

An offshore wind farm is shown at sunset or sunrise. The sky is a mix of blue and orange, with several bright, glowing yellow lines radiating from the central wind turbine towards the horizon. The water is dark blue with some whitecaps. In the background, many other wind turbines are visible, stretching across the horizon.

Low Inertia System Operation

Dr Xiaoyao Zhou
Operability Policy Manager

National Grid ESO's role

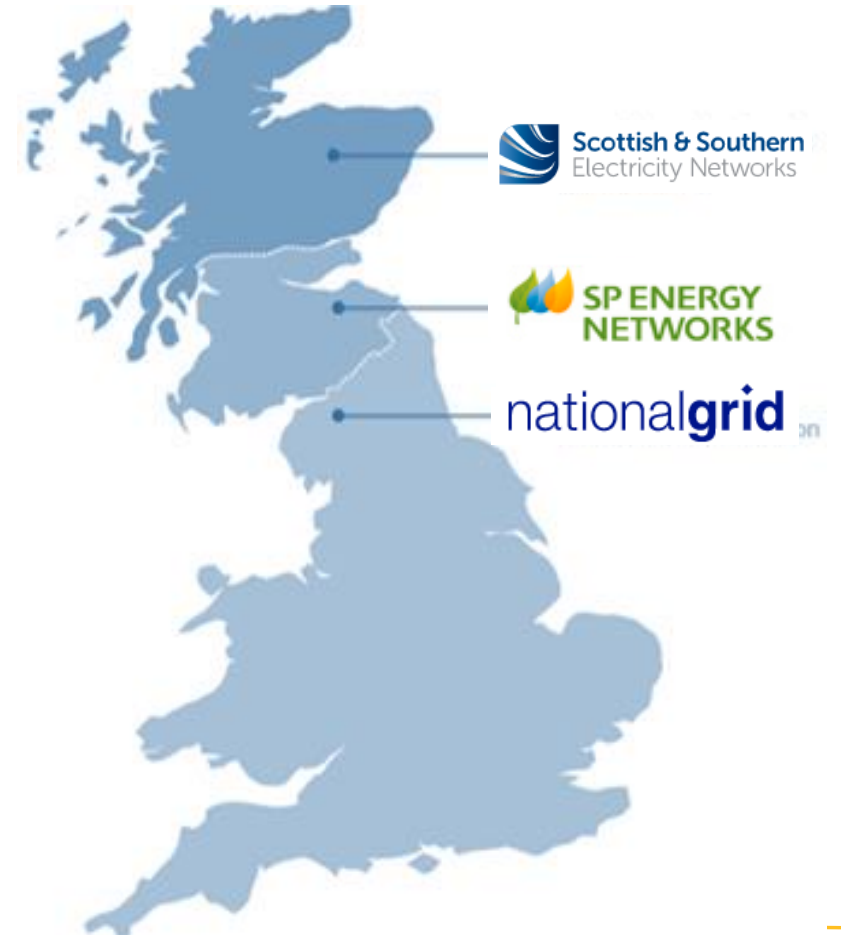
- Operates and balances the system
- Provides electricity network recommendations
- Operational planning
- Connection agreements
- Widens access and promotes competition
- Responsible for GB transmission charging and billing

NESO (National Energy System Operator) additional role



Strategic Planning

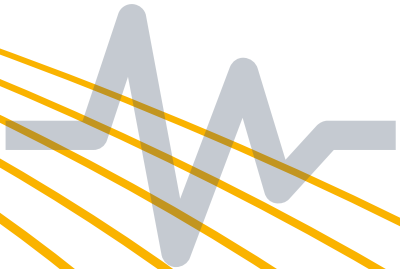
The transmission operators (TOs) own, build and maintain Britain's transmission infrastructure.



Zero-carbon operation

Fossil fuelled generation is reducing fast, causing operational challenges

- Frequency management
- Inertia and voltage control



Our plan for 2025:

- For short periods we can operate the transmission system carbon free and can accommodate all the zero carbon generation the market provides

Our plan for 2035:

- Zero carbon operation all the time
- Manage new challenges of flexibility and adequacy

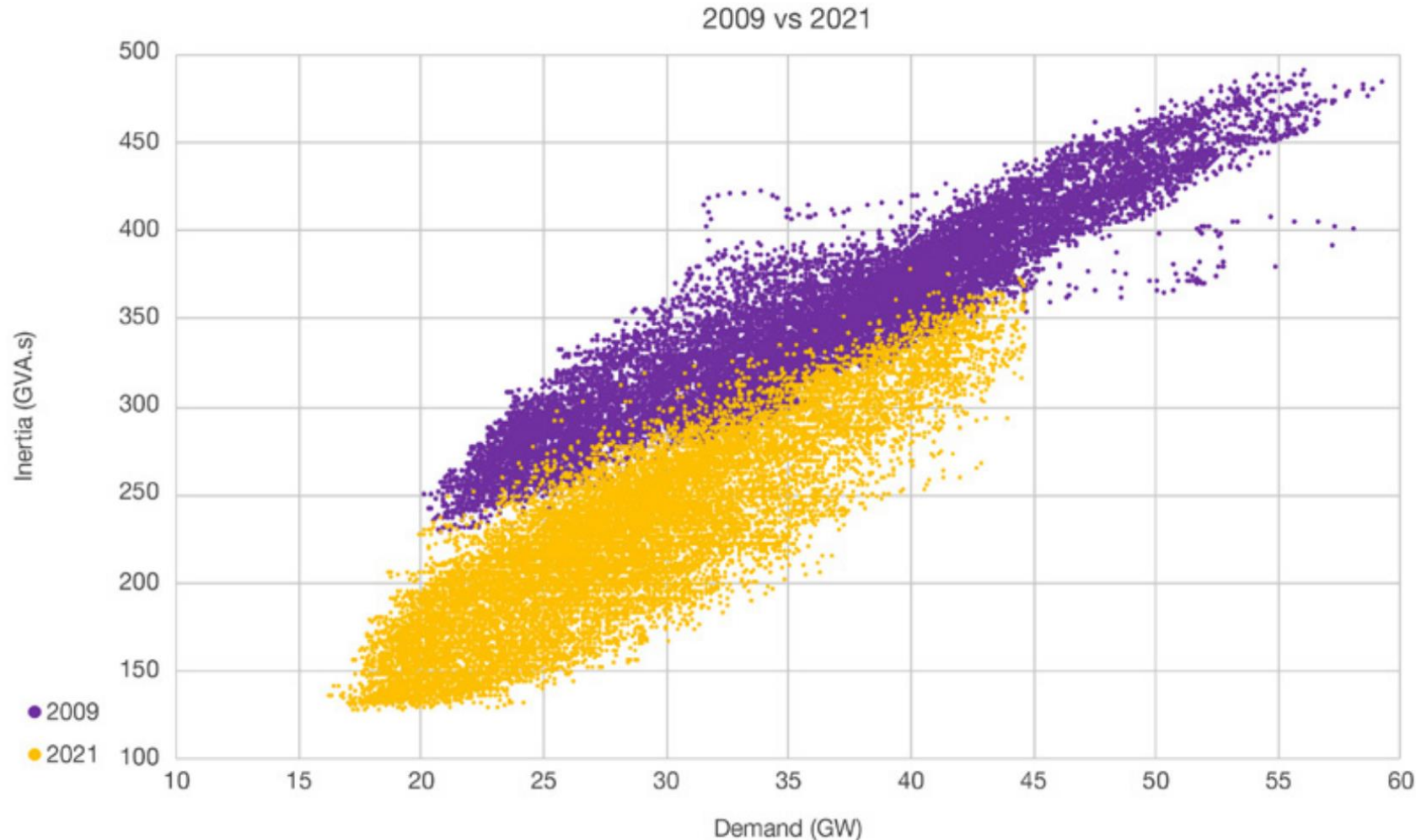


Notable records

- **91% zero carbon** on Jan 7th 2023
- **21.8GW Max wind** on Dec 21st 2023

How inertia has changed on the GB system

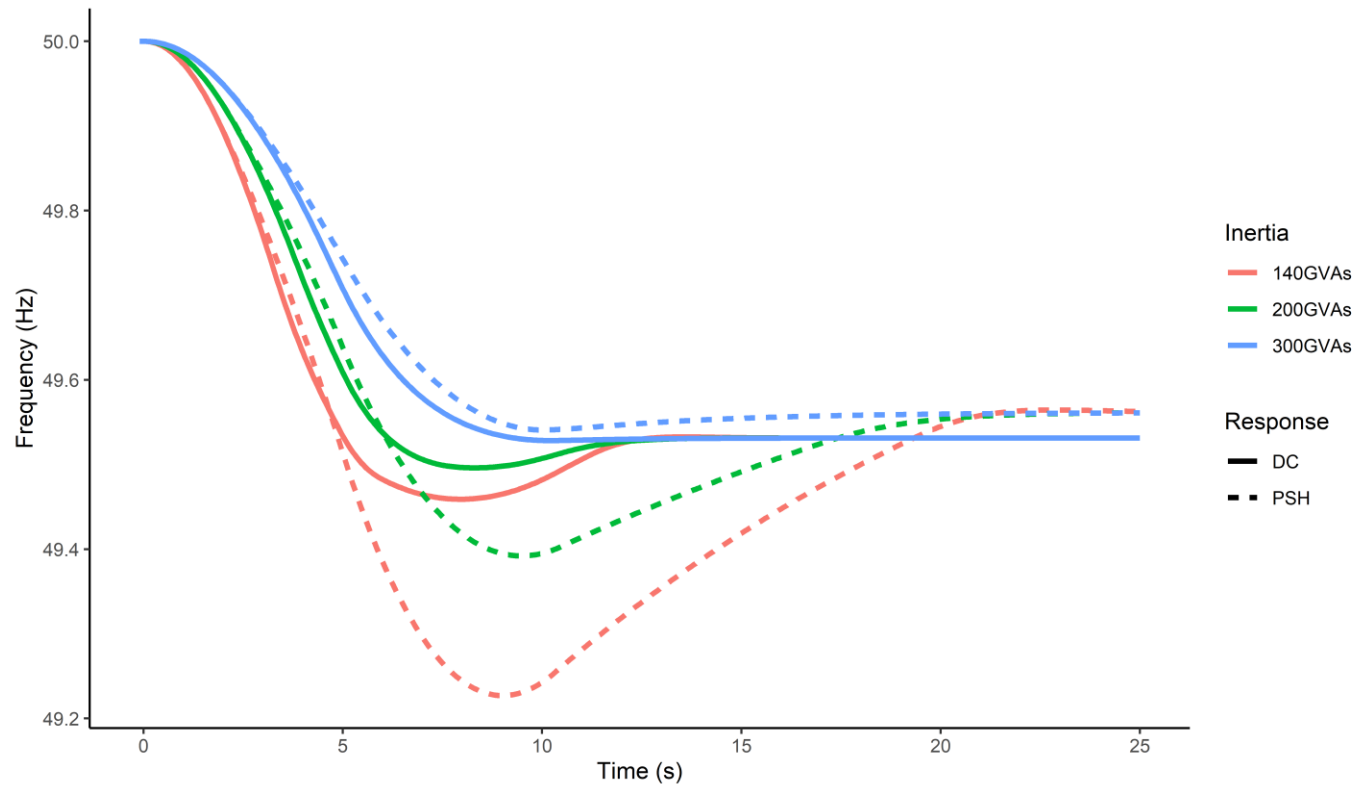
Inertia vs Demand



- Generally the maximum inertia now is lower than the minimum inertia was in 2009
- Average inertia provided by the market (pre-ESO actions) in 2023 to date is 180GVA.s

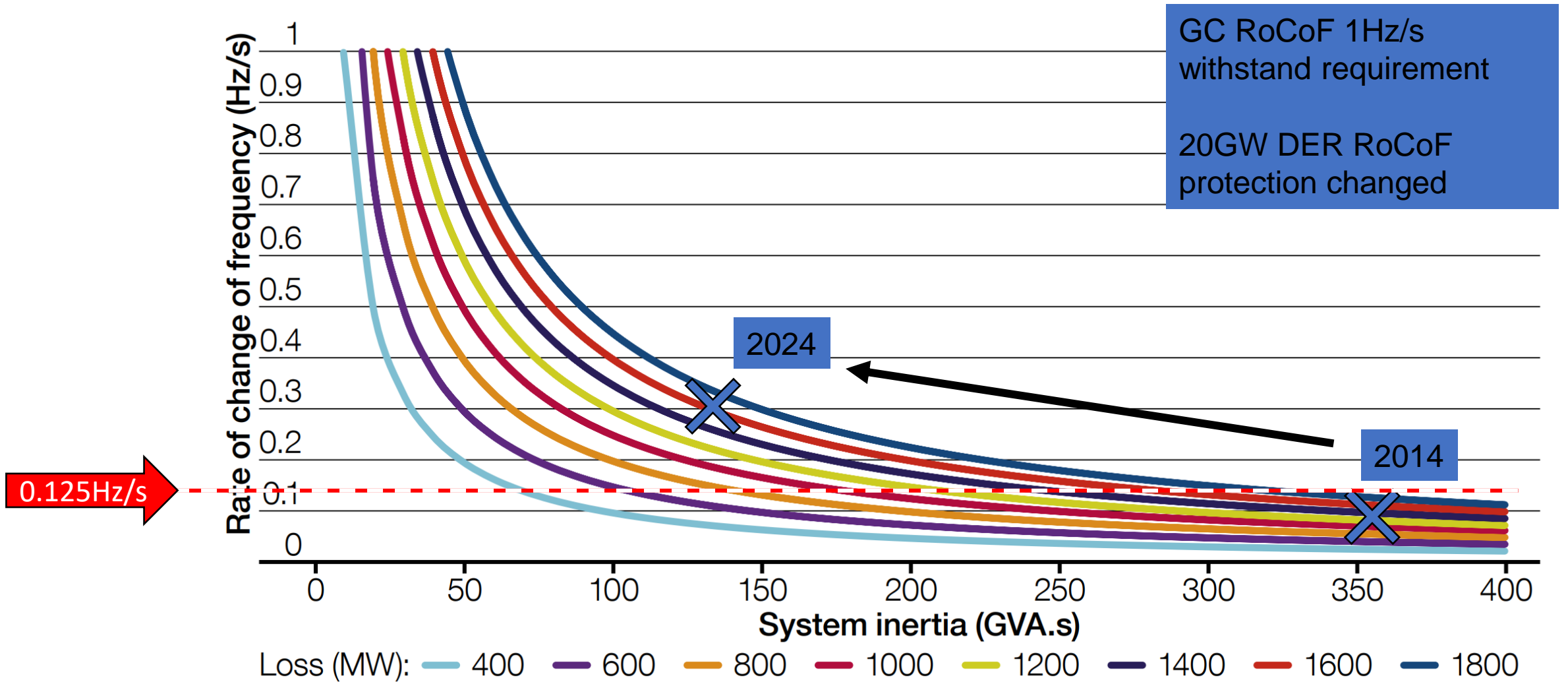
Manage frequency in a lower inertia system

Imbalance = 1600 MW , Initial frequency = 50 Hz
Option 1: PSH = 1000 MW
Option 2: DC = 1000 MW



- DER RoCoF protection change
- New frequency services
- Inertia market development
- Inertia measurement

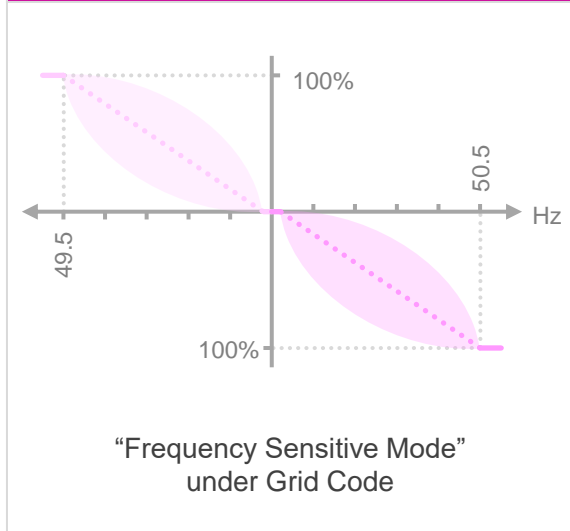
Impact of Falling Inertia on RoCoF



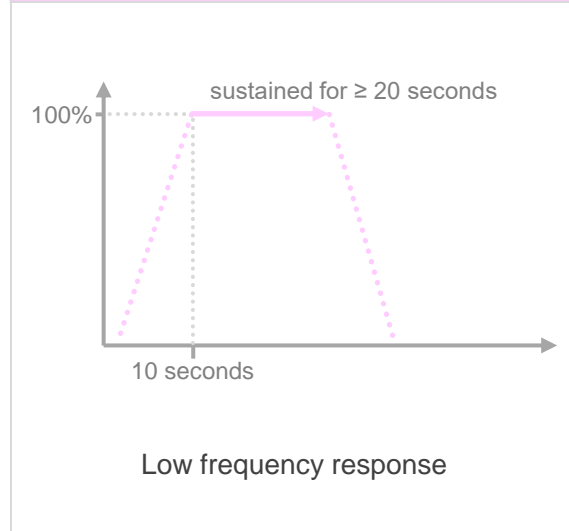


Frequency Services Development

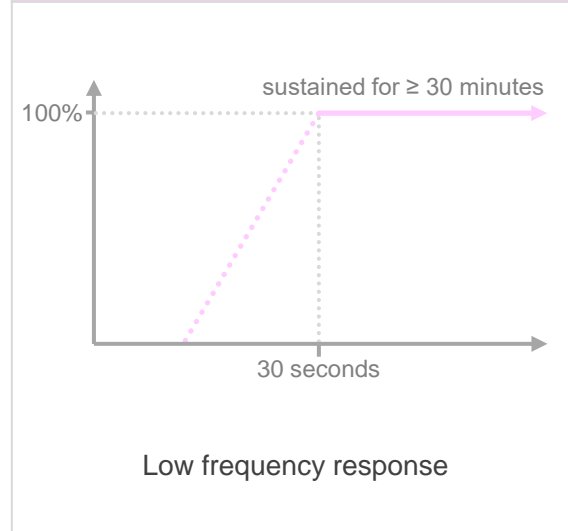
Mandatory Frequency Response



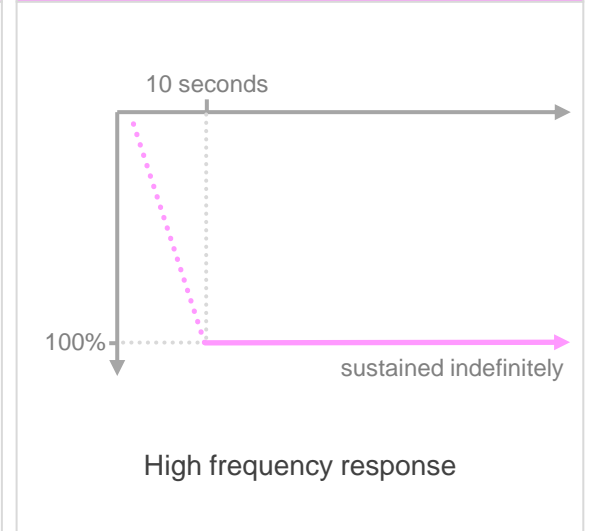
Primary



Secondary



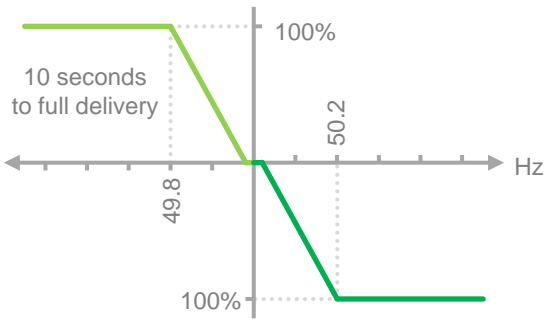
High



Key aspects other services need to cover before MFR can be phased out:

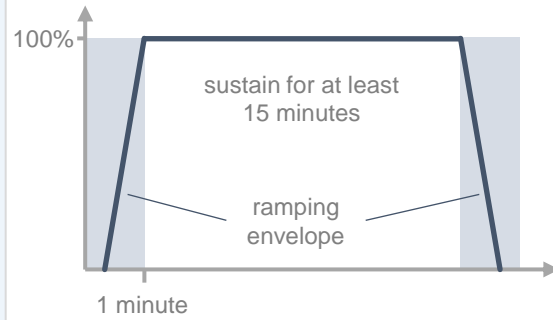
- Real-time procurement
- Sufficient supply to meet requirements

Dynamic Regulation



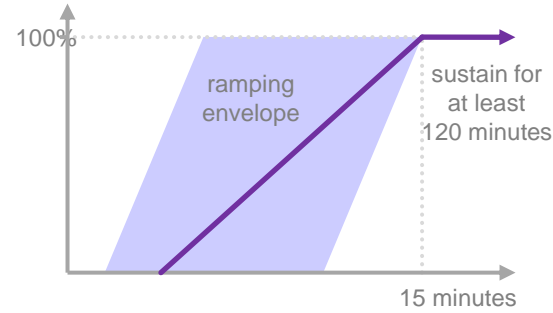
Assist in keeping frequency near to 50Hz during normal conditions

Quick Reserve



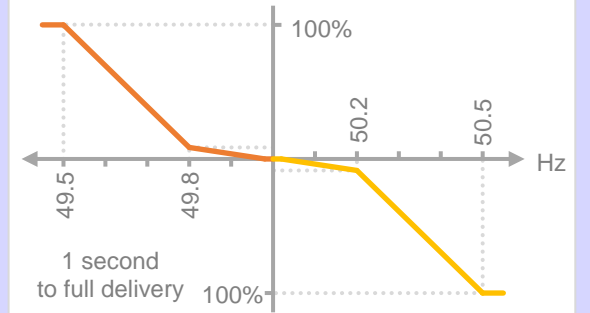
Recover frequency back towards 50Hz, mainly during normal conditions

Slow Reserve



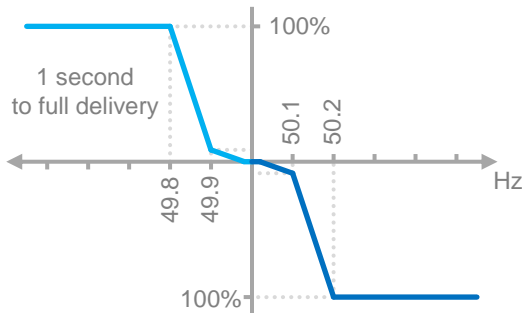
Recover frequency back to 0.2Hz within 15 minutes

Dynamic Containment



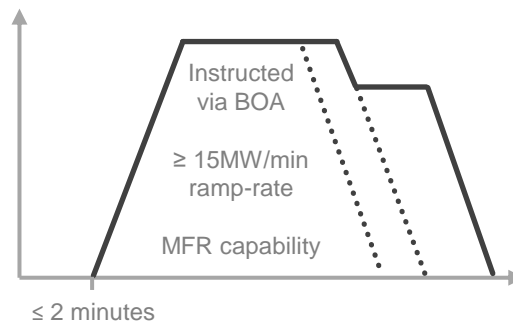
Prevent frequency deviations outside -0.8Hz / +0.5Hz following large losses

Dynamic Moderation



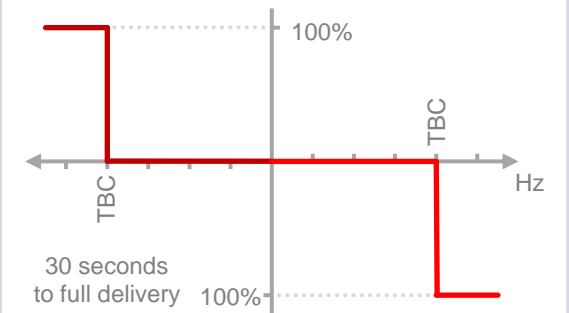
Assist in keeping frequency within 0.2Hz, especially during more volatile conditions

Balancing Reserve

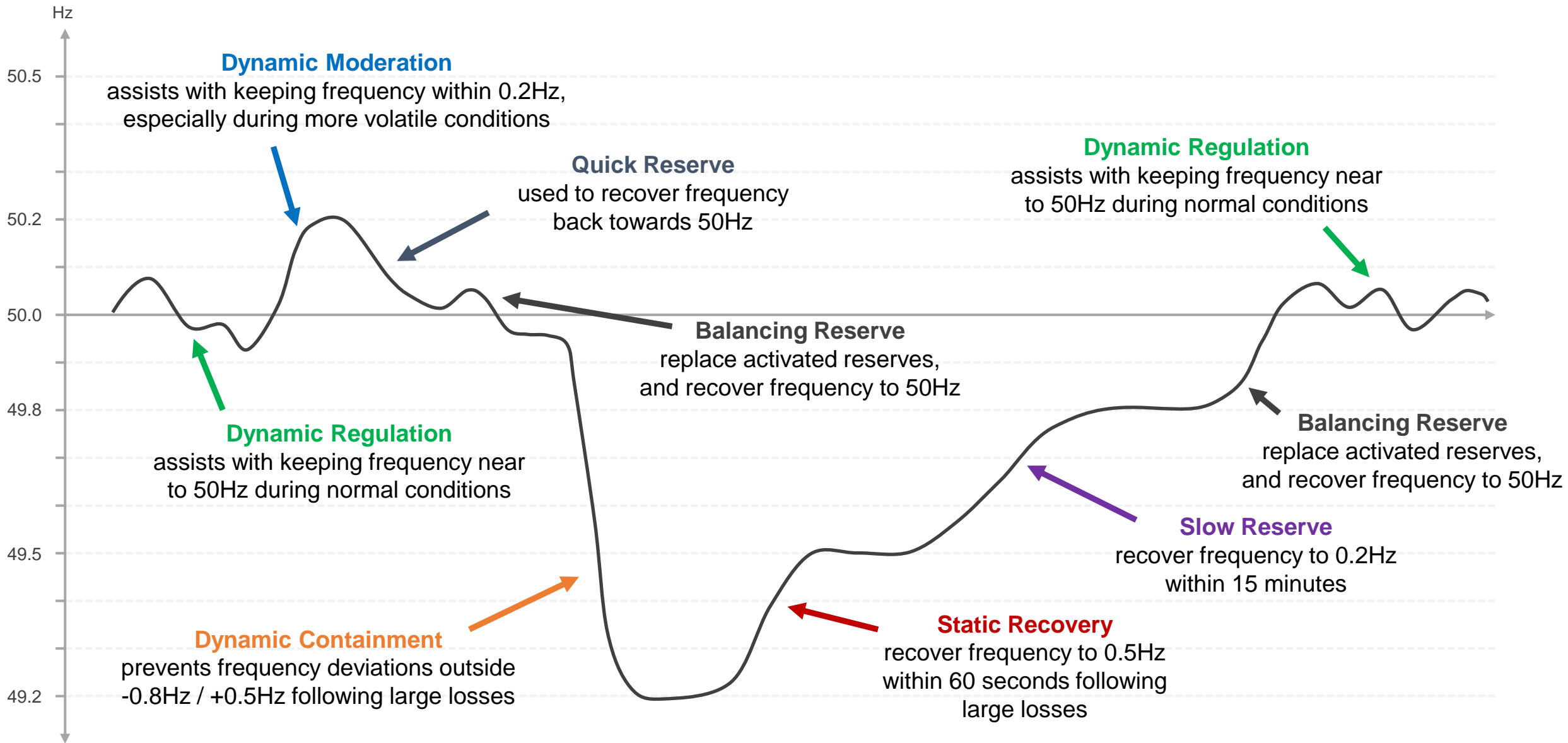


Manage real-time imbalances, and replace activated reserves

Static Recovery



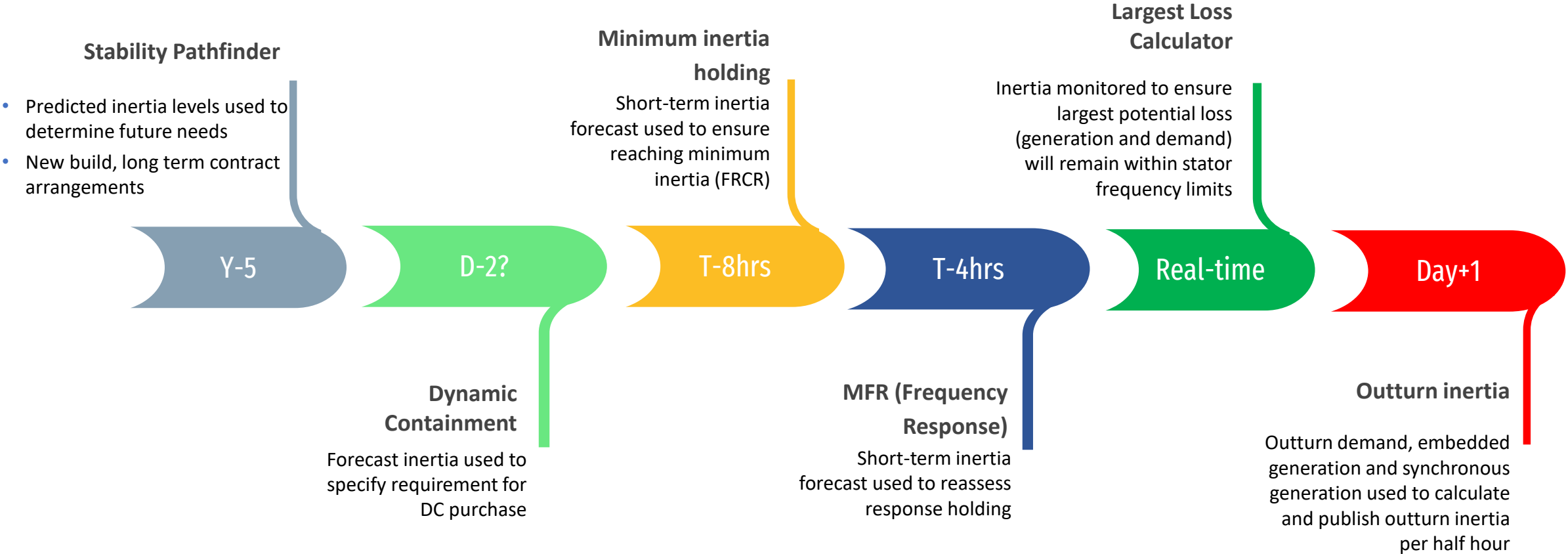
Recover frequency to 0.5Hz within 60 seconds following large losses





Inertia markets

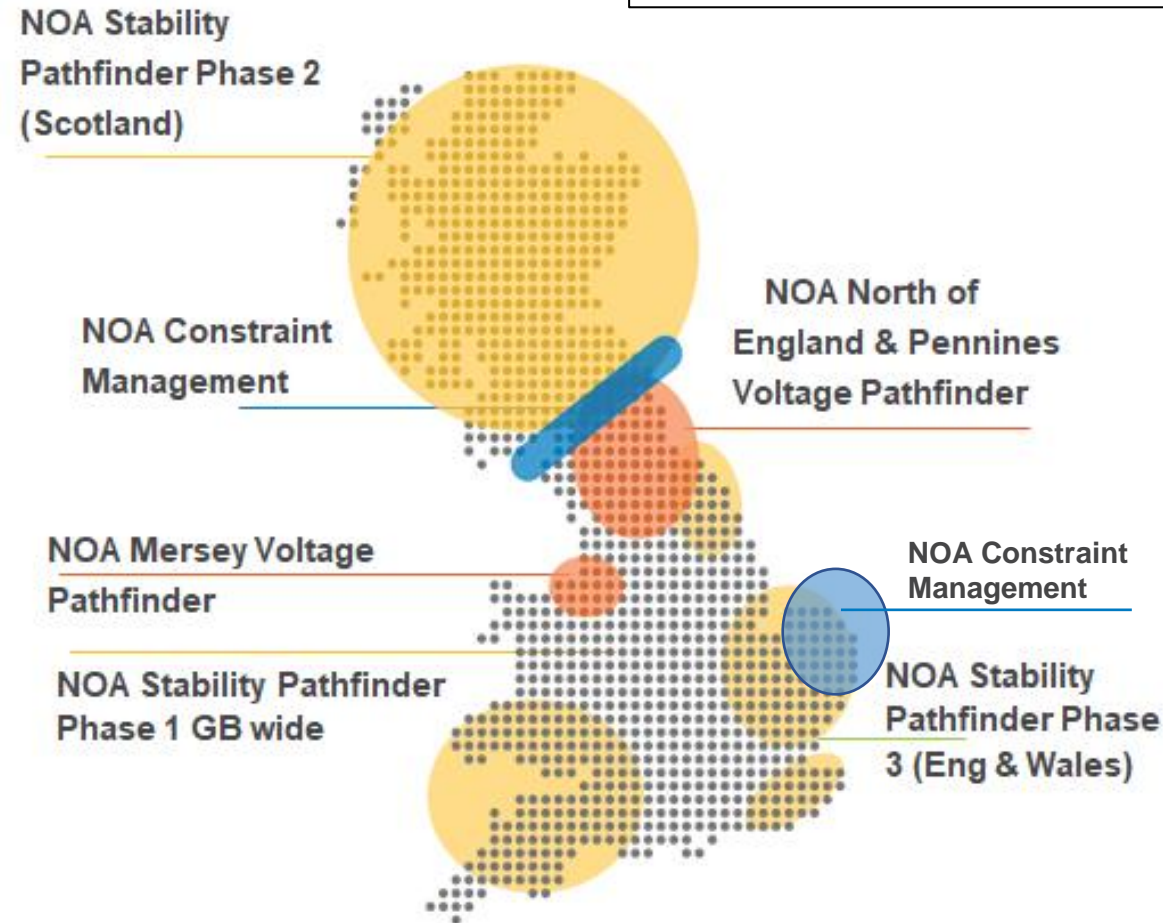
How we manage inertia across our timescales



Overview of Pathfinders so far

Stability Phase 2:

- 6GWs inertia procured across Scotland
- Paid for availability only – not for losses
- 90% availability across the year is mandatory
- 5 Sync comps and 5 GFC
- Will be in service between 2024-2034



Stability Phase 1:












- 12.5GWs inertia procured across GB
- Paid for availability and energy 'losses'
- All Synch Comps
- All units are now live and providing inertia to the system
- 6 year contract duration (Covid impact)

Stability Phase 3:

- 17.1GWs inertia procured across 5 regions in England and Wales
- SCL need is met
- Paid for availability only – not for losses
- 90% availability across the year is mandatory
- 29 Sync comps – (limited export capacity)
- Will be in service between 2025-2035

Stability Market Design Overview

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

		Long Term (Y-4)	Mid Term (Y-1)	Short Term (D-1)
 Purpose		<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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
	Contract duration	- 10+ years	- 3 years	- 1 y
 Product	Contract type	- Baseload availability	- Baseload availability	- Baseload availability
	Contract obligations	- e.g. 90% availability	- e.g. 90% availability	- e.g. 100% availability
 Eligibility		 Incremental investment  New build dedicated plants	 Incremental capability  Enhanced capability ¹	 Incremental /  existing capability  Existing plants

Mid Term Market – Expression of Interest (EOI)

Mid-Term (Y-1) Stability Market Round 1

9 October 2023

ESO are pleased to announce the launch of the first round of the Mid-Term (Y-1) Stability Market seeking stability services between 2025 and 2026.

On 3 October 2023 ESO opened the Expression of Interest (EOI) and Consultation window for Round 1 of the Mid-Term (Y-1) Stability Market www.nationalgrideso.com, inviting the market to express their interest in participating in the first round and provide consultation feedback on the published EOI documents.

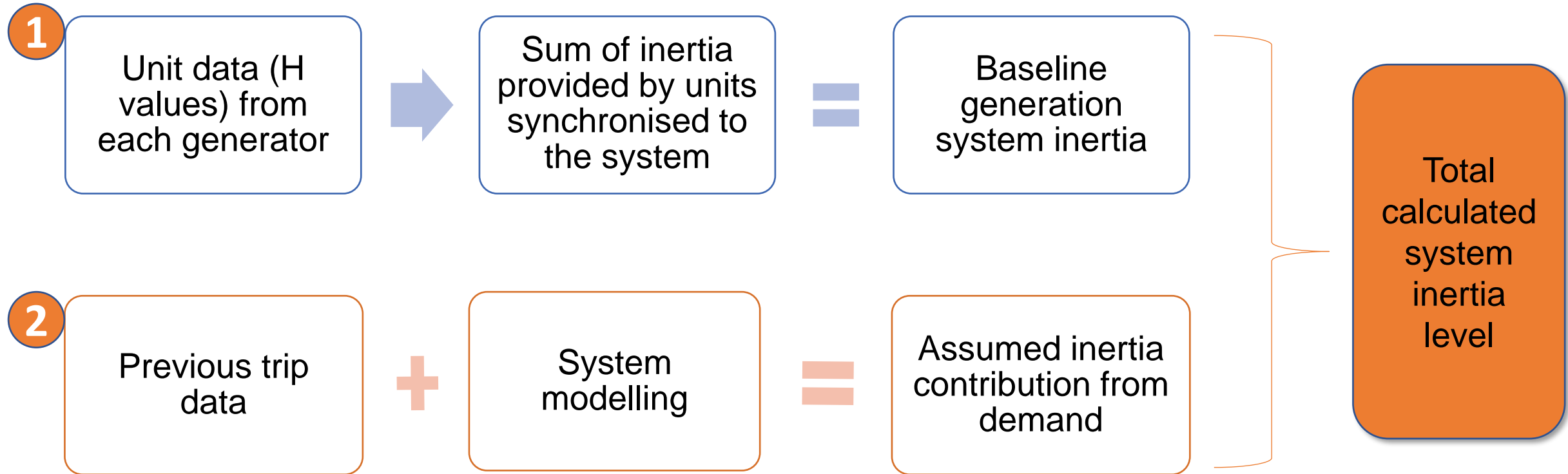
During this time we will be hosting two webinars, please use the links below to register:

[Mid-term \(Y-1\) Stability Market | ESO \(nationalgrideso.com\)](http://www.nationalgrideso.com)



Inertia Measurement

How have we previously calculated system inertia?



Two approaches to monitoring system inertia – PMUs and XMUs

GE: Scotland PMU's

- Operational since late 2021
- Monitors boundary flow
- Limited PMU availability (Scotland only)
- Forecast & Real-time



Reactive Technologies: full GB(XMUs)

- Operational since July 2022
- Full GB coverage with >40 XMU devices
- Real-time