp from 51 to 50Hz at 1 Hz/s
3	Hold for 1 Second
4	Ramp from 50Hz to 52Hz at 1 Hz/s
5	Ramp from 52Hz to 50Hz at 1 Hz/s
6	Hold for 1 Second
7	Ramp from 50Hz to 49Hz at 1 Hz/s
8	Ramp from 49Hz to 50Hz at 1 Hz/s
9	Hold for 1 Second
10	Ramp from 50Hz to 48Hz at 1 Hz/s

11	Ramp from 48Hz to 50Hz at 1 Hz/s
12	Hold for 1 Second
13	Ramp from 50Hz to 51Hz at 1 Hz/s.
14	Hold for 2 Seconds
15	Ramp from 51Hz to 50Hz at 1 Hz/s
16	Hold for 1 Second
17	Ramp from 50Hz to 52Hz at 1 Hz/s
18	Hold for 2 Seconds
19	Ramp from 52Hz to 50Hz at 1 Hz/s
20	Hold for 1 Second
21	Ramp from 50Hz to 49Hz at 1 Hz/s
22	Hold for 2 Seconds
23	Ramp from 49Hz to 50Hz at 1 Hz/s
24	Hold for 1 Second
25	Ramp from 50Hz to 48Hz at 1 Hz/s
26	Hold for 2 Seconds
27	Ramp from 48Hz to 50Hz at 1 Hz/s
28	Hold for 1 Second

7.3 Simulation for Dynamic Events

The profile shown in Figure 3 must be simulated to demonstrate plant behaviour during dynamic frequency events. An extract of this requirement will be provided in a form of a .csv file.

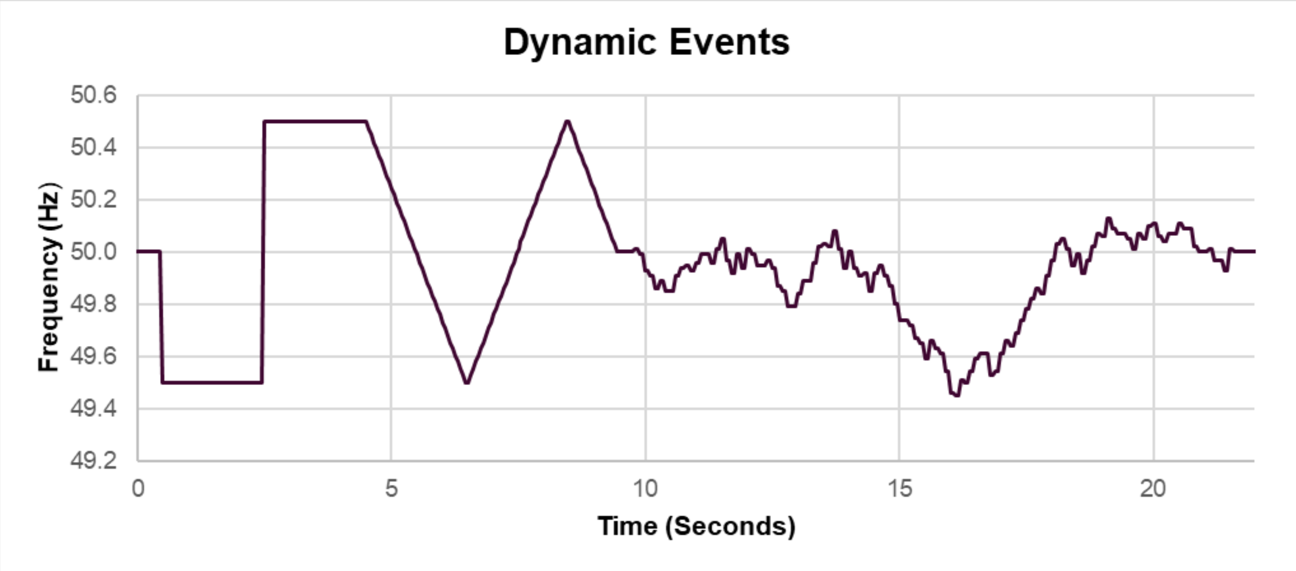


Figure 3: Dynamic Events.

8. Inertia Calculation Methodology

All providers who wish to stack Stability Services and Dynamic Frequency Response services, will need to submit an inertia delivery calculation methodology. This methodology will allow the active power relevant to the inertia service when stacked with dynamic frequency response services to be separated from the overall plant response.

It follows a process like that used for Bid Offer Actions and Physical Notifications, where a baseline is established to derive the frequency response delivery for monitoring purposes. By removing the inertia response from the active power of the plant's output, the remaining active power will be the frequency response power. This active power value will be used to determine the performance of the frequency response service delivery. Not removing the inertia response correctly may result in an incorrect frequency response power which does not meet the service requirements for the frequency response service, leading to penalties being applied to the provision of dynamic frequency response services.

This Inertia delivery calculation methodology must be agreed with NESO before the services can be stacked. At a minimum, the following information must be provided:

- A Flowchart of the process and methodology used to derive the active power relevant to inertia
- Methodology used to calculate Inertia and the Rate of Change of Frequency
- Metering Locations for the values used in the calculations
- Dataframe containing:
    - Input values at their measured resolution, e.g. active power, frequency, timestamp
    - Intermediary calculated values, e.g. delta P, RoCoF
- Final values
- Accuracy of inertia calculation against real system performance

It is at NESO's sole discretion if the calculation methodology is accepted. If the methodology is rejected, NESO will provide the reasons as to why it was unacceptable. Service Providers may resubmit a new methodology after addressing the concerns raised for the rejected submission.

Please note, that NESO reserves the right to update the inertia calculation process in future.

Accuracy of inertia delivery calculation

The accuracy of the inertia baseline method will be assessed by analysing the error between the delivered Inertia and the calculated inertia. For a frequency event, this can be calculated as:

$$(1)\ Error = \frac{abs\ (Inertia\ Delivery_{Calculated} - Inertia\ Delivery_{Simulated})}{Inertia\ Delivery_{Simulated}}$$

This error should be calculated for the following events at a minimum:

Table 6: Required Simulations for Accuracy Calculations

Step	Active Power Setpoint	Reactive Power Setpoint	Frequency Event

1	Max Export	Max Leading	50Hz to 49Hz, with a 1Hz/s RoCoF
2	Max Export	Max Lagging	50Hz to 49Hz, with a 1Hz/s RoCoF
3	Max Export	Max Leading	50Hz to 51Hz, with a 1Hz/s RoCoF
4	Max Export	Max Lagging	50Hz to 51Hz, with a 1Hz/s RoCoF
5	Max Import	Max Leading	50Hz to 49Hz, with a 1Hz/s RoCoF
6	Max Import	Max Lagging	50Hz to 49Hz, with a 1Hz/s RoCoF
7	Max Import	Max Leading	50Hz to 51Hz, with a 1Hz/s RoCoF
8	Max Import	Max Lagging	50Hz to 51Hz, with a 1Hz/s RoCoF

Show in Figures 4 and 5 are an example of how the error can be calculated and displayed from these simulations.

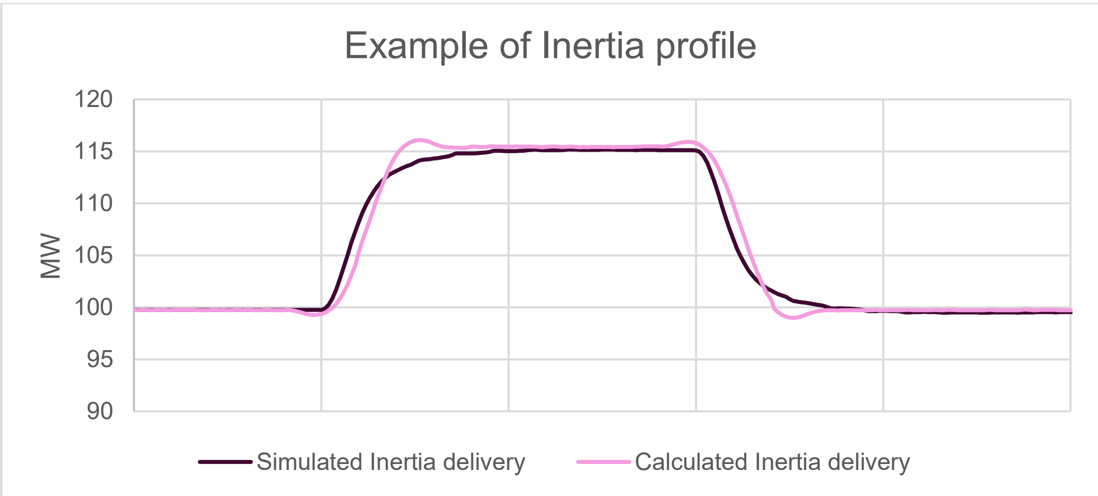


Figure 4: Calculated Inertia vs Delivered

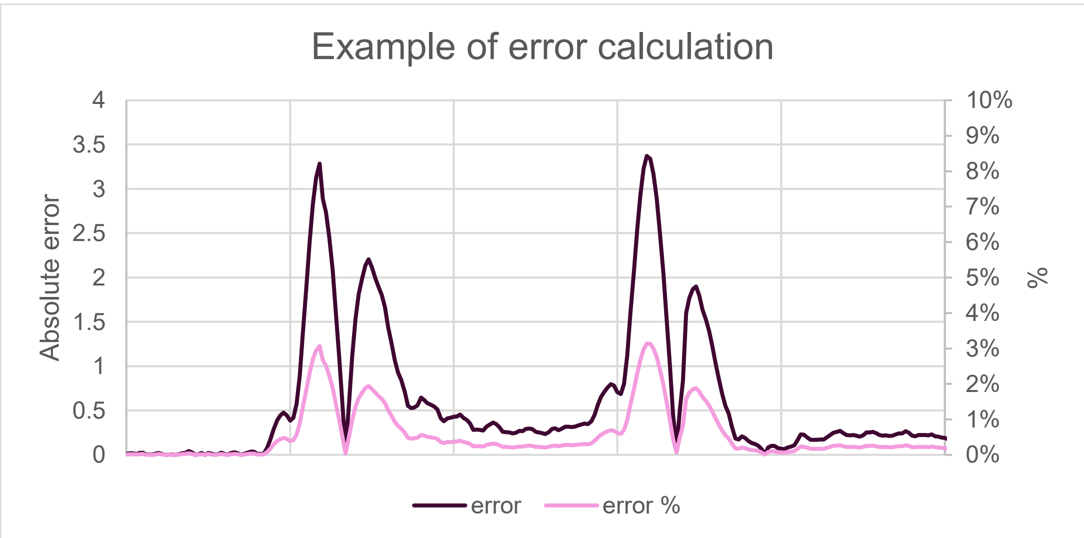
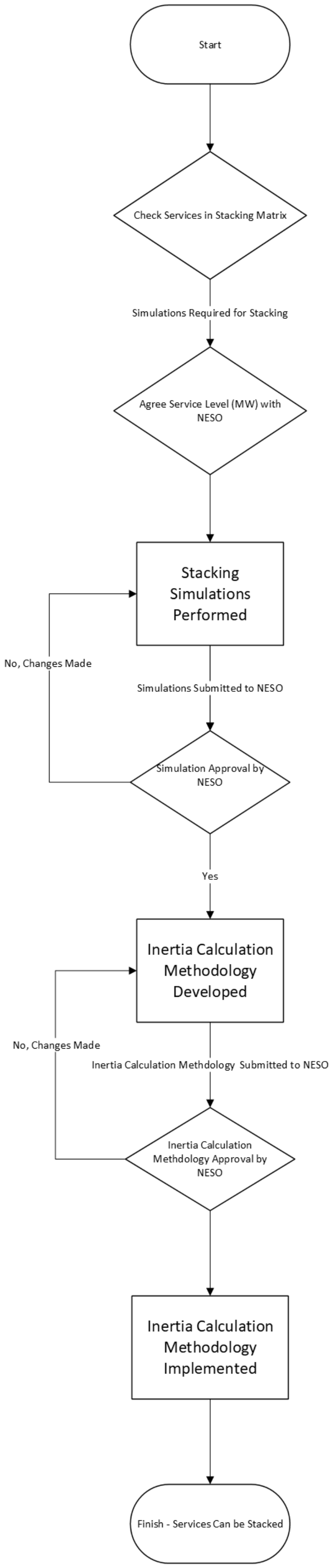


Figure 5: Calculated Inertia

Appendix A


Start
Check Services in Stacking Matrix
Simulations Required for Stacking
Agree Service Level (MW) with NESO
Stacking Simulations Performed
No, Changes Made
Simulations Submitted to NESO
Simulation Approval by NESO
Yes
Inertia Calculation Methodology Developed
No, Changes Made
Inertia Calculation Methdology Submitted to NESO
Inertia Calculation Methdology Approval by NESO
Inertia Calculation Methodology Implemented
Finish - Services Can be Stacked