

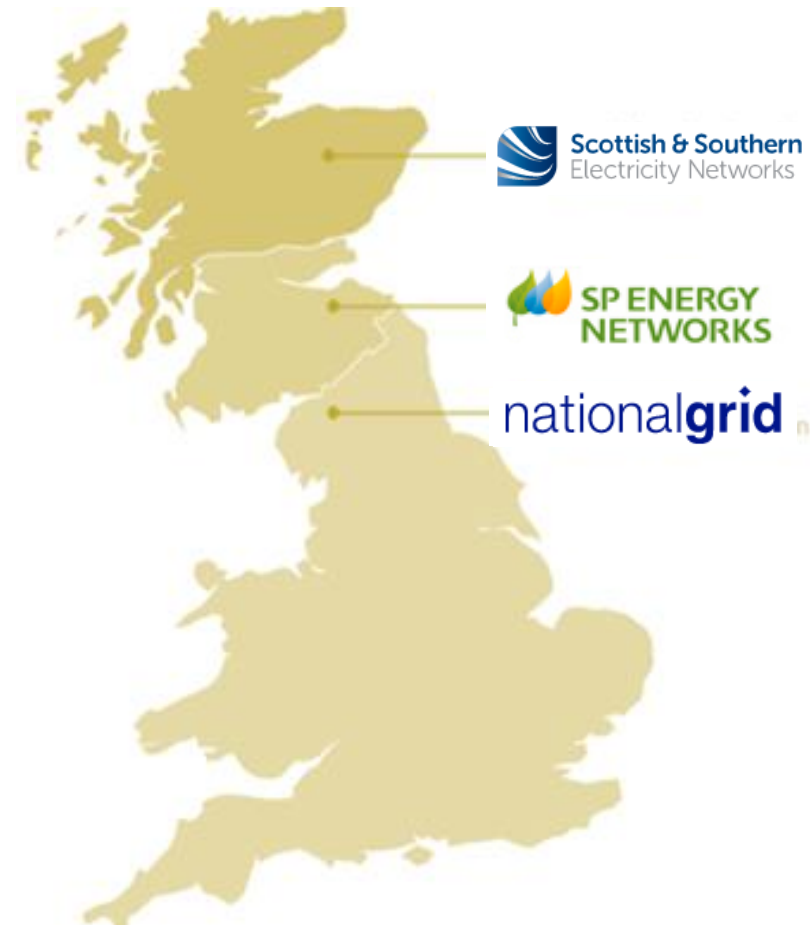
GB System Reliability with High Levels of IBRs

Dr Xiaoyao Zhou, NESO

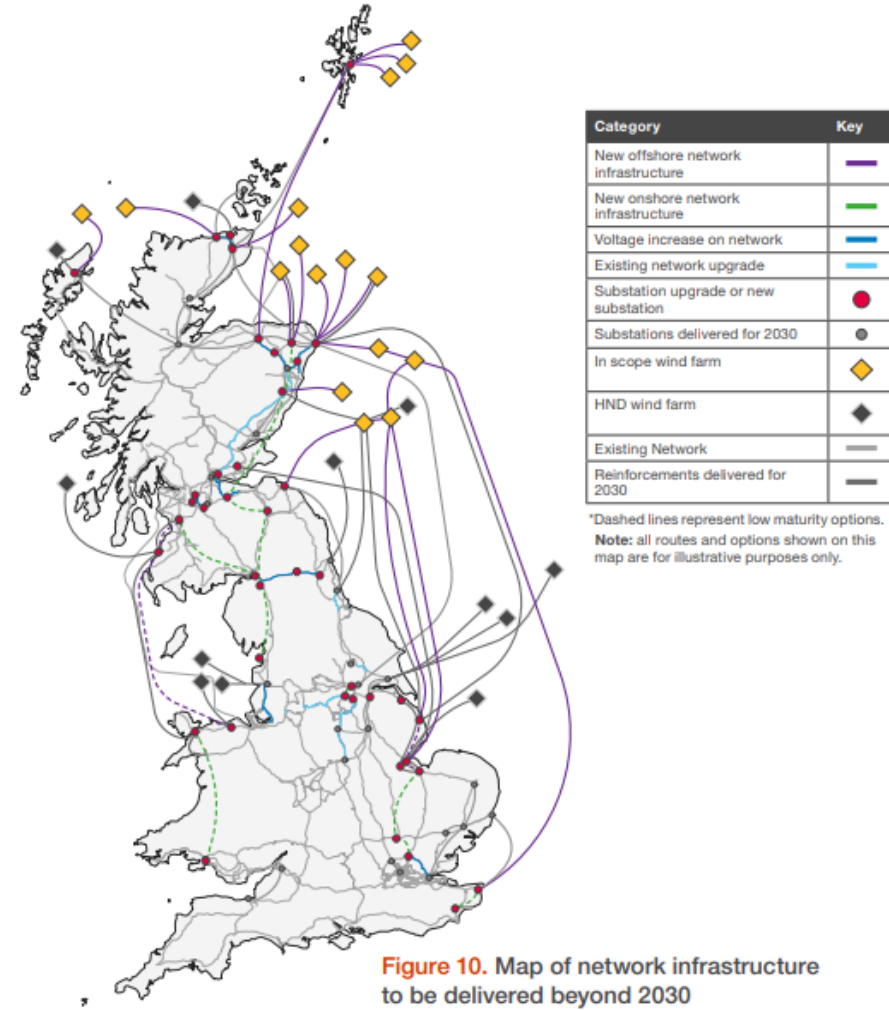
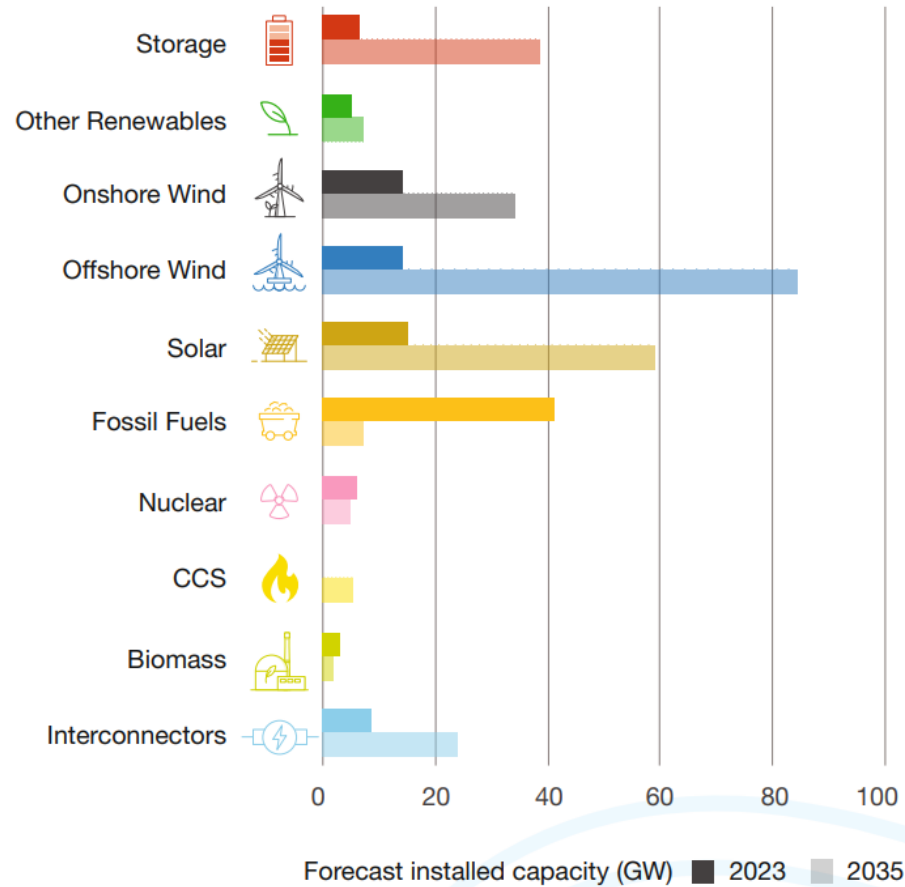
NESO's role

- 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.

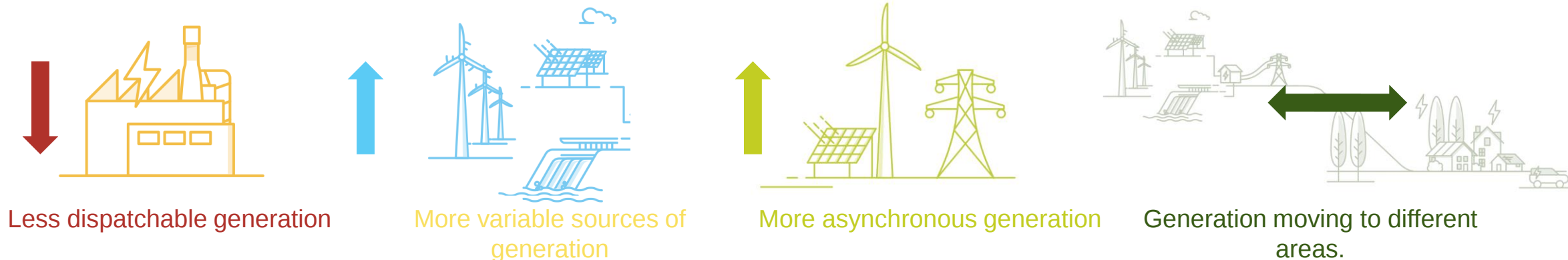


How GB System Evolves



Reliability Challenges

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

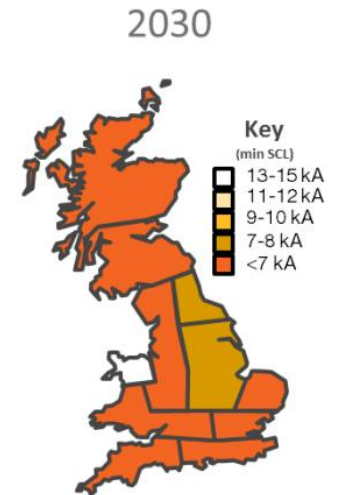
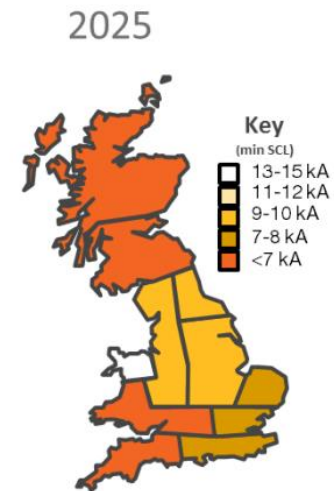
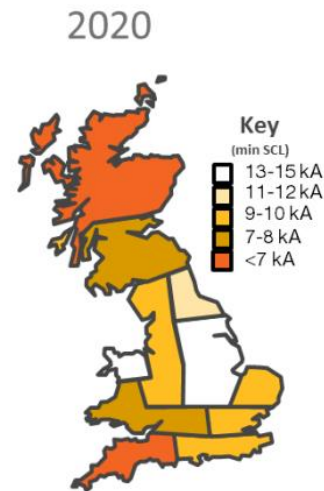
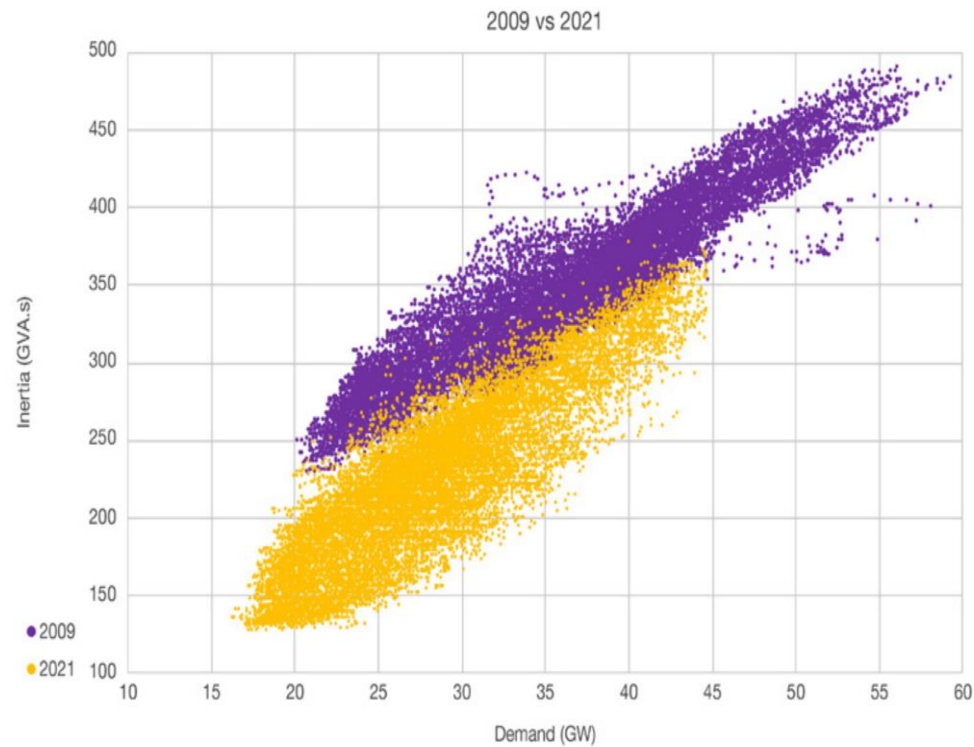


Each of these changes brings about new engineering challenges which have to be resolved to operate a zero carbon network.

- **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

Decline of system inertia and system strength

Inertia vs Demand



Declining Short Circuit Levels

6



Great Britain Grid Forming Best Practice Guide

April 2023

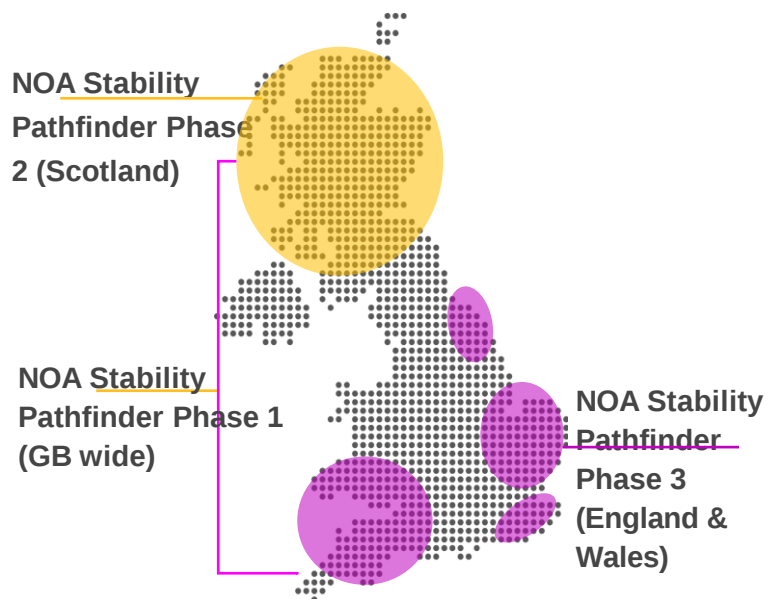
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Submitted: DD MONTH YEAR

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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

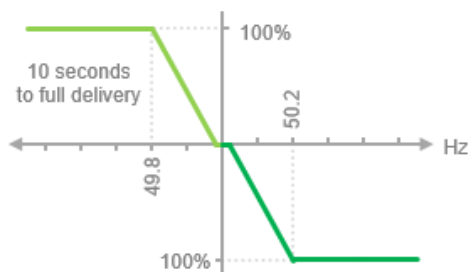
- To maintain compliance and reduce costs associated with managing stability, we are conducting an innovation project with AFRY to explore designing new markets to procure stability services. More details can be found [here](#).
- Phase 1 concluded in 2022 and recommended that a blend of long and short-term 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

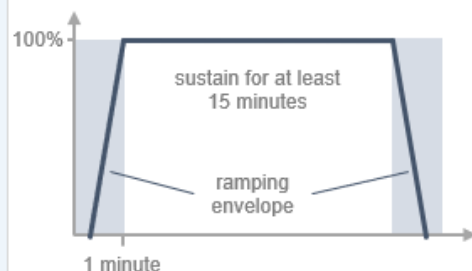
Pre-fault

Dynamic Regulation



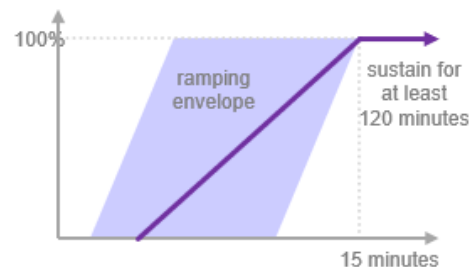
Assist in keeping frequency near to 50Hz during normal conditions

Quick Reserve



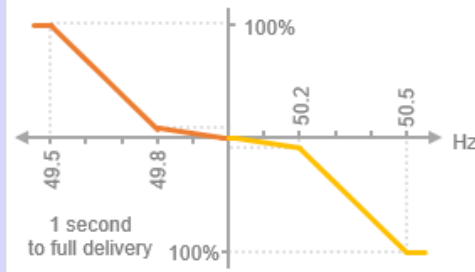
Recover frequency back towards 50Hz, mainly during normal conditions

Slow Reserve



Recover frequency back to 0.2Hz within 15 minutes

Dynamic Containment



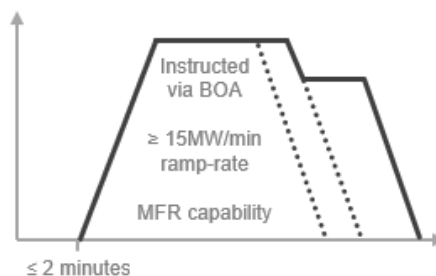
Prevent frequency deviations outside -0.8Hz / +0.5Hz following large losses

Dynamic Moderation



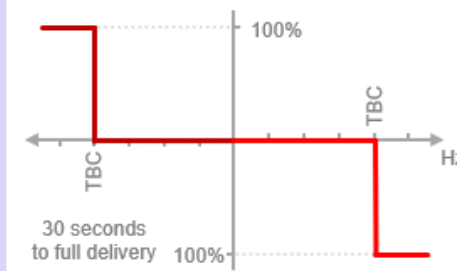
Assist in keeping frequency within 0.2Hz, especially during more volatile conditions

Balancing Reserve



Manage real-time imbalances, and replace activated reserves

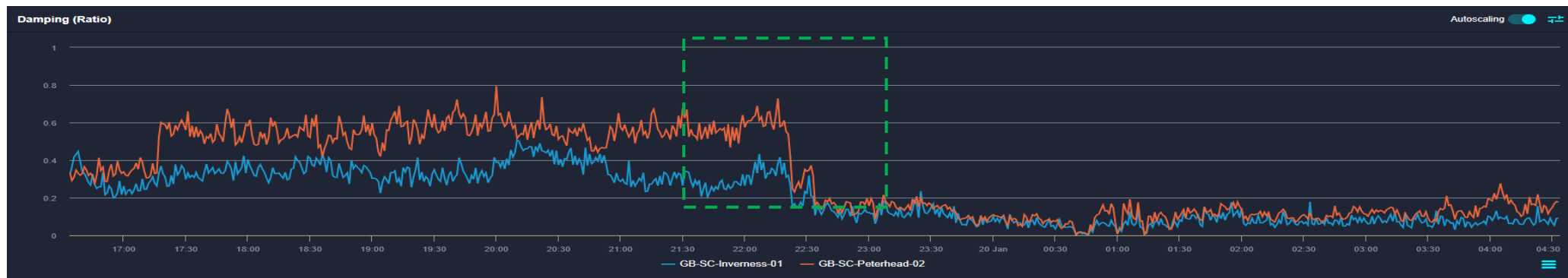
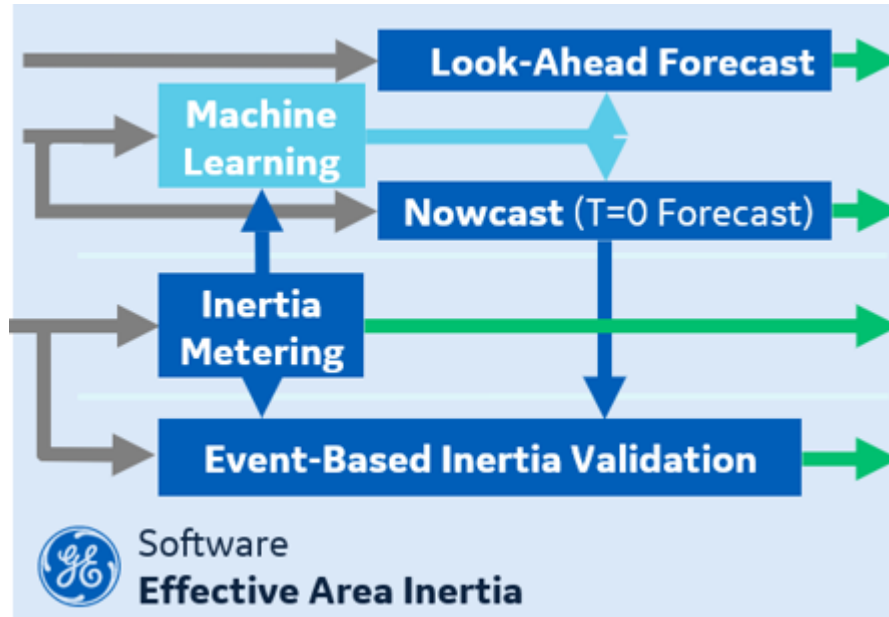
Static Recovery



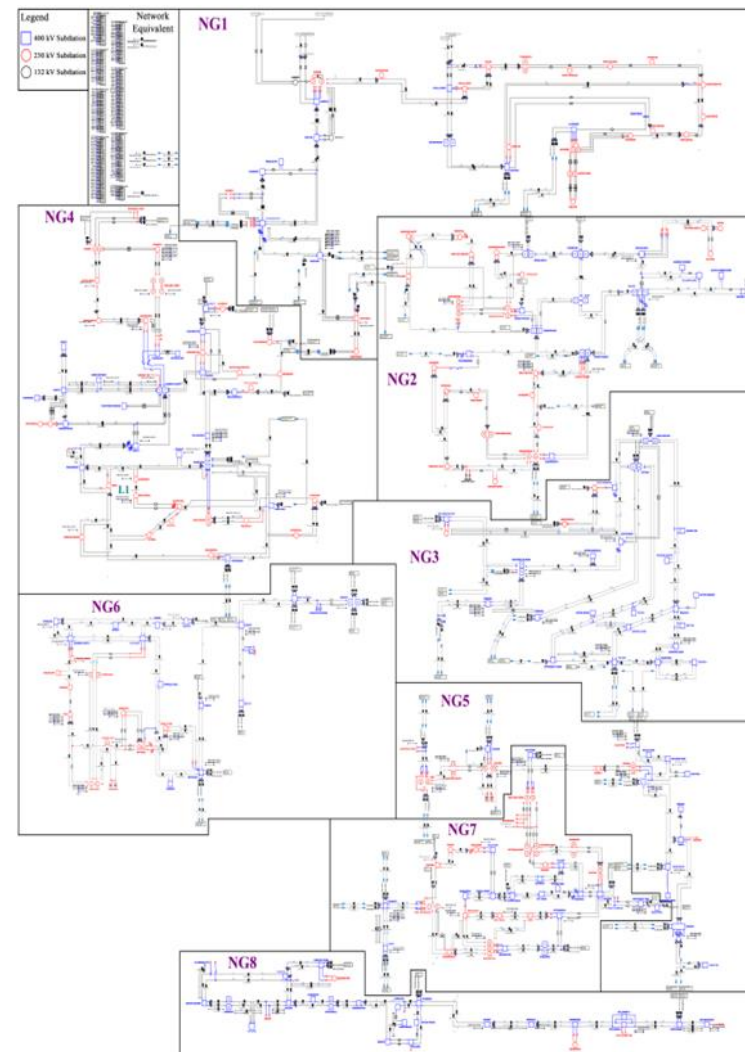
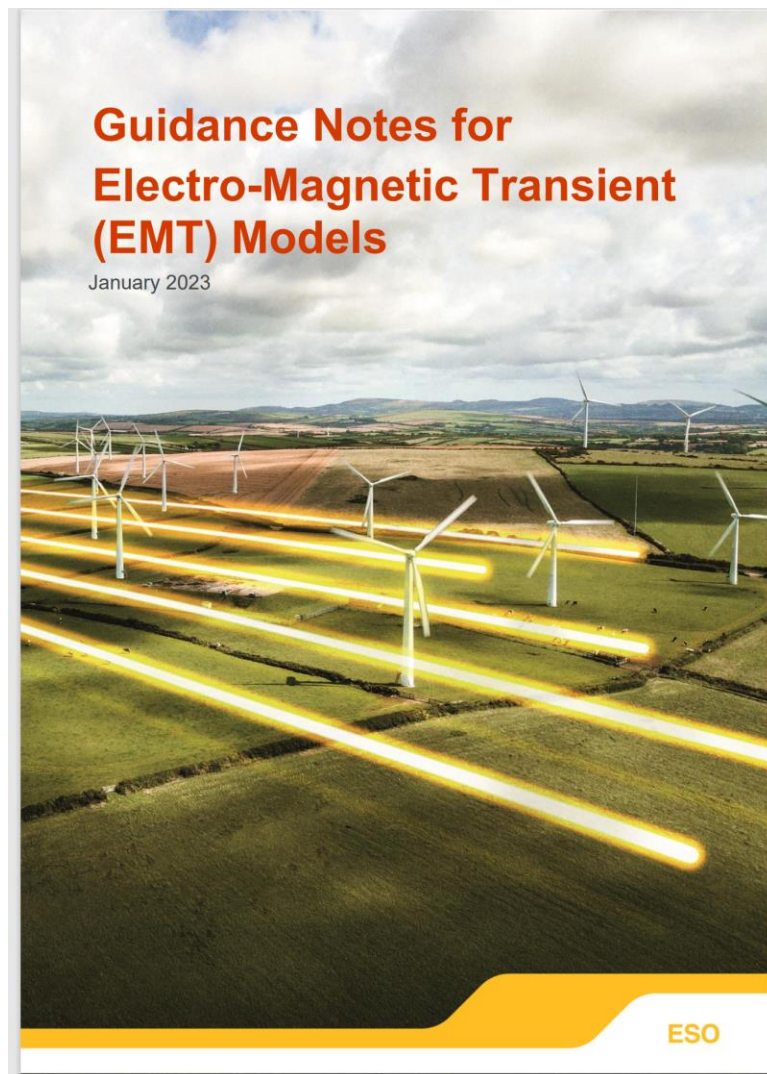
Recover frequency to 0.5Hz within 60 seconds following large losses

Post-fault

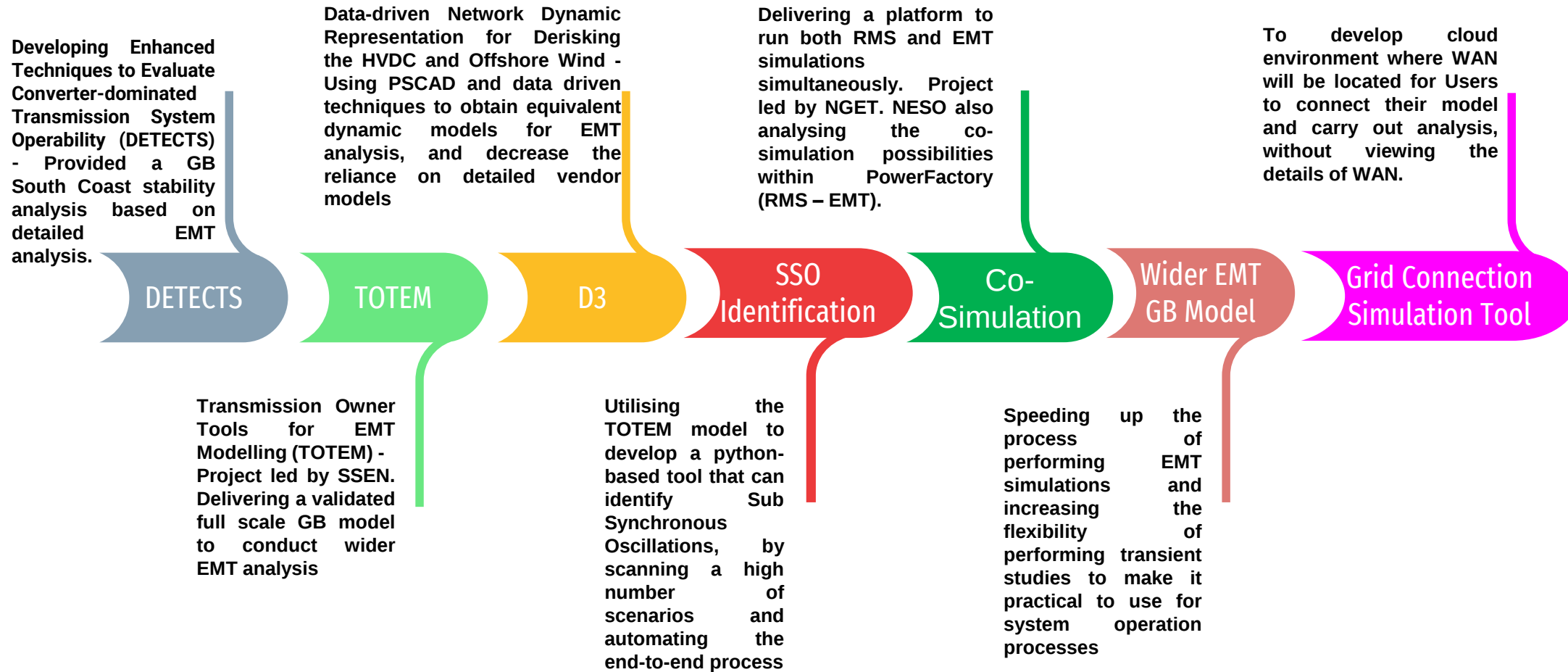
Enhanced Real Time Monitoring



GB EMT Model Development



Key projects on EMT Modelling



Thank You!