Market Products for System Stability

Presentation to ESIG

14 May 2024

ESIG

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Agenda

- Electricity System Operator: Our current and future role in Great Britain
- Our decarbonisation journey
- Stability: the operability challenge
- The controls we currently have in place to manage frequency & inertia
  - Frequency Risk & Control Report (FRCR)
  - Our new suite of dynamic frequency response products
- How we currently meet our stability needs
- Past & present: Pathfinders
- The Future: Stability Markets
  - Mid-term (Y-1) Stability Market

Electricity System Operator: Our Role

ESO

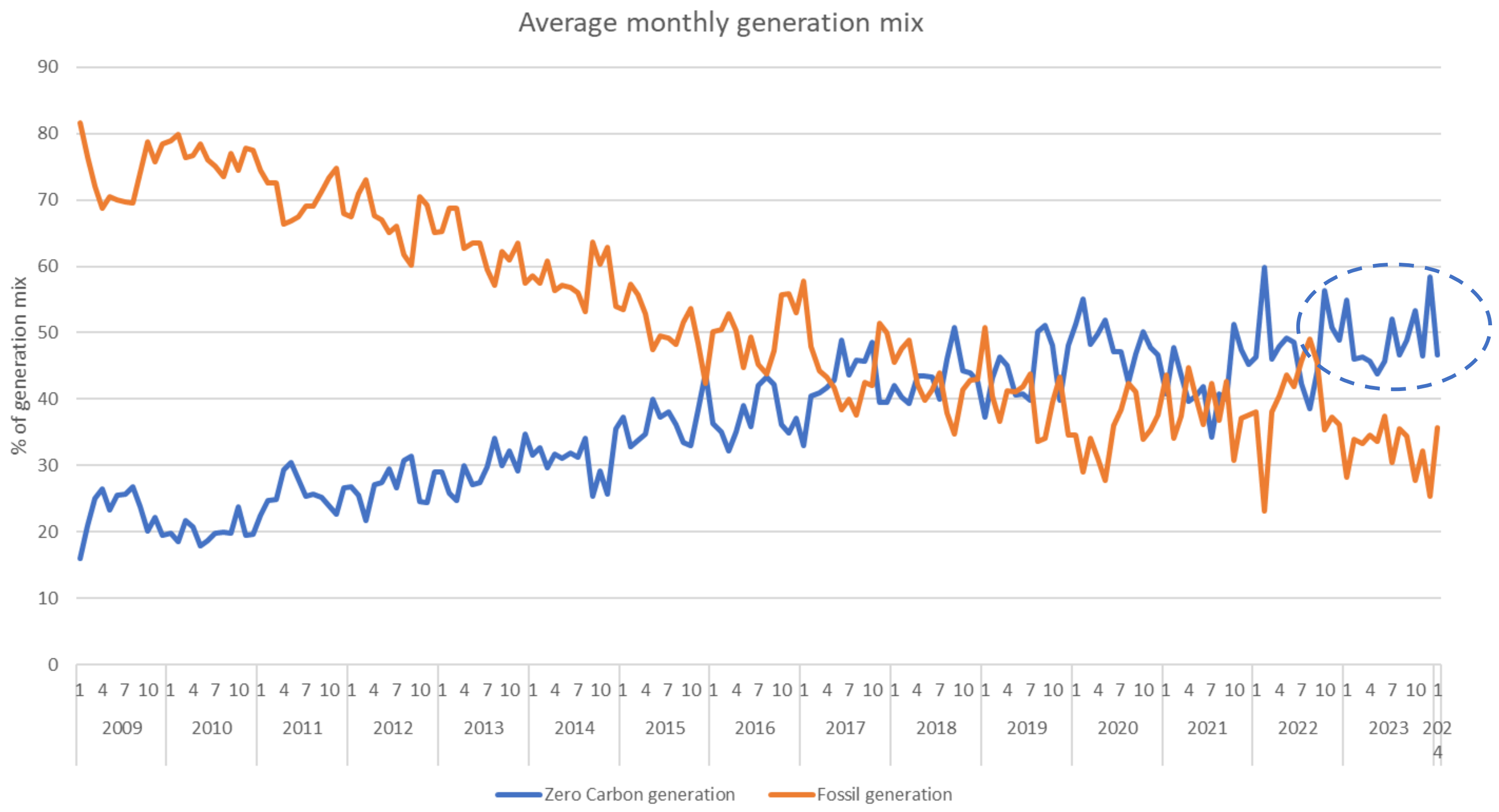
- Safe and secure operation of the electricity system
- Managing connections to the grid
- Designing and implementing efficient markets
- Modelling the network
- Managing codes and regulation
- Engaging with stakeholders as a trusted partner

As of 1st July 2024

National Energy System Operator (NESO)

+ Strategic whole system network planning
+ Resilience & emergency management
+ Net zero energy insights
+ Whole energy market development
+ Gas security of supply advice

The fastest decarbonising G20 country



Carbon intensity & ZCO record:

- 15 April 2024 at 14:00-14:30
- 19gCO_2/kWh
- 92% Zero Carbon
- System demand – 27.1GW

*excludes embedded wind and solar

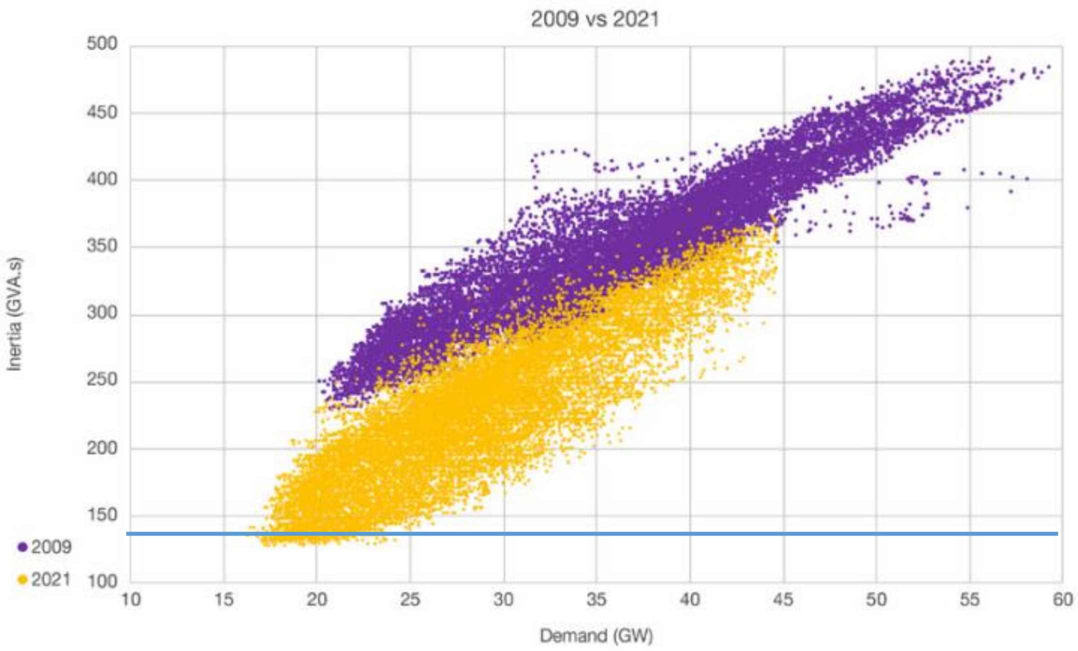
- Fossil fuel generation down 60% in a decade
- Zero carbon generation greater than fossil fuel generation for 16 months straight

- By **2025** the ESO has a target to operate the Transmission network **carbon free for short periods**. Record to date is ~92%
- By **2035** the electricity network needs to operate **carbon free all year round**

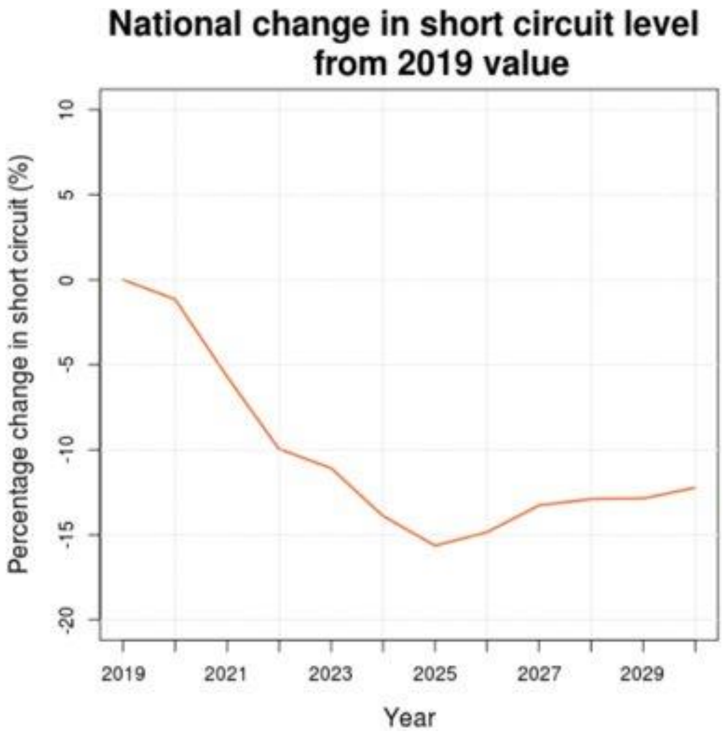
Stability: the operability challenge

We use the term 'Stability' to describe a broad range of operational challenges, some of which are:

- Inertia
- Dynamic reactive power
- Fault ride through
- Short circuit level
- Loss of mains protection



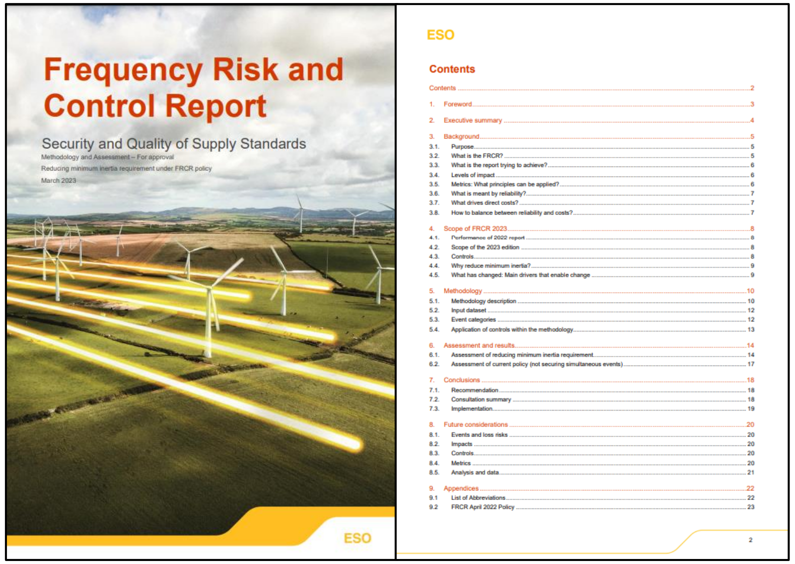
Level of 'market-provided' inertia (GVA.s) 2009 vs 2021.



The controls we currently have in place to manage frequency and inertia

Frequency Risk & Control Report

- ESO are required to produce an annual Frequency Risk and Control Report (FRCR) which sets out our cost vs risk appetite when managing frequency and inertia on the GB electricity system.
- This was an outcome following a 2019 power outage in GB on part of the network.
- FRCR allows us to regularly review the response, reserve and inertia holdings on the system.



Frequency Risk and Control Report

Security and Quality of Supply Standards

Methodology and Assessment – For approval

Reducing minimum inertia requirement under FRCR policy

March 2023

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<u>GB Minimum Inertia Operating Policy:</u>

Pre-2023
(140GVAs)

→

FRCR 2023
(red. to 120GVAs)

→

By 2025
(red. to 102GVAs)

The controls we currently have in place to manage frequency and inertia

Our new suite of dynamic response products

Dynamic Containment (DC)

This service is designed to help contain frequency within statutory limits +/- 0.5 Hz from the target frequency of 50 Hz.

Initiation time = 0.5s
Time to full delivery = 1s
Delivery duration = 15mins

Dynamic Moderation (DM)

This service is designed to help contain frequency within operational limits +/- 0.2 Hz from the target frequency of 50 Hz.

Initiation time = 0.5s
Time to full delivery = 1s
Delivery duration = 30mins

Dynamic Regulation (DR)

This service is designed to help contain frequency within operational limits +/- 0.2 Hz from the target frequency of 50 Hz.

Initiation time = 2s
Time to full delivery = 10s
Delivery duration = 60mins

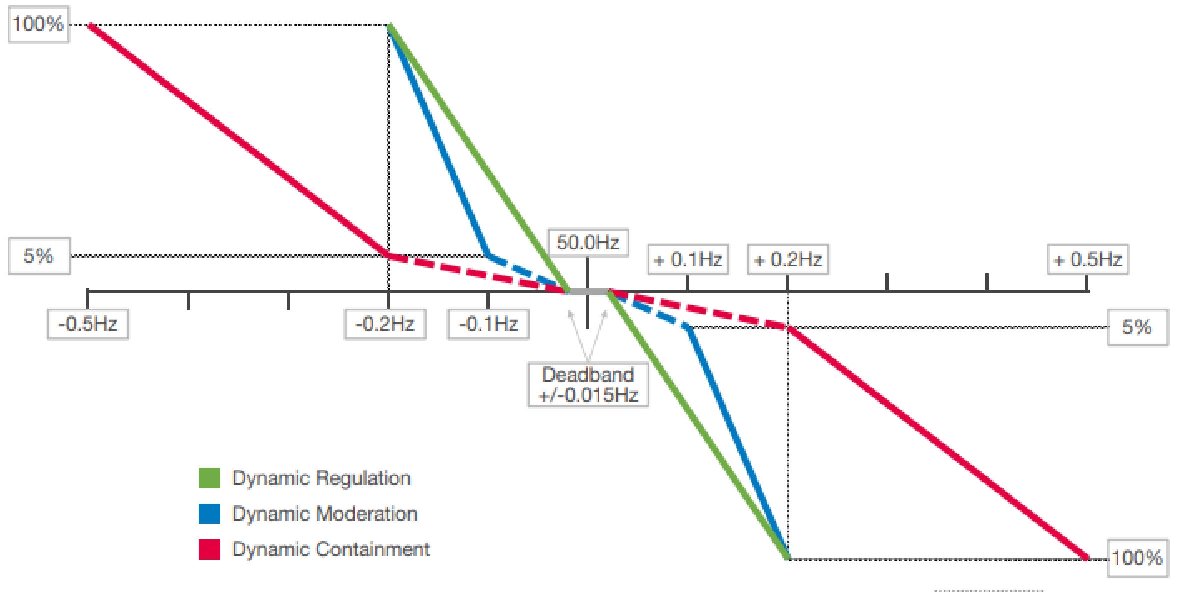


Figure 1: DC, DM and DR delivery requirement curves

- Day-ahead Pay-as-Clear co-optimised auctions
- Guaranteed availability payment £/MW/hr
- Bought in 6 x 4hr EFA blocks
- Stacking with other services permitted
- ~1.4GW DCH procured on average per EFA

How we currently meet our stability needs

Stability as a by-product of energy

- As a result of synchronous units (and demand) scheduling themselves in energy markets (e.g., wholesale, reserve), a proportion of inertia and SCL is provided as a by-product.
- This contributes significantly to a stable system and means that we often meet our 130GVA.s inertia threshold without further intervention.
- As the contribution from invertor-based generation increases, ESO have to take additional actions to ensure compliant system operation.

Stability Pathfinders

- All 12 units from Stability Phase 1 are now operational for dispatch by ESO control room. They contribute 12.5GVA.s inertia and required to be available for at least 90% of the year.
- These and future synchronous condensers, plus grid-forming battery energy storage from Stability Pathfinder Phase 2, are contracted on 6-10 year terms and help to facilitate our zero carbon operation commitments at low cost.

Balancing Mechanism

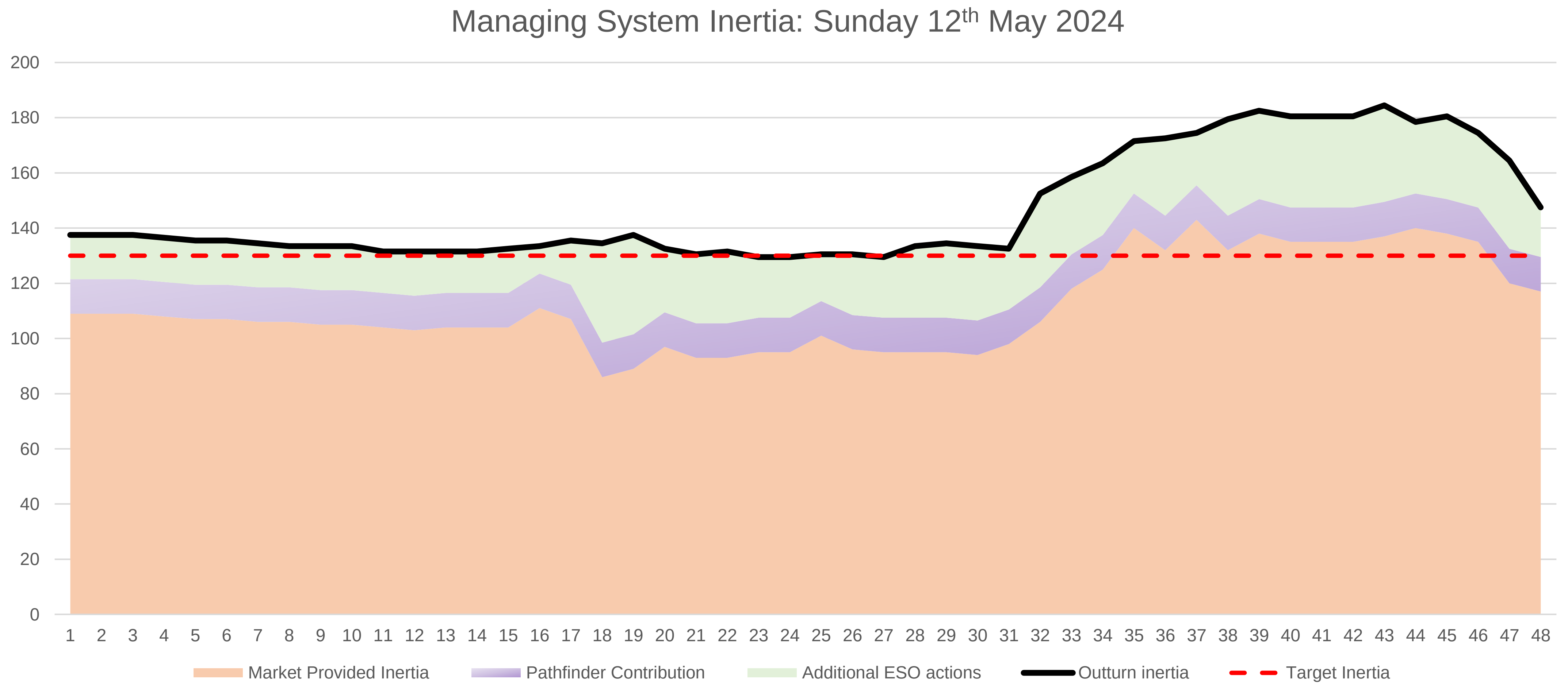
- Where there remains a requirement for stability in real-time with pathfinder units running, ESO use the Balancing Mechanism to instruct additional synchronous machines.
- Our stability requirements are typically greatest during low demand, high renewable periods where non-synchronous generation is the dominant energy source.
- Therefore, instructing synchronous machines for stability often coincides with curtailing cheaper/cleaner generation to ensure supply and demand remain balanced.

How we currently meet our stability needs

Stability as a by-product of energy

Stability Pathfinders

Balancing Mechanism



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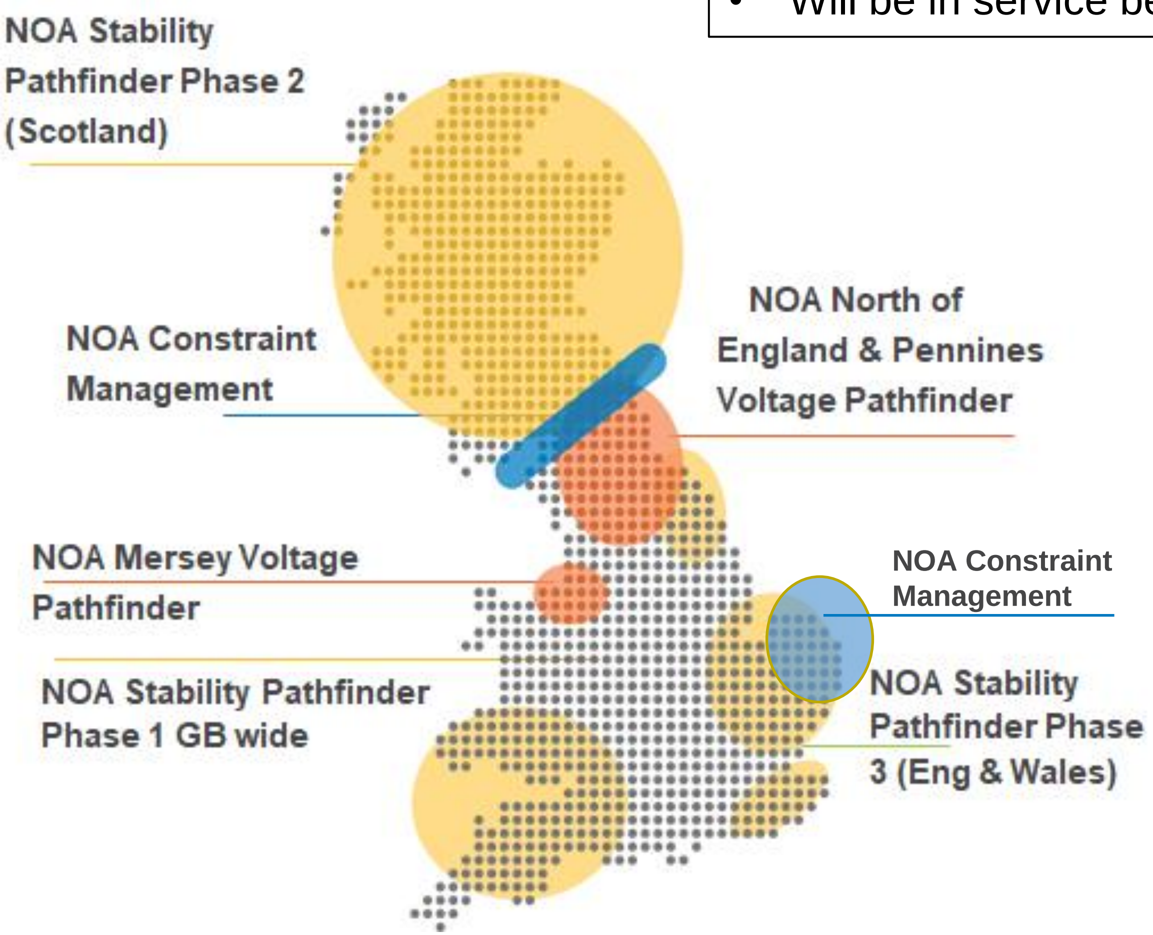
Stability Pathfinders

Stability Phase 2:
- 6GVA.s 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:
- 12.5GVA.s inertia procured across GB
- Paid for availability and energy ‘losses’
- All Synch Comps
- All units are now live and providing inertia
- 6 year contract duration (Covid impact)

Stability Phase 3:
- 17.1GVA.s inertia procured across 5 regions in E&W.
- SCL need is met
- Paid for availability only
- 90% availability across the year is mandatory
- 29 Sync comps
- 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 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* *Contract duration*	– Y-4 – 10+ years	– Y-4 – 3 years	– Y-1 – 1 year		– D-1 – Service windows
Product	*Contract type* *Contract obligations*	– Baseload availability – e.g. 90% availability		– Baseload availability – e.g. 90% availability		– 4 h (EFA blocks) – 100% availability
Eligibility		**Incremental investment** New build dedicated plants	**Incremental capability** Enhanced capability	**Incremental / existing capability** Existing plants		
Pricing	*Payment type* *Price mechanism*	Availability payment – £/MW.s/h – Pay-as-bid	Delivery payment – £/MW.s/h – Pay-as-bid	Availability payment – £/MW.s/h – Pay-as-bid	Delivery payment – £/MW.s/h – Pay-as-bid	Availability payment (delivery payment inc.) – £/MW.s/h – Pay-as-clear

Stability Market Design

Mid-term (Y-1 market)

- First of a kind worldwide.
- Launched in 2023 to procure a target capacity of 10GVA.s inertia.
- Contracts awarded by Oct. 2024 for delivery from Oct. 2025.
- Technical feasibility assessment followed by commercial optimisation against the alternative counterfactual.
- Eligibility criteria permits synchronous plant which can contribute inertia at 0MW export, plus non-synchronous plant with grid-forming capability.
- Expected technology types include synchronous compensators, grid-forming energy storage, pumped hydro.
- Y-1 market will be repeated annually.

		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 y
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; Delivery payment: – £/MW.s/h
	Price mechanism	Availability payment: – Pay-as-bid; Delivery payment: – Pay-as-bid

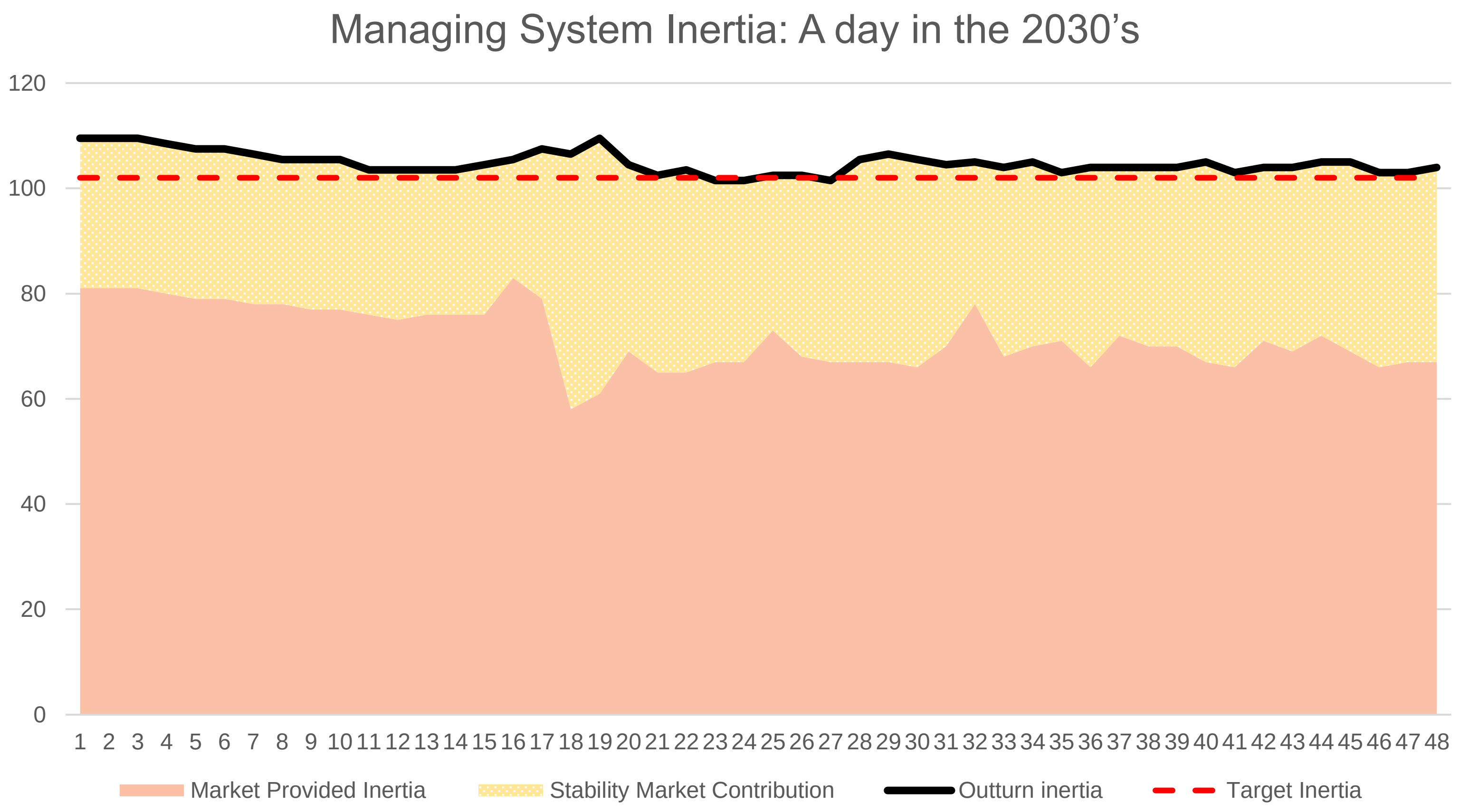
How we will meet our stability needs in the future

Stability as a by-product of energy

Stability Pathfinders

Balancing Mechanism

Stability Markets

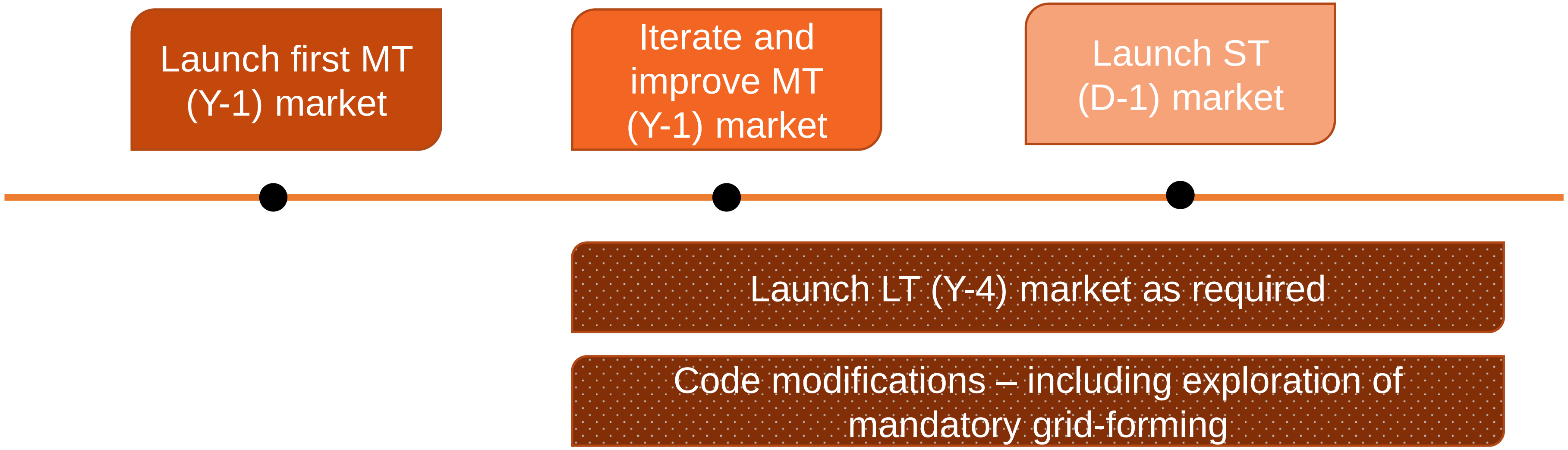


- ✓ Meeting inertia needs more cost efficiently
- ✓ Mitigation of system security risk through combination of long-term and short-term procurement
- ✓ Greater transparency and more explicit investment signals
- ✓ Facilitating zero carbon operation

Stability Market Design

Future work

- Stability markets need to be embedded and iterated to drive appropriate investment and maximum efficiency.
- Markets are technology agnostic but need to evolve with the changing technology mix and provider type.



- We are also pursuing innovation in the form of new inertia measurement tools, understanding inertia contribution of demand, and better network modelling practices.

Any questions please?

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