Mid-Term (Y-1) Stability Market

Round 1 (2025/26)

Proving Tests

April 2024

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Version Control

Date	Version number	Notes
16/02/2024	1.0	Initial version
16/04/2024	2.0	Section 2 'Overview' updated to reflect the stacking rule that allows stacking between existing Stability Pathfinder Service Contracts and the Mid-Term (Y-1) Stability Market. An update has also been made to Section 5 'Commercial Service Proving Tests'.

Contents

Overview

1. Aim

The aim of this document is to provide an overview of the compliance and proving tests that are required to be completed as part of the Mid Term (Y-1) Stability Market. These tests are an important part of the tender and demonstrate the real physical capability of the solution and its compliance against the relevant sections of the GB Grid Code. Please note all parties need to meet the requirements set out in ECC.6.3.19 for Grid Forming plant.

This document is intended to provide an overview of the Grid Code compliance activities a successful solution must undertake and details of the additional technical simulations and commercial service tests that would be expected to be demonstrated.

2. Overview

V2 Clarification: *This section has been clarified as part of the V2 publication.*

This document sets out the compliance simulations and capability tests that successful parties in the Mid Term (Y-1) Market will have to complete before their scheduled service start date.

The basis of compliance for both GB Grid Forming-Inverter (GBGF-I) [1]and GB Grid Forming-Synchronous (GBGF-S) [2]will be based upon the Grid Code. For both GBGF-I and GBGF-S, the Grid Code compliance procedure will follow the requirements for the host technology to which the Grid Forming equipment is installed with the additional tests detailed in ECP.A.9 being completed for GBGF-I technology. For clarity a hybrid solution would need to meet both the requirements for GBGF-I and GBGF-S.

Solutions must prove that the stacking of other services does not impact upon their delivery of the Stability Service. Stacking with other services or different operational strategy of assets may not be allowed if this is not proven at the compliance stage. For solutions stacking stability services, the demonstration of compliance and of the proving tests would be required at each permissible operating point.

In line with Clause 7 of the Standard Contract Terms for the Mid-Term Stability Market, should a Provider make any physical changes to their equipment (i.e., reducing the number of in-service inverters) during the course of the contract, ESO reserve the right to enact Clause 7.1 to request a Reproving Test to evidence the impact this has upon their delivery of the stability service.

As a part of being awarded a contract and in addition to completing Grid Code compliance obligations, successful parties will have to complete additional compliance activities, a summary of these are shown in **Table 1**.

Table 1: Summary of Compliance Requirements

Compliance Requirement	GBGF-I	GBGF-S
Phase Angle Withstand Simulation	✓	×
Inertia Value - From 1Hz/Sec RoCoF Simulation	✓	✓
Inertia Value – From 1Hz/Sec RoCoF Physical Testing	✓	×
Grid Forming Plant verification and validation (ECP.A.3.9.1)	✓	×

[1] [2] Any definitions used in this document will take their definition from the GB Grid Code.

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3. Grid Code Compliance

Please note all solutions must meet the fault ride through requirements in the ECC code (Section ECC.6.3.15). For GBGF-S solutions, the relevant sections of the Grid Code must be followed.

For additional guidance for Synchronous Condensers please refer to the Synchronous Condenser Guidance Note.

For GBGF-I solutions, the relevant sections of the Grid Code must be followed for the host technology as well as additional testing detailed in ECP.A.9. For more detail, please refer to the GB Grid Forming Guidance Notes and also the GB Grid Forming Best Practice Guide.

For both GBGF-I and GBGF-S solutions, the provision of an Electro-Magnetic Transient (EMT) model in addition to an RMS model is required, for this please refer to the EMT Guidance Notes.

4. Additional Technical Compliance Simulations

Within this section two additional simulations are covered; additional Phase Angle Withstand simulations required for GBGF-I solutions and additional RoCoF response simulations for both GBGF-I and GBGF-S solutions.

The simulations detailed in Table 2 only apply to GBGF-I solutions, the aim is to demonstrate the ability of GBGF-I solutions to remain connected and stable for Phase Jump Angles up to the withstand limit.

The following measurements are required for this simulation:

- voltage magnitude and phase angle at the Grid Entry Point (GEP) or User System Entry Point (USEP) and solution terminal.
- active power and reactive power at the Grid Entry Point or User System Entry Point and solution terminal.
- active, reactive, and total current at the Grid Entry Point or User System Entry Point and solution terminal.
- frequency and RoCoF at the Grid Entry Point or User System Entry Point
- The Phase Angle event should be modelled as an event within the Ideal voltage source.
- The equivalent system impedance (Z_{sys}) for the connection location parameters are to be obtained from NGESO (If Transmission Connected) or the relevant DNO (If Distribution Connected).
- The time step should not be greater than 1ms.
- The simulation should be setup in accordance with Figure 1.

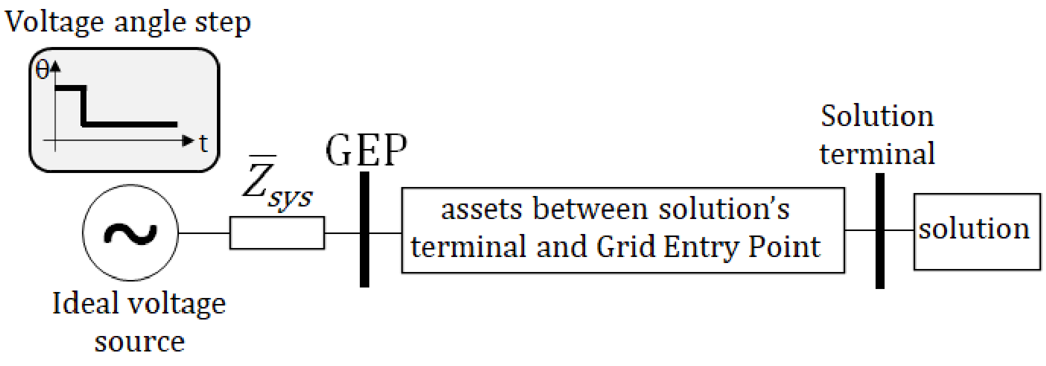

Figure 1: Network configuration for simulations in Table 2

Table 2: Phase Angle Withstand Simulations

Step	Initial Conditions	Event
1	If applicable, solution operating at **maximum active power export** (generation).	Apply a phase jump equivalent to the positive Phase Jump Angle Withstand

	Solution operating at **maximum reactive power export** (i.e. lagging mode or reactive power injection).	at the GEP or USEP. Allow conditions to stabilise for at least 10 seconds.
2	If applicable, solution operating at **maximum active power export** (generation). Solution operating at **maximum reactive power import** (i.e. leading mode or reactive power absorption).	Apply a phase jump equivalent to the positive Phase Jump Angle Withstand at the GEP or USEP. Allow conditions to stabilise for at least 10 seconds.
3	If applicable, solution operating at **maximum active power import** (demand). Solution operating at **maximum reactive power export** (i.e. lagging mode or reactive power injection).	Apply a phase jump equivalent to the positive Phase Jump Angle Withstand at the GEP or USEP. Allow conditions to stabilise for at least 10 seconds.
4	If applicable, solution operating at **maximum active power import** (demand). Solution operating at **maximum reactive power import** (i.e. leading mode or reactive power absorption).	Apply a phase jump equivalent to the positive Phase Jump Angle Withstand at the GEP or USEP. Allow conditions to stabilise for at least 10 seconds.
5	If applicable, solution operating at **maximum active power export** (generation). Solution operating at **maximum reactive power export** (i.e. lagging mode or reactive power injection).	Apply a phase jump equivalent to the negative Phase Jump Angle Withstand at the GEP or USEP. Allow conditions to stabilise for at least 10 seconds.
6	If applicable, solution operating at **maximum active power export** (generation). Solution operating at **maximum reactive power import** (i.e. leading mode or reactive power absorption).	Apply a phase jump equivalent to the negative Phase Jump Angle Withstand at the GEP or USEP. Allow conditions to stabilise for at least 10 seconds.
7	If applicable, solution operating at **maximum active power import** (demand). Solution operating at **maximum reactive power export** (i.e. lagging mode or reactive power injection).	Apply a phase jump equivalent to the negative Phase Jump Angle Withstand at the GEP or USEP. Allow conditions to stabilise for at least 10 seconds.
8	If applicable, solution operating at **maximum active power import** (demand). Solution operating at **maximum reactive power import** (i.e. leading mode or reactive power absorption).	Apply a phase jump equivalent to the negative Phase Jump Angle Withstand at the GEP or USEP. Allow conditions to stabilise for at least 10 seconds.

The simulations detailed In Table 3 must be completed by both GBGF-I and GBGF-S solutions. They aim to replicate the simulations that were required by providers at the feasibility study stage. For GBGF-I solutions all steps must be completed, for GBGF-S solutions only Steps 5-9 need to be completed. Hybrid solutions must complete all steps.

- voltage magnitude and phase angle at the Grid Entry Point or User System Entry Point and solution terminal.
- active power and reactive power at the Grid Entry Point or User System Entry Point and solution terminal.
- active, reactive, and total current at the Grid Entry Point or User System Entry Point and solution terminal.
- frequency and RoCoF at the Grid Entry Point or User System Entry Point
- The Frequency event should be modelled as an event within the Ideal voltage source.
- The equivalent system impedance (Z_{sys}) for the connection location parameters are to be obtained from NGESO (If Transmission Connected) or the relevant DNO (If Distribution Connected).

- The time step should not be greater than 1ms.
- The simulation should be setup in accordance with Figure 2.
- A summary of Inertia values should be provided and should match or be greater than the Inertia values stated in the feasibility study.

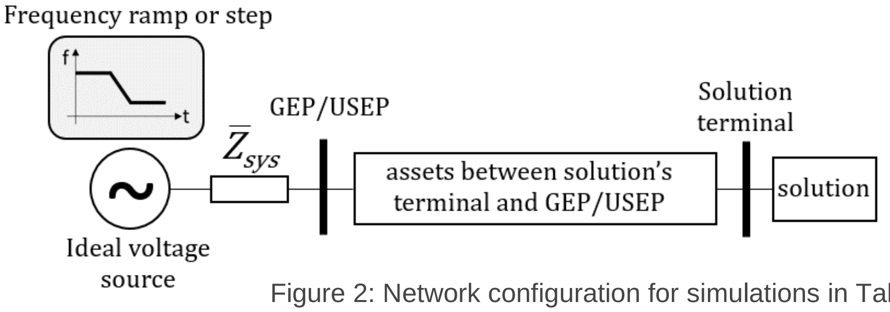

Figure 2: Network configuration for simulations in Table 3

Table 3: RoCoF Simulations

Step	Initial Conditions	Frequency Event
1	If applicable, solution operating at **maximum active power export** (generation). Solution operating at **maximum reactive power export** (i.e. lagging mode or reactive power injection).	Inject a 1 Hz frequency drop over a period of 1 second.
2	If applicable, solution operating at **maximum active power export** (generation). Solution operating at **maximum reactive power import** (i.e. leading mode or reactive power absorption).	Inject a 1 Hz frequency drop over a period of 1 second.
3	If applicable, solution operating at **maximum active power import** (demand). Solution operating at **maximum reactive power export** (i.e. lagging mode or reactive power injection).	Inject a 1 Hz frequency rise over a period of 1 second.
4	If applicable, solution operating at **maximum active power import** (demand). Solution operating at **maximum reactive power import** (i.e. leading mode or reactive power absorption).	Inject a 1 Hz frequency rise over a period of 1 second.
5	Solution operating at **zero** active power output. Solution operating at **maximum reactive power export** (i.e. lagging mode or reactive power injection).	Inject a 1 Hz frequency drop over a period of 1 second.
6	Solution operating at **zero** active power output. Solution operating at **maximum reactive power import** (i.e. leading mode or reactive power absorption).	Inject a 1 Hz frequency drop over a period of 1 second.
7	Solution operating at **zero** active power output. Solution operating at **maximum reactive power export** (i.e. lagging mode or reactive power injection).	Inject a 1 Hz frequency rise over a period of 1 second.
8	Solution operating at **zero** active power output. Solution operating at **maximum reactive power import** (i.e. leading mode or reactive power absorption).	Inject a 1 Hz frequency rise over a period of 1 second.

9	Solution operating at **zero** active power output. Solution operating at **zero** reactive power output.	Inject a frequency **step** event from 50Hz to 49Hz lasting for 0.5s.

Commercial Service Proving Tests

A requirement of the Mid-Term (Y-1) Stability Market Framework Agreement and Standard Contract Terms is the proving of the contracted inertia from providers. Due to the inherent ability of GBGF-S plant to provide inertia, these tests are not required from this type of solution. However, it is a requirement that GBGF-S solutions submit evidence of their inertia value through their manufacturer data sheets. The objective of these tests is to demonstrate that the tendered inertia value is deliverable across the asset's operating range. These tests should be completed through physical testing, if this is not possible, please contact the ESO to agree alternative equivalent tests sufficient to prove the contracted capability within the Provider's commercial agreement. **V2 Clarification**: The ESO reserves the right to witness any of these tests.

These tests should be completed with both Frequency Sensitive Mode (FSM) and Limited Frequency Sensitive Mode (LFSM) disabled. For each test measurements of the Grid Forming Plant's Active ROCOF Response Power, System Frequency, and time (in ms) should be recorded. The resolution of these recordings should be adequate to demonstrate the performance of the plants. All steps in Table 4 must be completed.

Table 4: Details of Inertia Tests

Step	Initial Conditions	Frequency Event
1	If applicable, solution operating at **maximum active power export** (generation). Solution operating at **maximum reactive power export** (i.e. lagging mode or reactive power injection).	Inject a 1 Hz frequency drop over a period of 1 second.
2	If applicable, solution operating at **maximum active power export** (generation). Solution operating at **maximum reactive power import** (i.e. leading mode or reactive power absorption).	Inject a 1 Hz frequency drop over a period of 1 second.
3	If applicable, solution operating at **maximum active power import** (demand). Solution operating at **maximum reactive power export** (i.e. lagging mode or reactive power injection).	Inject a 1 Hz frequency rise over a period of 1 second.
4	If applicable, solution operating at **maximum active power import** (demand). Solution operating at **maximum reactive power import** (i.e. leading mode or reactive power absorption).	Inject a 1 Hz frequency rise over a period of 1 second.
5	Solution operating at **zero** active power output. Solution operating at **maximum reactive power export** (i.e. lagging mode or reactive power injection).	Inject a 1 Hz frequency drop over a period of 1 second.
6	Solution operating at **zero** active power output. Solution operating at **maximum reactive power import** (i.e. leading mode or reactive power absorption).	Inject a 1 Hz frequency drop over a period of 1 second.

7	Solution operating at **zero** active power output. Solution operating at **maximum reactive power export** (i.e. lagging mode or reactive power injection).	Inject a 1 Hz frequency rise over a period of 1 second.
8	Solution operating at **zero** active power output. Solution operating at **maximum reactive power import** (i.e. leading mode or reactive power absorption).	Inject a 1 Hz frequency rise over a period of 1 second.
9	Solution operating at **zero** active power output. Solution operating at **zero** reactive power output.	Inject a frequency **step** event from 50Hz to 49Hz lasting for 0.5s.