Public

GB System Reliability with High Levels of IBRs

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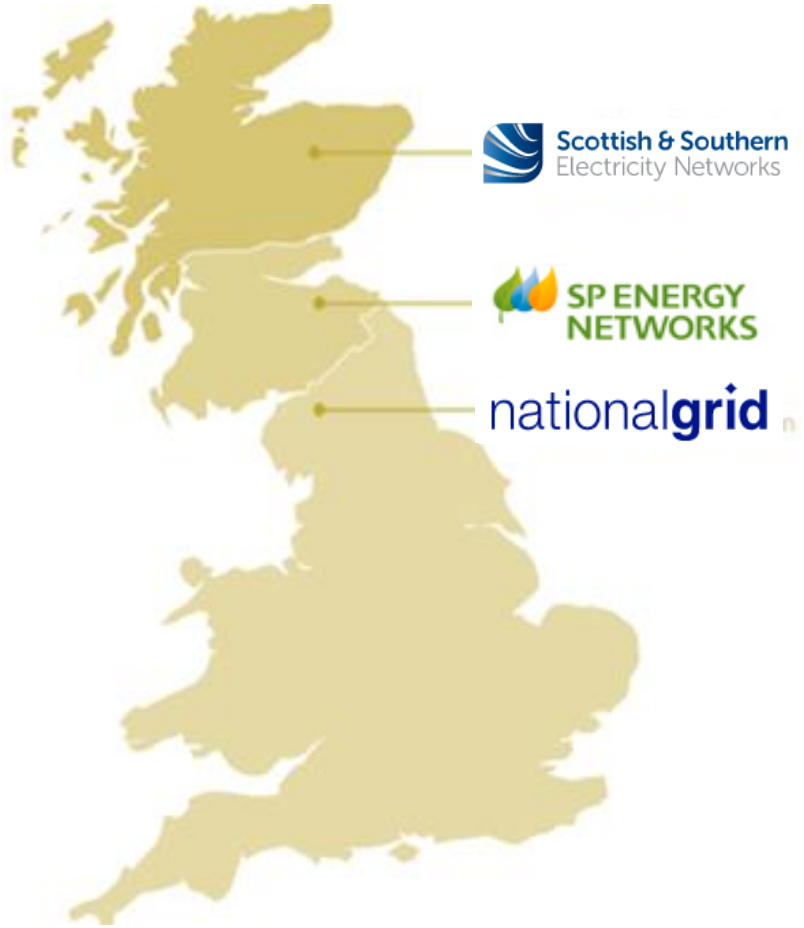
NESO
National Energy System Operator

NESO's role

- Operates and balances the system
- Whole energy system planning
- 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.



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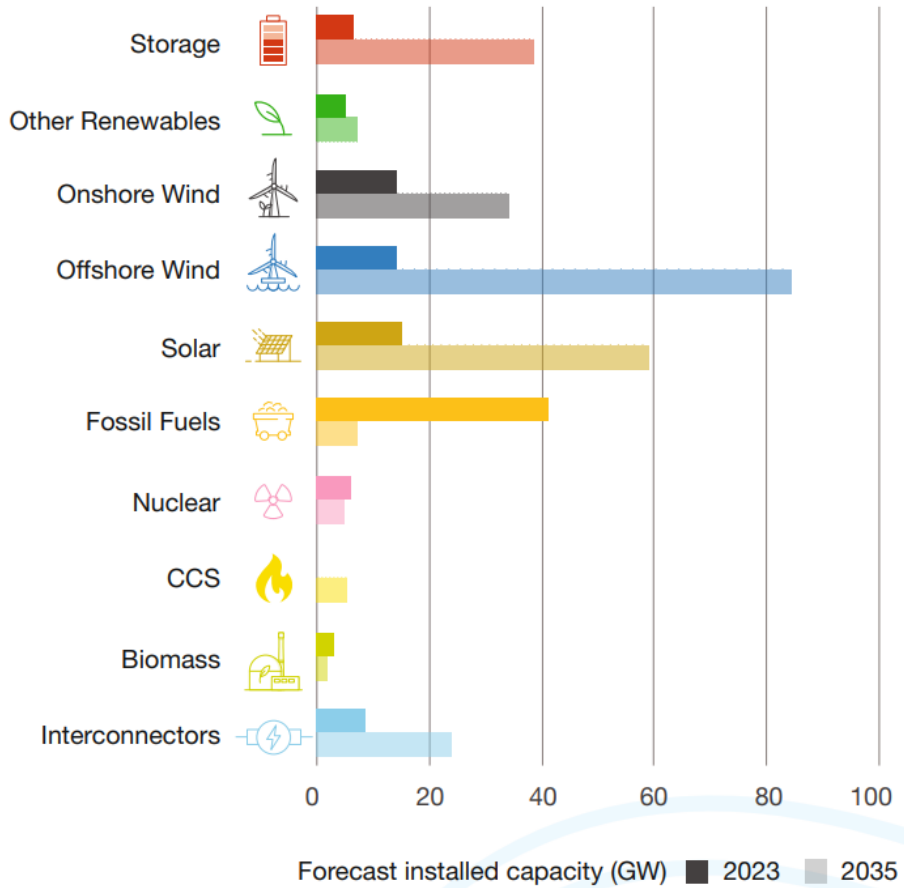
How GB System Evolves



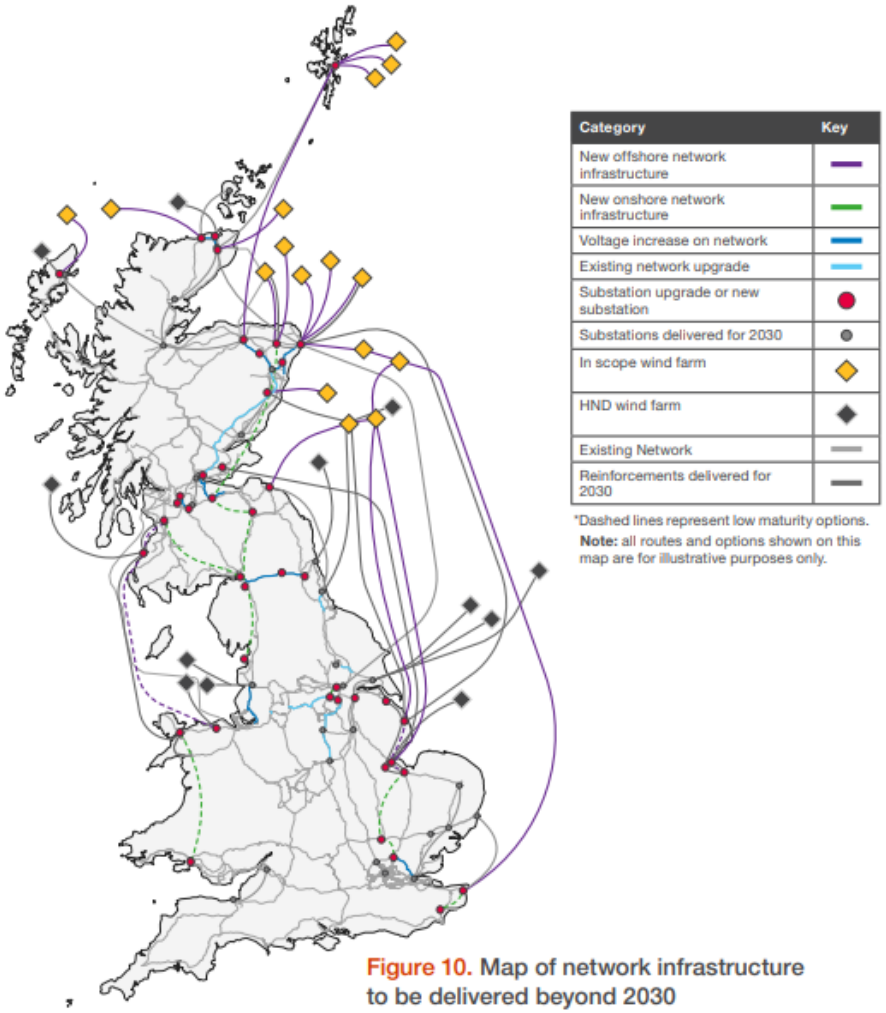


Figure 10. Map of network infrastructure to be delivered beyond 2030

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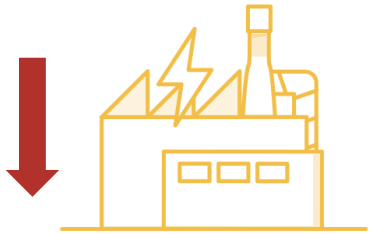
Reliability Challenges

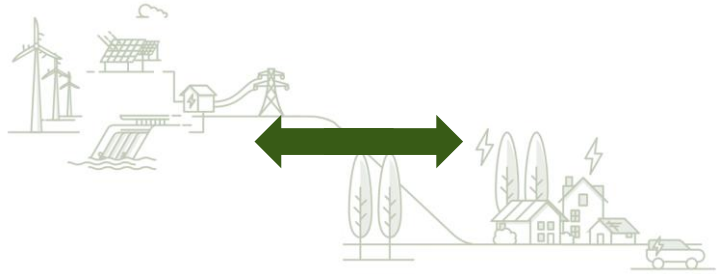
Decarbonisation of the GB power system has resulted in changes in four key areas:



Less dispatchable generation

More variable sources of generation

More asynchronous generation



Generation moving to different areas.

Each of these changes brings about new engineering challenges which have to be resolved to operate a zero carbon network.

- **Frequency** - As more non-synchronous generation connects, system inertia lowers requiring faster acting response. More variability in the system requires fast acting reserves. Large and small loss sizes require services which respond dynamically to the frequency.
- **Stability** - More non-synchronous generation is reducing the levels of stability capability provided to the network. To ensure the system is stable for faults on the network, services to provide inertia and short circuit levels need to be procured.
- **Voltage** - Less dispatchable generation and changes to network flows brought about by generation moving away from demand is increasing the requirements to absorb reactive power on the GB network.
- **Thermal** – More variable sources of generation combined with generation moving to different areas are creating more thermal constraints on the network requiring more innovative solutions to manage congestion prior to network build
- **Resource Adequacy –** the right generation mix, flexible demand and storage
- **Flexibility -** what, where and when can we leverage flexibility
- **System Restoration –** how do you restart a renewable dominated system

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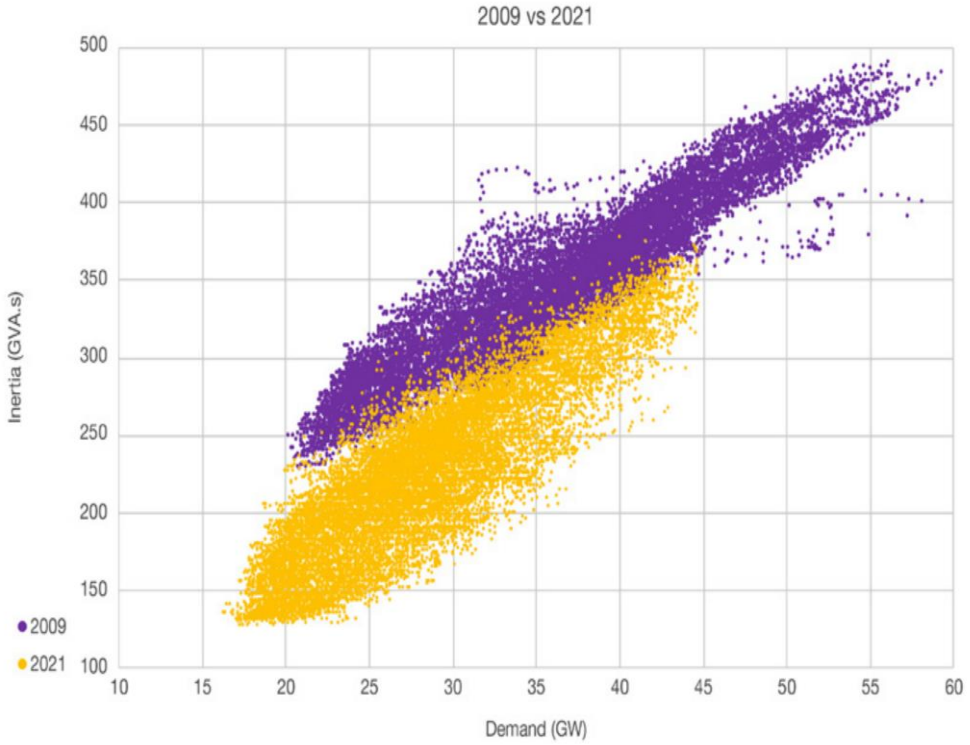
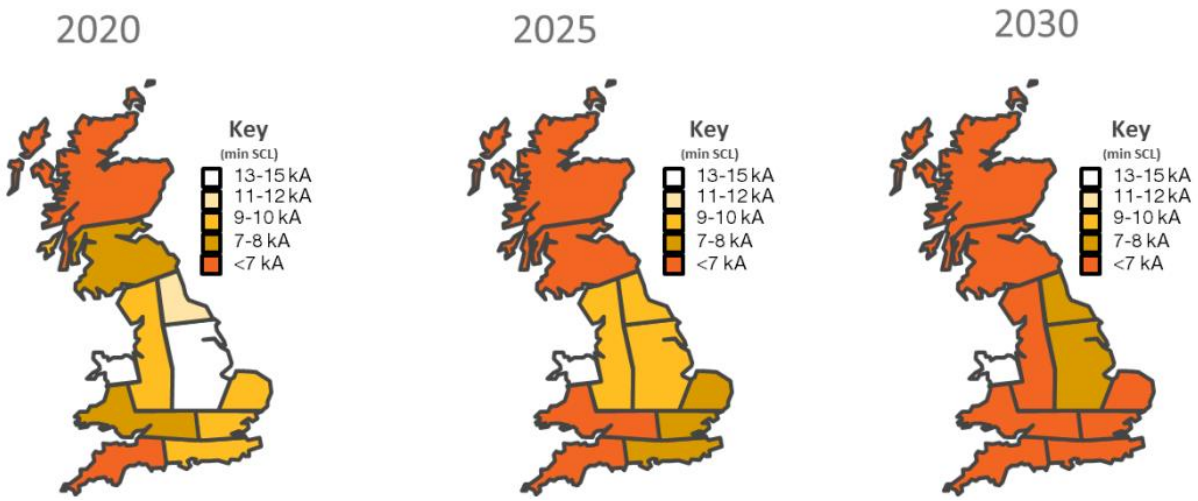
Decline of system inertia and system strength

Inertia vs Demand





Declining Short Circuit Levels

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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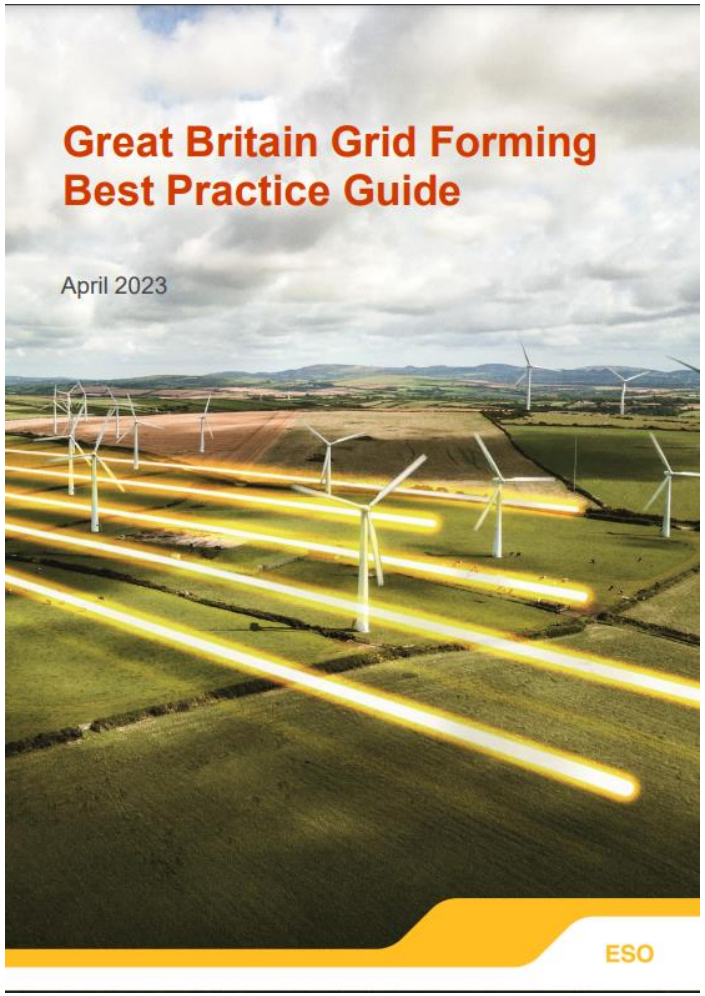

GC0XXX
Submitted: DD MONTH YEAR

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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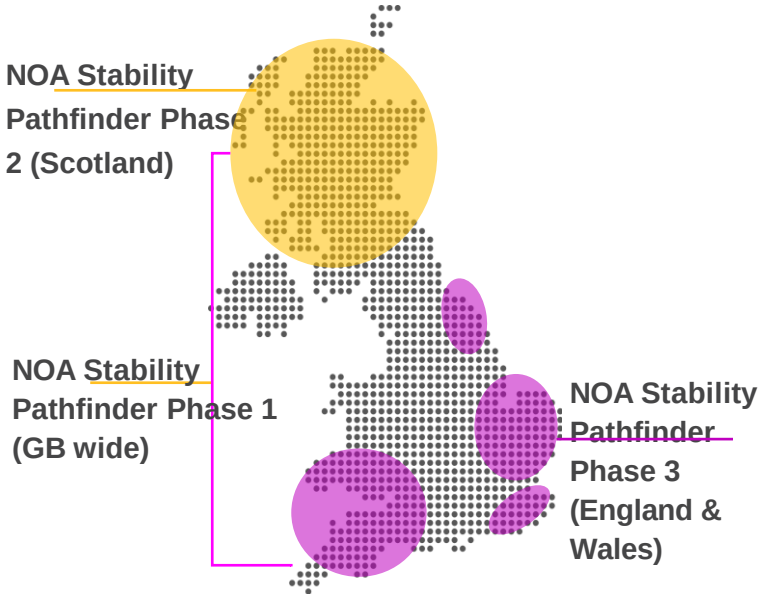
Stability Pathfinder

	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

Stability Market Design

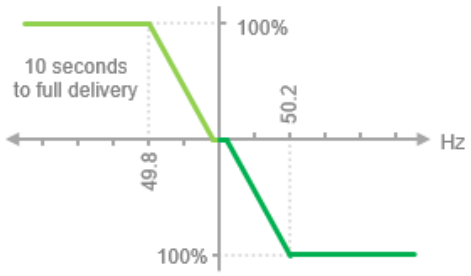
- To maintain compliance and reduce costs associated with managing stability, we are conducting an innovation project with AFRY to explore designing new markets to procure stability services. More details can be found here.
- Phase 1 concluded in 2022 and recommended that a blend of long and short-term competitive procurement is the optimal approach.
- Phase 2 concluded in 2023 built on Phase 1 and provided more detailed evaluation of eligibility rules, contract structure and procurement strategy.

		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-1	– D-1
	Contract duration	– 10+ y	– 1 y	– 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

Frequency services

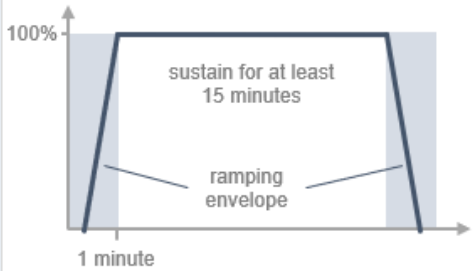
Pre-fault

Dynamic Regulation



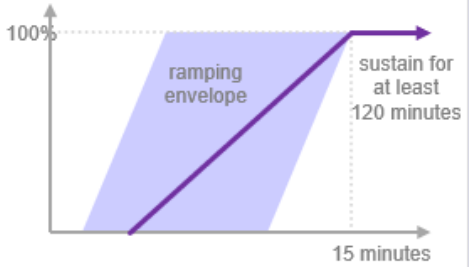
Assist in keeping frequency near to 50Hz during normal conditions

Quick Reserve



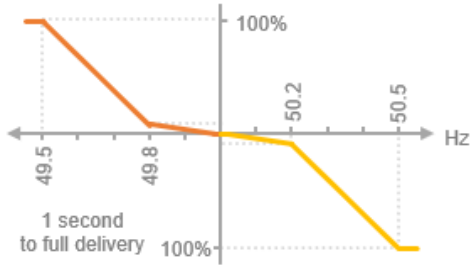
Recover frequency back towards 50Hz, mainly during normal conditions

Slow Reserve



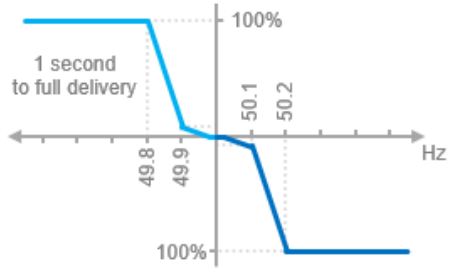
Recover frequency back to 0.2Hz within 15 minutes

Dynamic Containment



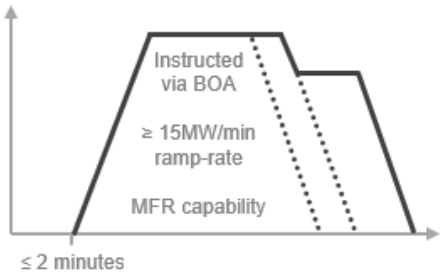
Prevent frequency deviations outside -0.8Hz / +0.5Hz following large losses

Dynamic Moderation



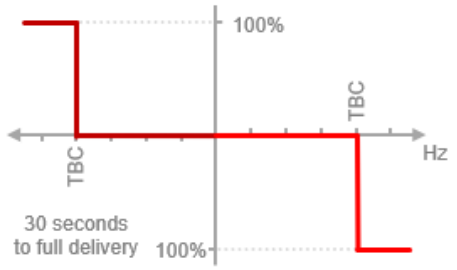
Assist in keeping frequency within 0.2Hz, especially during more volatile conditions

Balancing Reserve



Manage real-time imbalances, and replace activated reserves

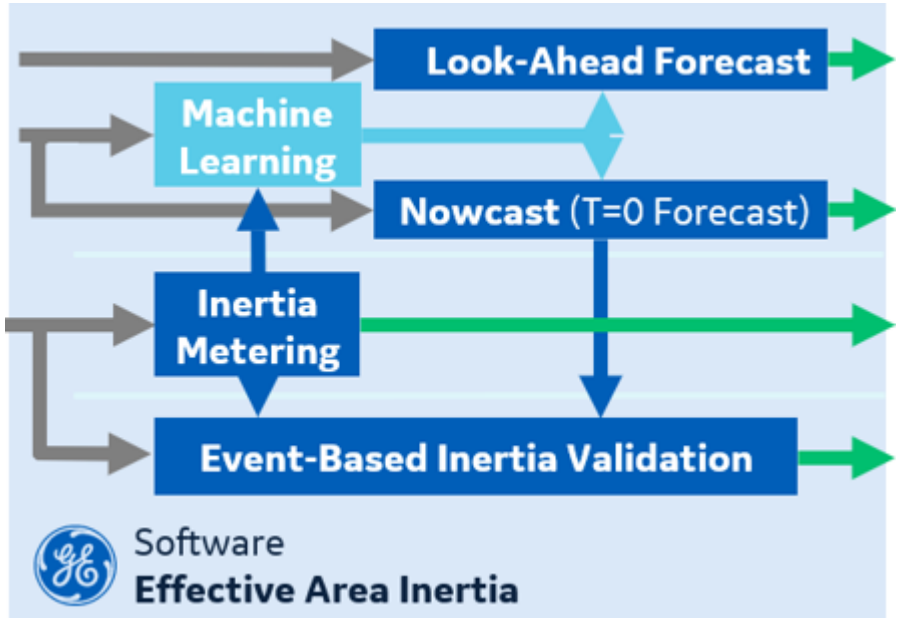
Static Recovery

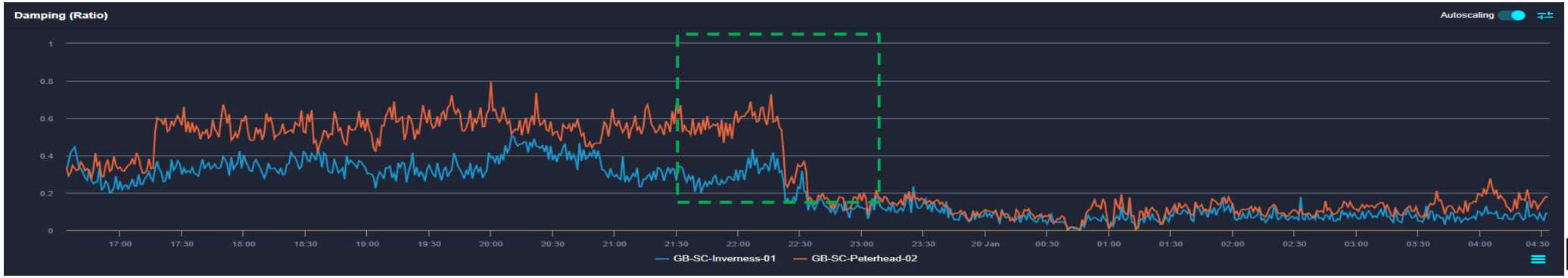


Recover frequency to 0.5Hz within 60 seconds following large losses

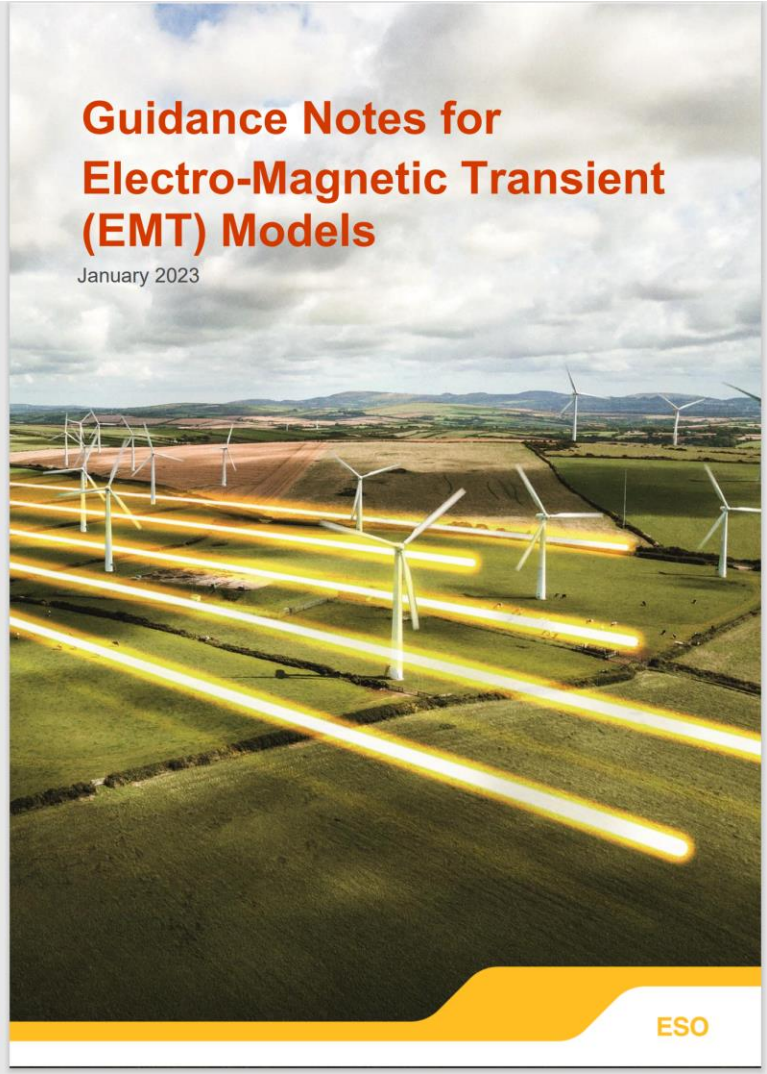
Post-fault

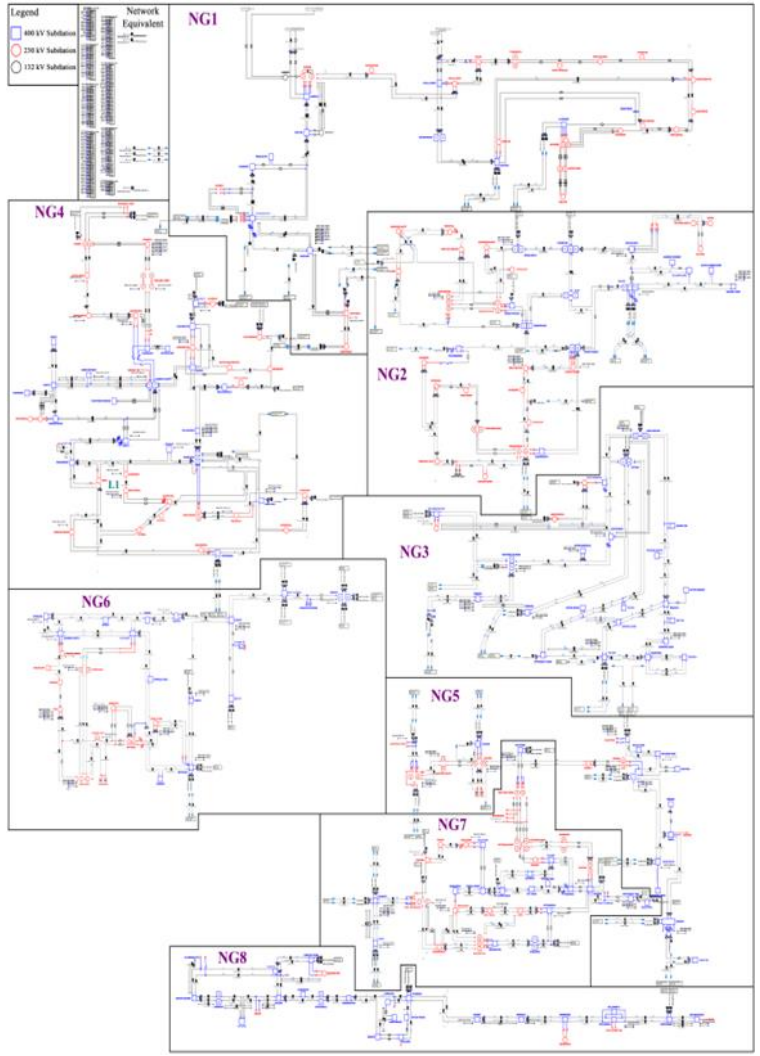
Enhanced Real Time Monitoring





GB EMT Model Development





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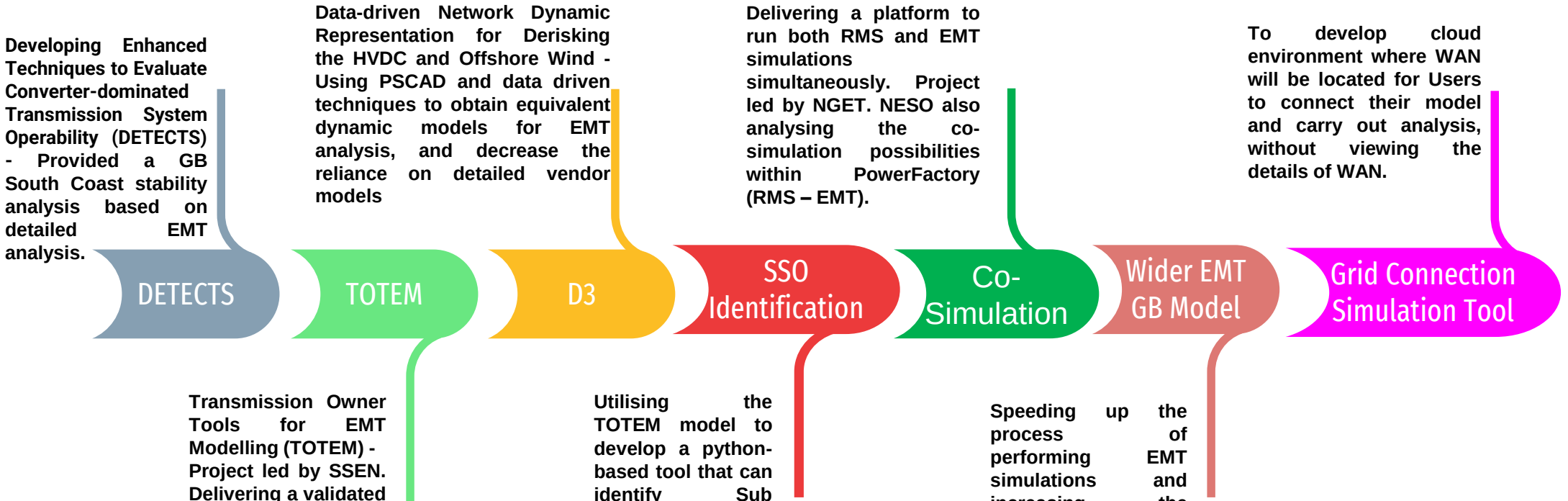
Key projects on EMT Modelling



Thank You!

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