Public

Grid Forming development in GB: Grid Code, Compliance Process and Market Arrangement

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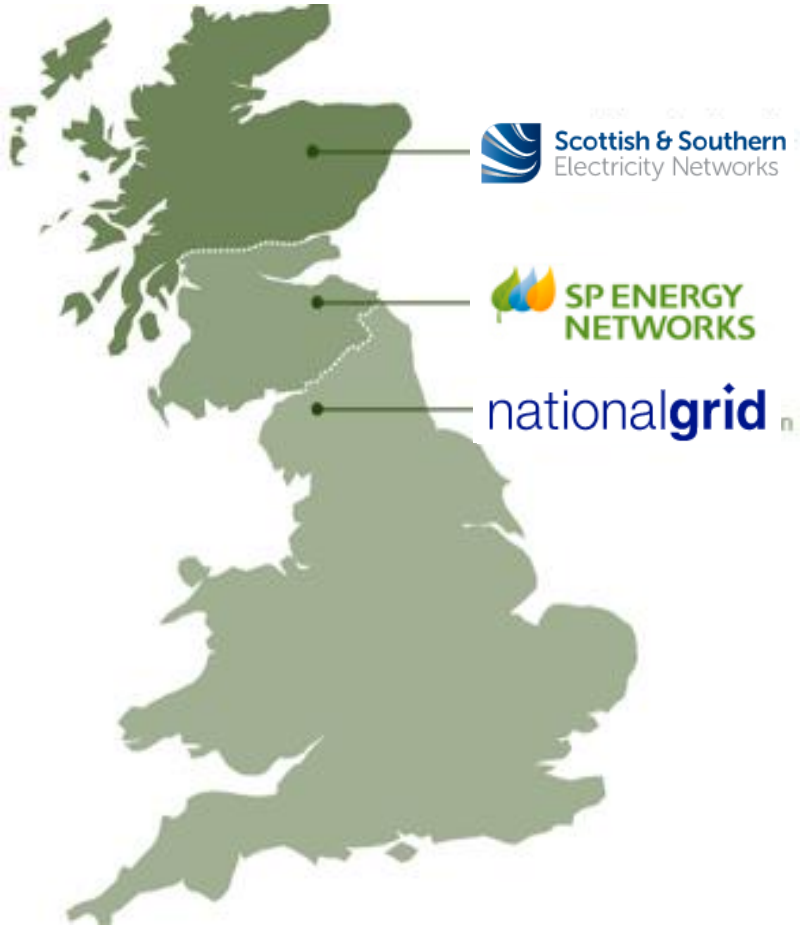
NESO
National Energy System Operator

NESO's role

- Operates and balances the system
- Provides electricity network recommendations
- Operational planning
- Connection agreements
- Widens access and promotes competition
- Responsible for GB transmission charging and billing

The **transmission operators** (TOs) own, build and maintain Britain's transmission infrastructure.



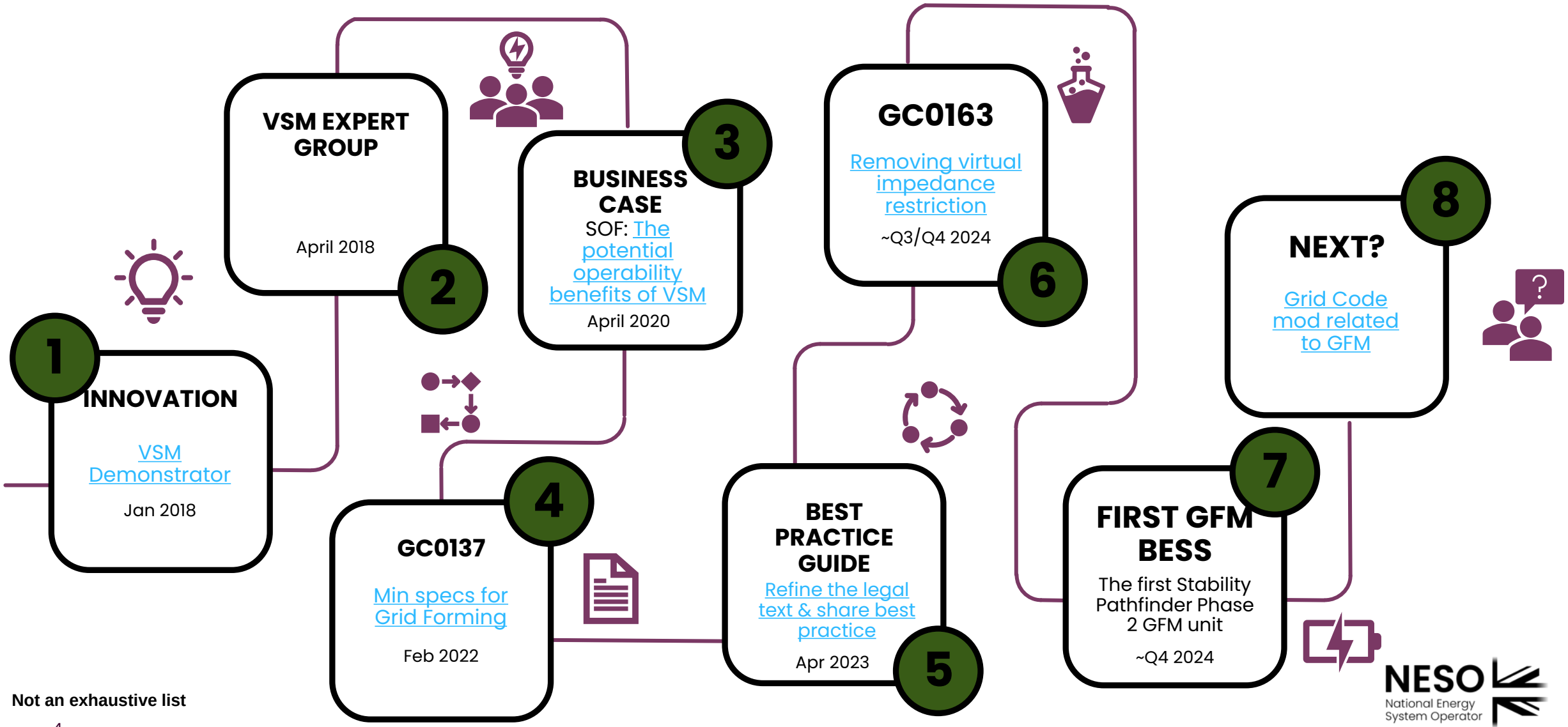
NESO (National Energy System Operator) from Oct 2024

NESO National Energy System Operator

CP30 NESO advice

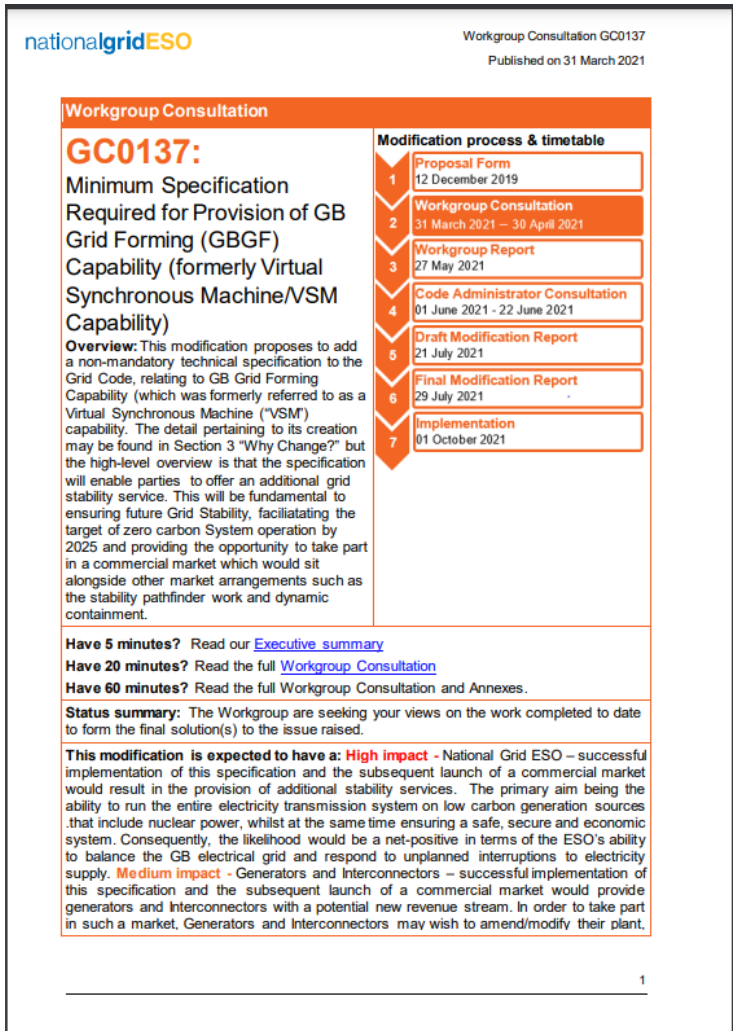
	Installed Capacities (GW)		
Technology	**2023**	**2030 Further Flex and Renewables**	**2030 New Dispatch**
Offshore wind	14.7	50.6	43.1
Onshore wind	13.7	27.3	27.3
Solar	15.1	47.4	47.4
Nuclear	6.1	3.5	4.1
Biomass/BECCS	4.3	4.0	3.8
Low carbon dispatchable power	0	0.3	2.7
Other renewables	4.7	5.7	5.7
Batteries	4.7	27.4	22.6
LDES	2.8	7.9	4.6
Interconnectors	8.4	12.5	12.5
Unabated gas	37.4	35.0	35.0

GB Grid Forming History



Not an exhaustive list

GB Grid Forming Development



nationalgridESO

Workgroup Consultation GC0137
Published on 31 March 2021

Workgroup Consultation

GC0137:

Minimum Specification Required for Provision of GB Grid Forming (GBGF) Capability (formerly Virtual Synchronous Machine/VSM Capability)

Overview: This modification proposes to add a non-mandatory technical specification to the Grid Code, relating to GB Grid Forming Capability (which was formerly referred to as a Virtual Synchronous Machine ("VSM") capability. The detail pertaining to its creation may be found in Section 3 "Why Change?" but the high-level overview is that the specification will enable parties to offer an additional grid stability service. This will be fundamental to ensuring future Grid Stability, faciliatating the target of zero carbon System operation by 2025 and providing the opportunity to take part in a commercial market which would sit alongside other market arrangements such as the stability pathfinder work and dynamic containment.

Modification process & timetable

1. Proposal Form — 12 December 2019
2. Workgroup Consultation — 31 March 2021 – 30 April 2021
3. Workgroup Report — 27 May 2021
4. Code Administrator Consultation — 01 June 2021 - 22 June 2021
5. Draft Modification Report — 21 July 2021
6. Final Modification Report — 29 July 2021
7. Implementation — 01 October 2021

Have 5 minutes? Read our Executive summary

Have 20 minutes? Read the full Workgroup Consultation

Have 60 minutes? Read the full Workgroup Consultation and Annexes.

Status summary: The Workgroup are seeking your views on the work completed to date to form the final solution(s) to the issue raised.

This modification is expected to have a: High impact - National Grid ESO – successful implementation of this specification and the subsequent launch of a commercial market would result in the provision of additional stability services. The primary aim being the ability to run the entire electricity transmission system on low carbon generation sources .that include nuclear power, whilst at the same time ensuring a safe, secure and economic system. Consequently, the likelihood would be a net-positive in terms of the ESO's ability to balance the GB electrical grid and respond to unplanned interruptions to electricity supply. **Medium impact** - Generators and Interconnectors – successful implementation of this specification and the subsequent launch of a commercial market would provide generators and Interconnectors with a potential new revenue stream. In order to take part in such a market, Generators and Interconnectors may wish to amend/modify their plant,

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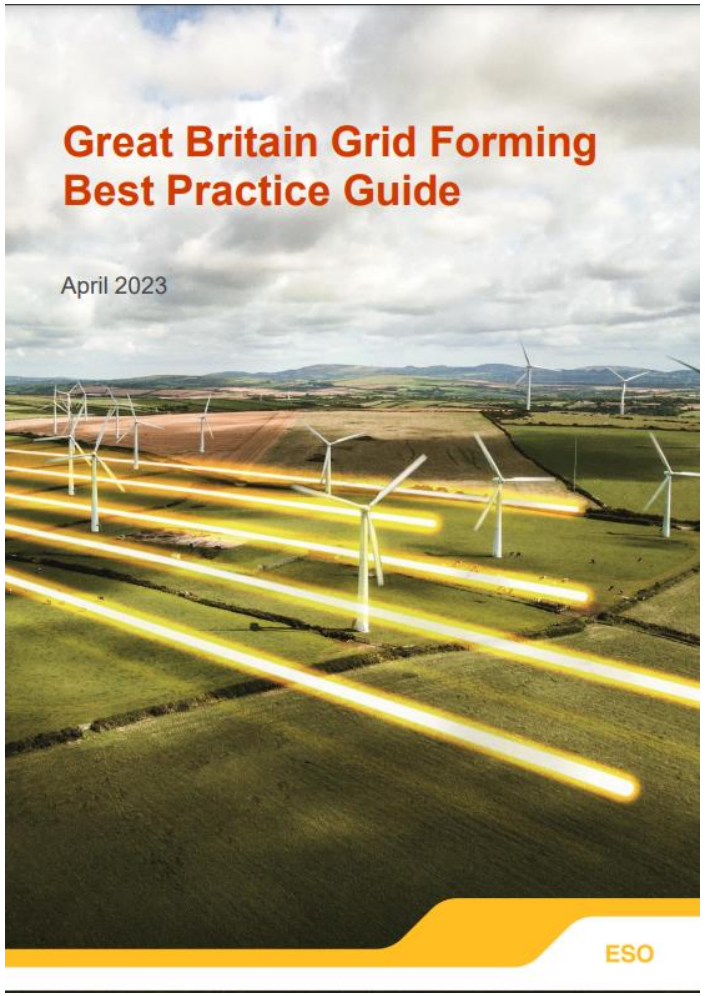

GC0XXX
Submitted: DD MONTH YEAR

ESO

Grid Code Modification Proposal Form

GC0XXX:

GB Grid Forming (GBGF) - capability mandate, clarity on definitions, changes to performance requirements and changes to compliance tests and simulations.

Overview: This modification aims to mandate Grid Forming Capability on certain types and sizes of plants. This modification also aims to update the Grid Code in respect of the Grid Forming requirements arising from i) the Great Britain Grid Forming Best Practice Guide, ii) Stakeholder comments, iii) the industrial experience gained from the Stability Pathfinder work / Compliance Process, iv) developments in Europe.

Modification process & timetable

TBD

Status summary: The Proposer will be setting up an Expert Group which aims to develop recommendations ahead of a formal Grid Code Modification.

This modification is expected to have a: High impact

Manufacturers, Generators, the ESO, Transmission Owners, Offshore Transmission Owners.

Modification drivers: Harmonisation, New Technologies, System Operability, System Planning, System Security, Net Zero

Proposer's recommendation of governance route	Standard Governance modification with assessment by a Workgroup

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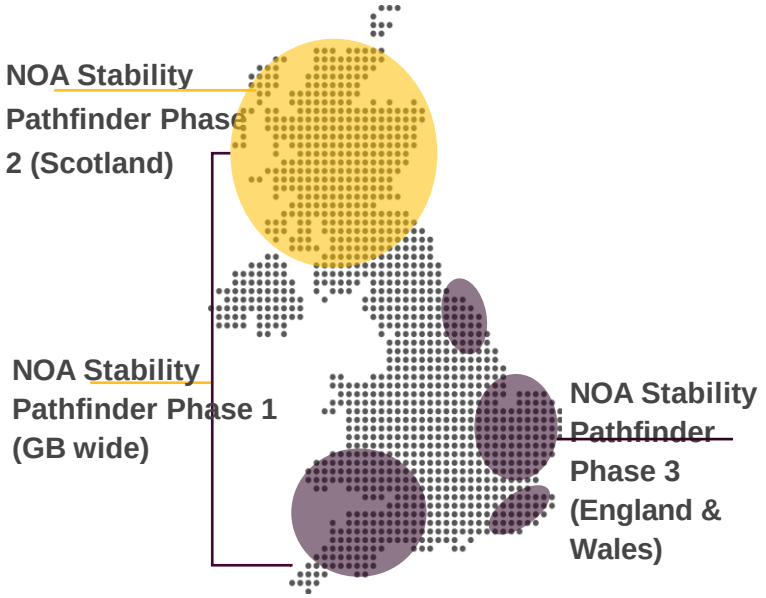
Stability Pathfinder

	Stability Pathfinder Phase 1	Stability Pathfinder Phase 2	Stability Pathfinder Phase 3
Requirement	Inertia and dynamic voltage GB wide	Inertia, SCL and dynamic voltage	Inertia, SCL and dynamic voltage
Status	All Synchronous compensators most units now live	5 GFM BESS 5 SynComp Go-live from Apr 24	29 Synchronous compensators Go-live expected from 2025
Participating technology	0MW Synchronous Compensators only	Synchronous and Grid Forming Converter based	Synchronous and Grid Forming Converter based
Procurement regions	GB wide	Scotland	England and Wales
Procurement volume	12.5 GW.s of inertia	8.4 GVA of SCL 6 GW.s of inertia	7.5 GVA of SCL 15 GW.s of inertia
Contract Detail	Up to 6 years	End of Mar 2034	End of Mar 2035 £1.35b
Contract payments	Availability payments for SCL& Inertia Utilisation payments for reactive power		



https://www.neso.energy/industry-information/balancing-services/network-services-procurement/stability-network-services-procurement

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Stability Market Assessments

Inertia

- SynComps: Provide almost the same inertial response irrespective of the pre-event operational point or event direction (rise or drop of frequency).

- GFM BESS: Inertial response could vary based on pre-event active/reactive power operational point and event direction (rise or drop of frequency).

Hence, the concept of the "minimum guaranteed inertia".

MW	Max Export	Max Export	Max Export	Max Export	Max Import	Max Import	Max Import	Max Import
MVAr	Max Export	Max Import	Max Export	Max Import	Max Export	Max Import	Max Export	Max Import
Event	Hz dip	Hz dip	Hz rise	Hz rise	Hz dip	Hz dip	Hz rise	Hz rise
Inertia	**H1**	**H2**	**H3**	**H4**	**H5**	**H6**	**H7**	**H8**

Minimum enters tender assessment and contract

SCL

- SynComps: The magnitude of its short circuit current contribution for a 3ph bolted fault may vary depending on the pre-event operational point.

- GFM BESS: Short circuit current contribution is fairly constant across pre-event operational points.

Hence, the concept of the "minimum guaranteed SCL".

MW	Max export	Max export	Max export	Max import	Max import	Max import	0	0	0
MVAr	Max export	Max import	0	Max export	Max import	0	Max export	Max import	0
Event	3ph fault (0RV)	3ph fault (0RV)	3ph fault (0RV)	3ph fault (0RV)	3ph fault (0RV)	3ph fault (0RV)	3ph fault (0RV)	3ph fault (0RV)	3ph fault (0RV)
SCL	**SCL1**	**SCL2**	**SCL3**	**SCL4**	**SCL5**	**SCL6**	**SCL7**	**SCL8**	**SCL9**

Minimum enters tender assessment and contract

Stability Market Overview

To maintain compliance and reduce costs associated with managing stability, we have concluded an innovation project to explore designing new markets to procure stability services.

		Long Term (Y-4)		Mid Term (Y-1)	Short Term (D-1)
Purpose		– Procure capacity in advance (LT), to signal the need for new assets – Allow financing of new build capacity (and enhanced capability, TBD) through LT contracts		– Procure capacity in advance (MT), to adjust LT procurement in case necessary – Allow MT financing of new, incremental and existing capability able to provide stability	– Procure capacity to fulfil residual of total requirements for Stability closer to real time (ST) – Allow remuneration of marginal costs for providing Stability.
Timeline	*Procurement lead time*	– Y-4	– Y-4	– Y-1	– D-1
	Contract duration	– 10+ years	– 3 years	– 1 year	– Service windows
Product	*Contract type*	– Baseload availability		– Baseload availability	– 4 h (EFA blocks)
	Contract obligations	– e.g. 90% availability		– e.g. 90% availability	– 100% availability
Payment Design		– Availability only		Synchronous Machines – Availability and Utilisation Inverter Based Generation – Availability Only.	– Utilisation Only.

Live Stability Markets

- We are moving away from ad hoc stability pathfinders into a market design to allow more regular procurement (Network Service Procurement)

- These markets will operate over a spectrum of time horizons, covering both the short and long term.

- We have concluded the first year of our Stability Mid–Term market this market awarded 5 contracts to 5 providers for 5 GVA.s of inertia. The value of these contracts is £25 Million for the provision of inertia for the delivery year Oct 25 – Sep 26,

- We have now launched our second year of the Mid-Term Stability Market, we are seeking 10-15 GVA.s of inertia for the delivery year Oct 26 – Sep 27

		Mid Term (Y-1)
Purpose		– Procure capacity in advance (MT), to adjust LT procurement in case necessary – Allow MT financing of new, incremental and existing capability able to provide stability
Timeline	*Procurement lead time*	– Y-1
	Contract duration	– 1 year
Product	*Contract type*	– Baseload availability
	Contract obligations	– e.g. 90% availability
Eligibility		**Incremental / existing capability** Existing plants
Pricing	*Payment type*	Availability payment – £/MW.s/h – Pay-as-bid Delivery payment* – £/MW.s/h – Pay-as-bid
	Price mechanism	

*Delivery payments made to GBGF-S providers only.

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Tender Process and Timelines

Expression of Interest (EOI) and Consultation Stage → Invitation to Tender (ITT) Stage → NESO Tender Assessments → NESO Sanction Process → Contract Award

Milestone	Key Date
Consultation Feedback Deadline	17 April 2025
Expression of Interest Deadline	28 April 2025
ITT Launch	June/July 2025
ITT Submission Deadline	December 2025
NESO Tender Assessments	December 2025 – May/June 2026
Contract Award	June 2026

Grid Forming Requirements

Typical Suite of Simulations and Tests for GB Grid Forming Plant

Grid Forming Plant

Grid Forming Requirements (ECC.6.3.19)

Generic Requirements

1. Reactive Power Capability
2. Voltage Control
3. Active Power Control
4. Power Output with falling frequency
5. Frequency Response (LFSM/FSM)
6. Fault Ride Through
7. Damping Control

Simulations (ECP.A.3.9)

1. Active RoCoF Response Power
2. Active Phase Jump Power
3. Fast Fault Current Injection
4. Acting Damping Power
5. NFP/Bode Plot

Testing (ECP.A.9.1)

1. Active RoCoF Response Power
2. Active Phase Jump Power
3. Fast Fault Current Injection
4. Acting Damping Power

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GFM modelling and Compliance approach

Model Requirement	Compliance
• RMS • EMT	• Offline model simulation • FAT • On site Commissioning test

Further consideration

- Grid Forming Compliance Testing: inverter lever and plant level; type registration?
- Phase Jump Angle Withstand of 60 degrees
- Frequency domine tools for GFM validation
- System Monitoring - Inertia and Phase Jump Angle where applicable
- Mandating GFM, minimum GFM requirements

Questions?

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