National Grid ESO Stability Market Design: Final Webinar

17th July 2023

PRESENTATION OF THE FINAL OUTCOMES

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Agenda

WHAT IS THE PROJECT?

ESO is undertaking an innovation project aimed at creating a new marketplace for services to resolve future system challenges with Stability

Context

ESO role

NG ESO is responsible for ensuring the operability of the electricity system (ultimately adhering to the SQSS). This includes management of system frequency and voltage.

Net-zero & stability require-ments

NG ESO has the ambition to operate a zero-carbon grid. Potential for RES in GB is vast, but this has an impact on the requirements for system stability services due to the stability characteristics of these technologies

Stability arrange-ments

NG ESO uses a suite of tools called balancing arrangements, which include a complex set of nested marketplaces. NG ESO has regulatory freedom and incentives to contract with service providers over a range of timescales and products

Potential solution

This project presents the recommendations for the design of future Stability markets and to enable ESO to commence implementation

Project focus

KEY QUESTION:
What is the ideal design for a stability market that allows ESO to meet its stability requirements whilst making optimal economic decisions and also enabling wide participation with minimal barriers to entry?

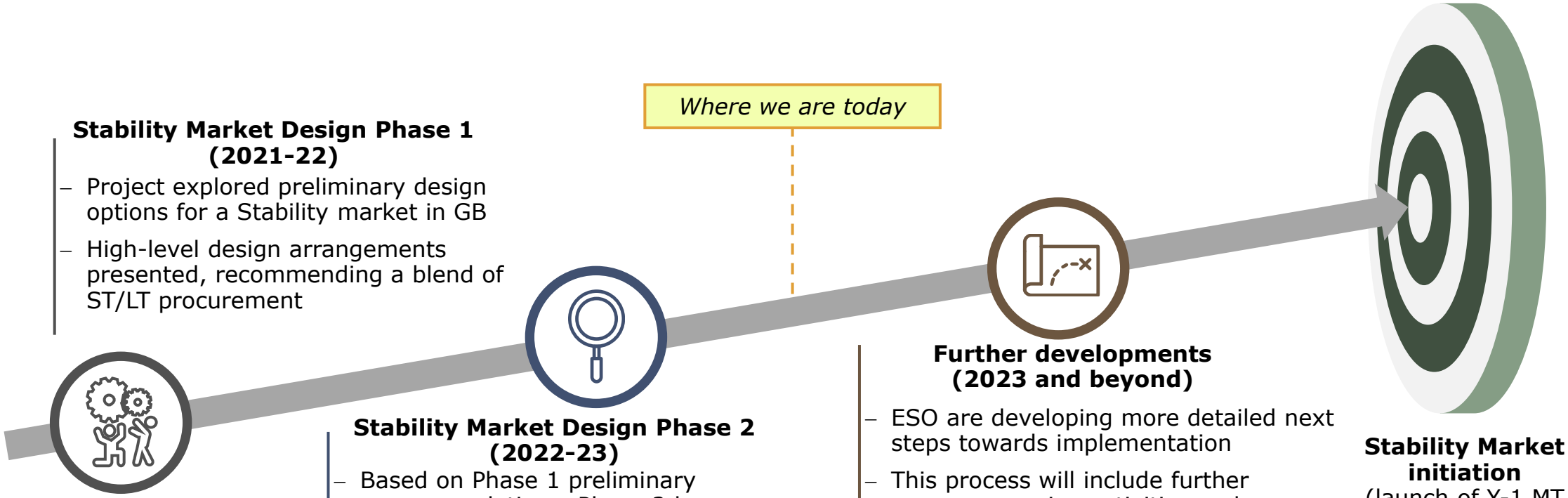
PROJECT OBJECTIVES:
- Analyse possible design options for a stability market, to address future growth of requirements for stability
- Evaluate different design models, supported by feedback received from Industry and ESO representatives

PROJECT OUTCOMES:
Provided a recommended market design model for Stability, nailing down eligibility, contract, pricing and product rules under different market timeframes[1]

1. i.e. Long-Term, Mid-Term, Short-Term | SQSS: Security and Quality of Supply Standard; RES: Renewable Energy Sources

PROJECT ROADMAP

Phases 1 and 2 of the project have provided final recommendations for the future Stability market model



Stability Market Design Phase 1 (2021-22)

- Project explored preliminary design options for a Stability market in GB
- High-level design arrangements presented, recommending a blend of ST/LT procurement

Stability Market Design Phase 2 (2022-23)

- Based on Phase 1 preliminary recommendations, Phase 2 has investigated some outstanding design questions (e.g. eligibility rules, contract structures, procurement strategies) providing final recommendation for the future Stability market design

Further developments (2023 and beyond)

- ESO are developing more detailed next steps towards implementation
- This process will include further process mapping activities and stakeholder engagement to fine-tune final market rules
- Mid-Term (Y-1) Stability market will be the first one to be launched, whilst Y-4 and D-1 are progressing in parallel

Stability Market initiation (launch of Y-1 MT in 2023)

LT: Long-Term; ST: Short-Term; MT: Mid-Term

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Stability is defined by ESO through three products, which address different issues affecting the system

	What it is	Why it matters to National Grid
Inertia 	– The system inertia is the kinetic energy stored in the rotors of the synchronous generators – In case of a sudden change in system frequency, these parts will carry on spinning and slow down the change in frequency	– Slows down the rate of change of frequency and allows frequency response to detect and respond to the failure – Allows generators to remain stable and connected to the network
Short Circuit Levels (SCL) 	– Short circuit level (SCL) is the amount of current that flows on the system during a fault – SCL is important during such a fault as it helps NG to maintain system voltage	– Low amounts of SCL can lead to bigger disturbances which spreads further due to any voltage change (protections also take longer to operate at low SCL) – SCL is regional, and is expected to decline at different rates across the country
Dynamic Voltage Support (DVS) 	– Faults on the system have a combined frequency and voltage effect (interaction between frequency drop/power flow and voltage) – In both cases, the result is an oscillation of power, voltage and frequency. To help reduce the impact of this unwanted effect dynamic voltage support can be used	– Synchronous generation provides more dynamic voltage support than non synchronous generation does – To continue integrating more non synchronous connection, additional dynamic voltage support will be needed

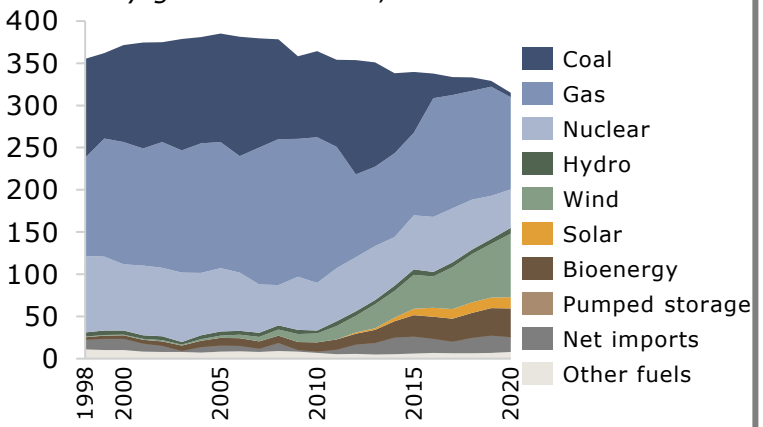
The increased need to manage stability manifests as a result of the decline in synchronous generation and growth of non-synchronous generation

Historical
What happened in the past?

Historically, stability was provided as a by-product of synchronous generation and was in abundance.

Reactive power production for voltage and inertia for frequency stability was co-produced when generating.

Electricity generation in GB, TWh

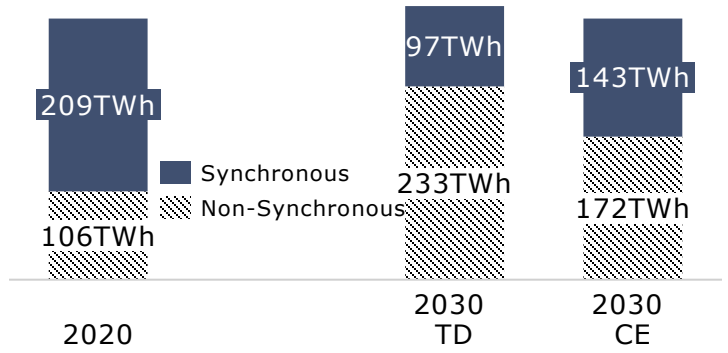


Today
What is happening now?

Rapid growth in renewables, retirement of synchronous generation and changes to the structure of demand. Systems get lighter and short circuit levels decrease at times with very high renewable penetration.

The management of grid stability has become increasingly expensive and we are exploring new commercial options for stability services including Pathfinders.

Projected generation (FES 2019), TWh

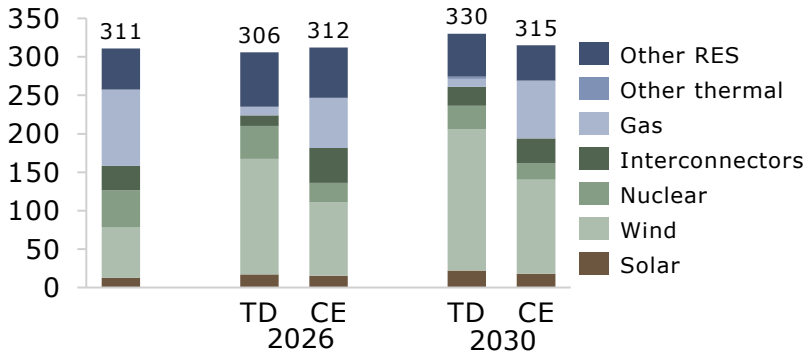


Future
Where is the system going?

Stability requirements will vary significantly under different operational situations within the power system.

When the system is dominated by technologies not inherently capable of providing system stability, ESO will need to procure additional services to meet this shortfall.

Projected generation (FES 2019), TWh



TD: Two Degrees; CE: Consumer Evolution

Current arrangements procure Stability across several timeframes. However, there are challenges for cost-efficiency and investment signals

Pathfinder contracts

long-term targeted provision[1]

The ESO procures some stability services through 6-10 years Pathfinders contracts.

- The stability Pathfinders have been procuring a number of LT providers, offering a route to market for new & existing solutions in competition with the TO
- A targeted approach accounting for location
- A competitive, but ad-hoc, tender process with lowest cost solutions selected for service delivery

Electricity market schedule

short-term global passive provision[1]

Stability services are exogenously provided to the ESO by the wholesale market as a "by-product" of synchronous generation

- Market schedule is determined exogenously to ESO's, being a result of traded positions in wholesale markets
- Some stability services materialise as by-product of generation due to the technical characteristics of certain technologies
- Historically, this was where the majority of stability services[1] would be delivered, but technology shift means that market schedule can no longer provide all/most stability needed

Balancing mechanism

short-term targeted provision[1]

ESO can procure stability services from providers in the Balancing Mechanism (bundled with active power)

- The BM is the primary tool to maintain compliance with physical system needs (e.g. thermal, voltage & stability constraints)[2]
- Procuring stability services through the BM often requires providers to deliver stability whilst generating energy

What is the desired solution for the future?

Legend **Passive (+unpaid)** **Targeted (+paid)**

1. Stability services as a broader concept (inertia, SCL, DRP) have only recently come into existence as scarcity in the provision has manifested due to shifting technology trends; 2. Other direct contracts such as SpinGen also exist but are not widespread | LT: Long-Term; BM: Balancing Mechanism; TO: Transmission Owner

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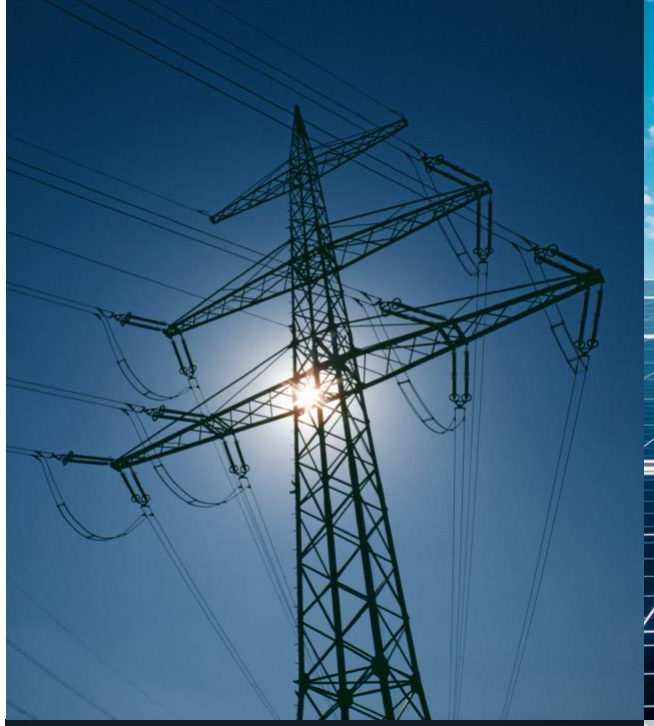

LT market is designed to underpin investments in Stability, while MT and ST will provide revenue streams for existing units

SKELETON OF STABILITY MARKET DESIGN

		Long Term (Y-4)	Mid Term (Y-1)	Short Term (D-1)
Purpose		– Procure capacity in advance (LT), to fulfil share of total requirements for Stability otherwise likely not to be met at delivery time – Allow financing of new build capacity (and enhanced capability[1]) through LT contracts	– Procure capacity in advance (MT), to adjust LT procurement in case necessary – Allow MT financing of any existing capability able to provide stability (e.g. expired PF contracts, enhanced capability[1])	– Procure capacity to fulfil residual of total requirements for Stability closer to real time (ST) – Allow remuneration of marginal costs for providing Stability at 0MW (proving a change in behaviour)
Eligibility		New build; Enhanced capability[1]	Existing capability	
Timeline	*Procurement lead time*	– Y-4	– Y-1	– D-1
	Contract duration	– 10y+ for new build; 3y for enhanced capability[1]	– 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
Pricing	*Payment type*	*Availability payment*: – £/MW.s/h; *Delivery payment*: – £/MW.s/h	*Availability payment*: – £/MW.s/h; *Delivery payment*: – £/MW.s/h	*Delivery payment (avail. paym. embedded)*: – £/MW.s/h
	Price mechanism	– Pay-as-bid	– Pay-as-bid	– Pay-as-clear

1. Existing assets with additional investments to provide incremental Stability | PF: Pathfinder; SP: Settlement Period; LT: Long-Term; MT: Mid-Term; ST: Short-Term

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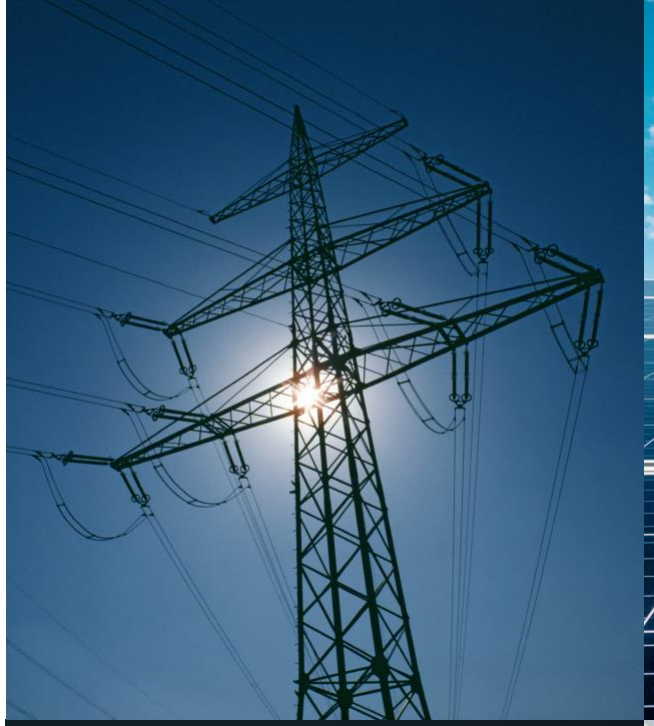


Analysis and recommendations for selected topics of interest addressed during Phase 2 of the project will be presented today

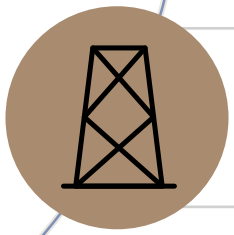
QUESTIONS ADDRESSED ON SELECTED TOPICS OF INTEREST WITHIN PROJECT PHASE 2

ELIGIBILITY MODEL:

- *How do we define incremental investment, incremental capabilities and existing capabilities?*
- *Can existing capability enter the LT market?*
- *How do we enforce the selective eligibility for the ST market?*

PAYMENT MODEL:

- *What contract resolution should we choose for the ST market?*
- *Should we have a utilisation payment for the services in the LT, MT and/or ST markets?*



TO PARTICIPATION MODEL:

- *What are the key considerations for treatment of the TO assets?*
- *What is the role of the TO in the LT market?*
- *How is depreciation of TO assets assessed in a competitive market?*

ESO will publish the detailed analysis and recommendations for all the exam questions on its Stability Market Design webpage

TO: Transmission Owner; LT: Long-Term; MT: Mid-Term; ST: Short-Term

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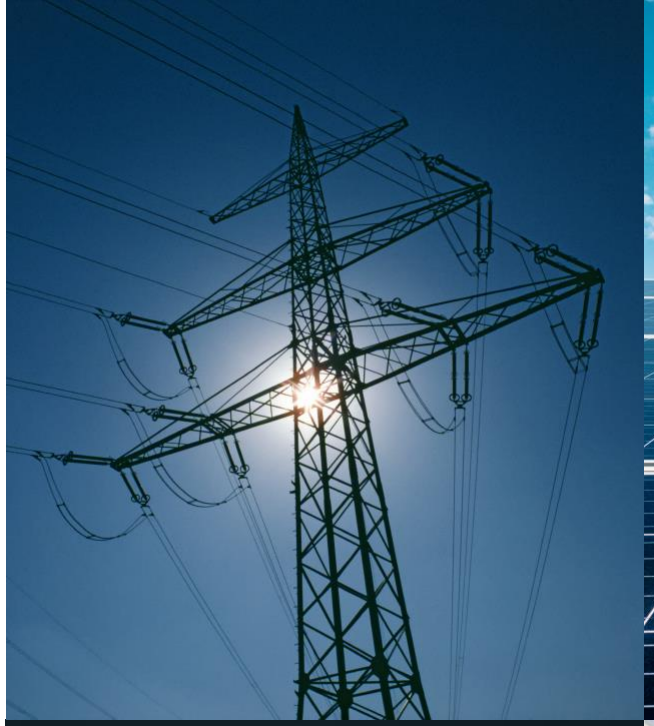


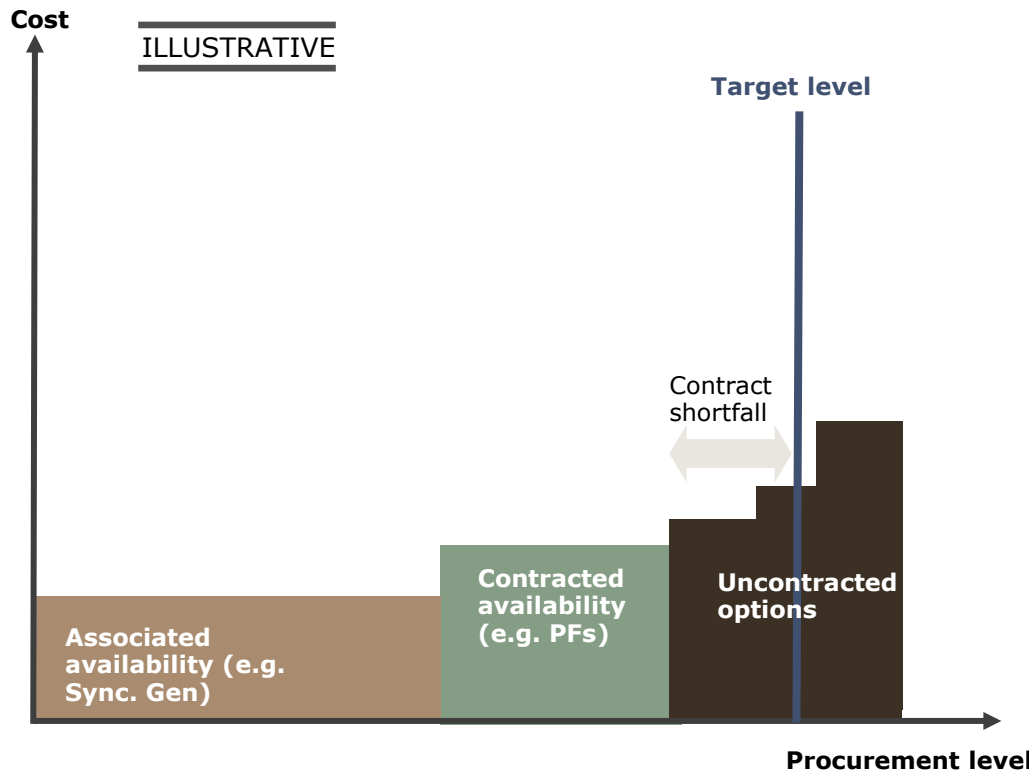
ELIGIBILITY RULES: PROCUREMENT APPROACH

Net procurement through shortfall and opportunistic buying is the desired approach, meeting system needs while optimising costs

'PAY FOR ADDITIONALITIES' MODEL

- Treating the stability market as a substitute for BM activity, which will keep a minor role in the procurement
- Payment principle is to "*pay for action*", rewarding only those providers willing to change their behaviour ('**net procurement**') in order to:
  1. Maintain the incentive to provide stability services
  2. Minimise windfall gains
- Trading strategy can be undertaken under different (and complementary) approaches in all market timeframes:
  - *Shortfall:* procuring only the minimum capacity to meet target level
    → ***Principle:*** *buy now before it is too late*
  - *Opportunistic:* procuring to minimise costs compared to counterfactual (i.e. avoiding more expensive solutions at later timeframes)
    → ***Principle:*** *buy when it is cheapest*

ILLUSTRATIVE REPRESENTATION OF PROCUREMENT STRATEGY



BM: Balancing Market; PF: Pathfinder

GENERAL SELECTIVE CHARACTERISTICS RULES

The Long-Term market will allow ESO to fulfil Stability shortfalls over long periods through either new or incremental capability

LT Market	New build	Enhanced capability
Eligibility conditions	– New assets with capability to provide stability at 0MW – Must meet availability requirements	– Existing assets undertaking additional investments to provide incremental or enable 0MW stability – Must meet availability requirements
Expected participating solutions	New non-synch. gen. with GFC[1] New non-synch. storage with GFC New synchronous condenser[2]	Existing non-synch. gen. with new GFC[1] Existing non-synch. storage with new GFC Existing synch. condenser with new flywheel Existing synch. gen. with new clutch
Contract length	10+ years	3 years
Lead time	Y-4	Y-4 (units could have early start option with conditions)

Logic behind the market?		
ESO	Procures necessary capacity (shortfall) in case of long requirements periods	Mitigates risk to lock capacity for too long periods when not necessary
Providers	Better matches investment profile of a completely new asset	Better matches investment profile of retrofitting existing plants[3]

1. And potentially equipped with additional storage as well; 2. Potentially equipped with a flywheel storage as well | GFC: Grid Forming Converter; LT: Long-Term

GENERAL SELECTIVE CHARACTERISTICS RULES

The Mid-Term market allows ESO to adjust residual shortfalls on a yearly basis and providers to finance residual costs of existing assets

MT Market	Existing capability
Eligibility conditions	– Any existing assets able to provide stability at 0MW (e.g. expired PF contracts) – Must meet availability requirements
Expected participating solutions	Existing non-synch. gen. with GFC[1] Existing synchronous condenser[2] Existing non-synch. storage with GFC Existing synch. gen. with clutch
Contract length	1 year
Lead time	Y-1

Logic behind the market?

ESO

– Mitigates risk to lock capacity for too long periods when not necessary

– Secures (potentially cheap) capacity otherwise closing[3]

Providers

– Allows financing of residual fixed costs of existing plants[4]

1. And potentially equipped with additional storage as well; 2. Potentially equipped with a flywheel storage as well; 3. e.g. Synchronous generation units otherwise closing; 4. Expired Pathfinders contract units | GFC: Grid Forming Converter; PF: Pathfinder; MT: Long-Term

GENERAL SELECTIVE CHARACTERISTICS RULES

The Short-Term market will allow ESO to refine its procurement on a D-1 basis, using the Balancing Mechanism as backstop at real-time

ST Market	Existing capability
Eligibility conditions	– Any existing assets able to provide stability at 0MW (e.g. expired PF contracts) – Must meet availability requirements
Expected participating solutions	Existing non-synch. gen. with GFC[1] Existing synchronous condenser[2] Existing non-synch. storage with GFC Existing synch. gen. with clutch
Contract length	4h - EFA blocks
Lead time	D-1

Logic behind the market?

ESO

– Mitigates risk to lock capacity for too long periods when not necessary
– Procures D-1 residual needs when necessary

Providers

– Most suitable way to market for existing plants characterised by relatively high variable costs
– Preferable way for those providers not be able to commit for long periods (i.e. years in LT/MT)

1. And potentially equipped with additional storage as well; 2. Potentially equipped with a flywheel storage as well | GFC: Grid Forming Converter; PF: Pathfinder; ST: Short-Term; LT: Long-Term; MT: Mid-Term

CONTRACT RESOLUTION

Contract lengths have been designed in order to match both ESO procurement requirements and risk appetite of different providers

	Long-Term		Mid-Term	Short-Term
Expected market participants	New build	Enhanced capability	Existing capability	
Contract lengths	10+ years	3 years	1 year	4h - EFA blocks

Rationale behind contract length

	Long-Term		Mid-Term	Short-Term
ESO	– Secure capacity with high availability when Stability needs are forecasted for long periods	– Optimises procurement costs over limited periods of needs (3y)	– Optimise procurement costs over limited periods of needs (1y) – Secure (potentially cheap) capacity otherwise closing[2]	– Procure D-1 residual needs when necessary
Providers	– Better match investment profile and asset lifetime of a new asset	– Better match investment profile of retrofitting an existing plant[1]	– Allow financing of residual fixed costs of existing plants[3]	– Way to market for units not willing to commit for long periods[4]

1. One year contract is likely to be not sufficient to support investments such as e.g. grid forming converters or clutches; 2. e.g. Synchronous generation units otherwise closing; 3. Expired Pathfinders contract units; 4. e.g. non dedicated battery storage, willing to stack Stability with other sources of revenues

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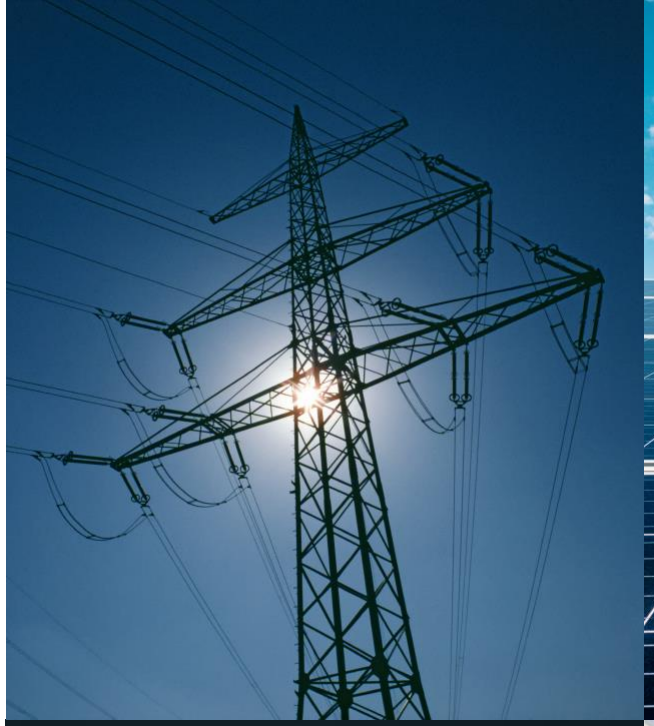
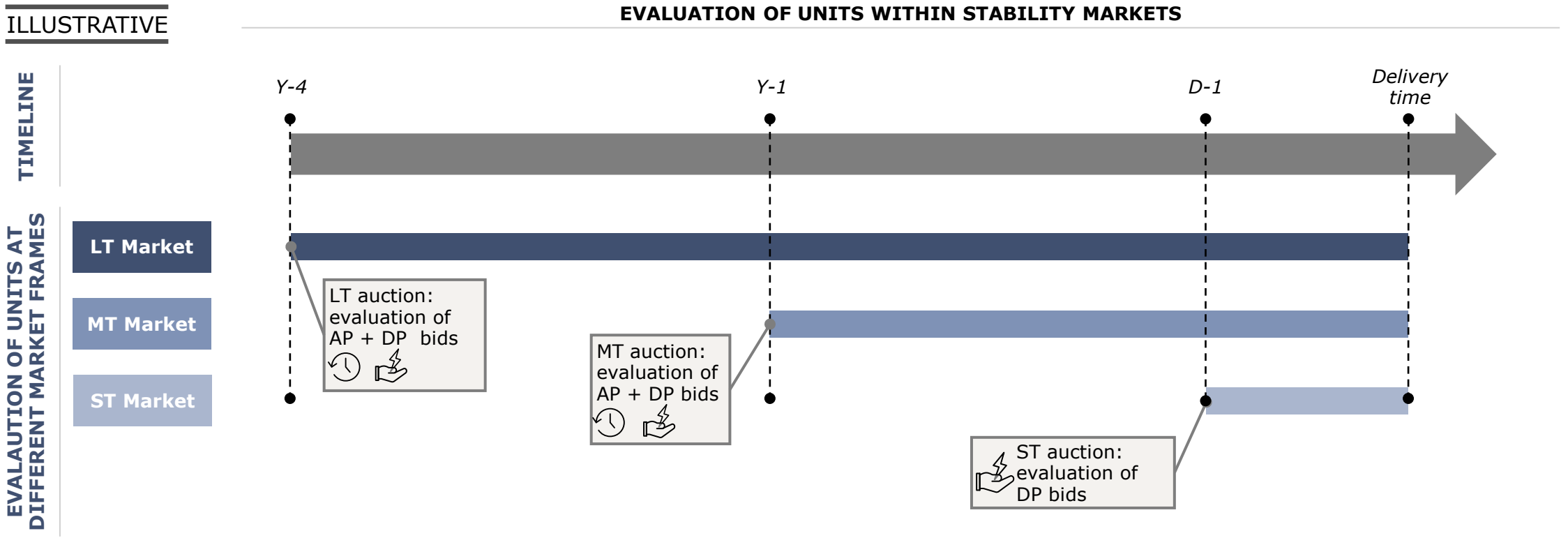


TIMELINE ON EVALUATION OF UNITS WITHIN THE STABILITY MARKETS

We recommend a two-part payment structure to reflect provider costs, allowing ESO to use units in a cost-effective manner

ILLUSTRATIVE



Definitions of payment components

Availability Payment (AP): offer for being 'active' and available to provide Stability at later timeframes. Embeds cost opportunity of not participating in other markets

Delivery Payment (DP): offer for delivering Stability as instructed by ESO. Embeds marginal costs (e.g. energy consumptions) to deliver the service and possibly opportunity costs in case of ST contract

DP: Delivery Payment; AP: Availability Payment LT: Long-Term; MT: Mid-Term; ST: Short-Term

Legend *Time period between procurement and actual delivery of stability – varies by market timeframe* *Availability payment* *Delivery payment*

EVALUATION OF MODELS

Payments are a blend of pay-as-bid for LT and MT markets (two-part payments) and pay-as-clear for ST market (delivery payments only)

	LT Market	MT Market	ST Market
Availability payment	– £/MW.s/h – Pay-as-bid – Selection through LT auction (Y-4) – Adjusted yearly (e.g. indexed to CPI)	– £/MW.s/h – Pay-as-bid – Selection through MT auction (Y-1)	– *N.a. (effectively embedded in DP)*
Delivery payment	– £/MW.s/h – Pay-as-bid – DP is fixed at contract signature and adjusted (e.g. function of spot energy prices and/or indexed to annual CPI)	– £/MW.s/h – Pay-as-bid – DP is fixed at contract signature and adjusted	– £/MW.s/h – Pay-as-clear – Selection through ST auction (D-1)

LT, MT and ST offers for the DP are evaluated together to determine the units to select close to real time

LT: Long-Term; MT: Mid-Term; ST: Short-Term; AP: Availability Payment; DP: Delivery Payment; SBP: System Buy Price (Imbalance Price); CPI: Consumer Price Index

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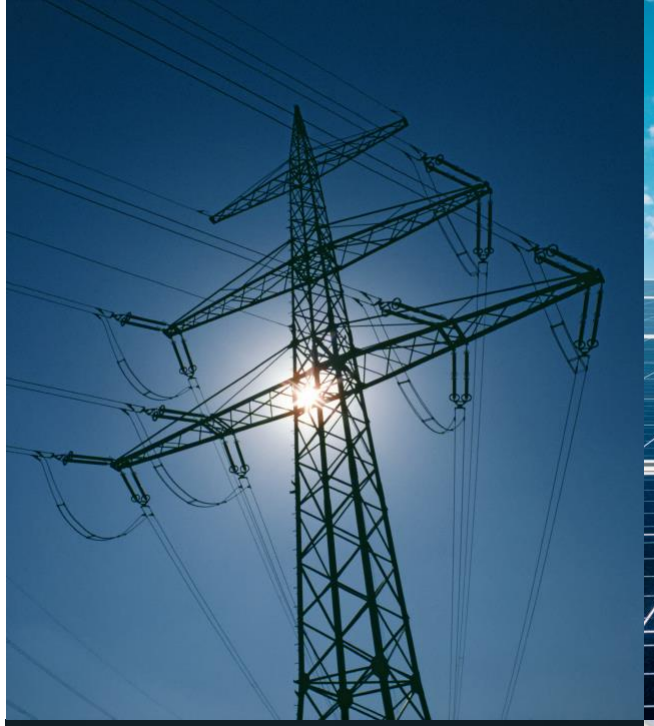

FINAL MODEL TO PARTICIPATION IN LT

As in Pathfinders, TOs will provide a counterfactual for evaluation of LT market, but under a longer evaluation period (10+ years)

Initial situation

- During Stability Pathfinder, TOs participated indirectly in LT auctions, by providing a counterfactual
- A similar approach has been considered for the LT Stability market

Possible changes of the status quo

- In the PF methodology TOs are assumed to recover their full costs over the tender period, without considering a residual value afterwards. This could result in low competitive pressure applied on the commercial providers[1]
- For this reasons alternative models (based on the current Pathfinder one) have been appraised

Recommended model for TOs within Stability LT auction

- The recommended model confirmed PF methodology, but with a longer evaluation period where possible and so also longer contracts (10+ years)
- This would allow commercial providers to evaluate costs over a period closer to the actual technical (and useful) life of their assets

1. Who may assume some residual value | TO: Transmission Owner; LT: Long-Term; PF: Pathfinder

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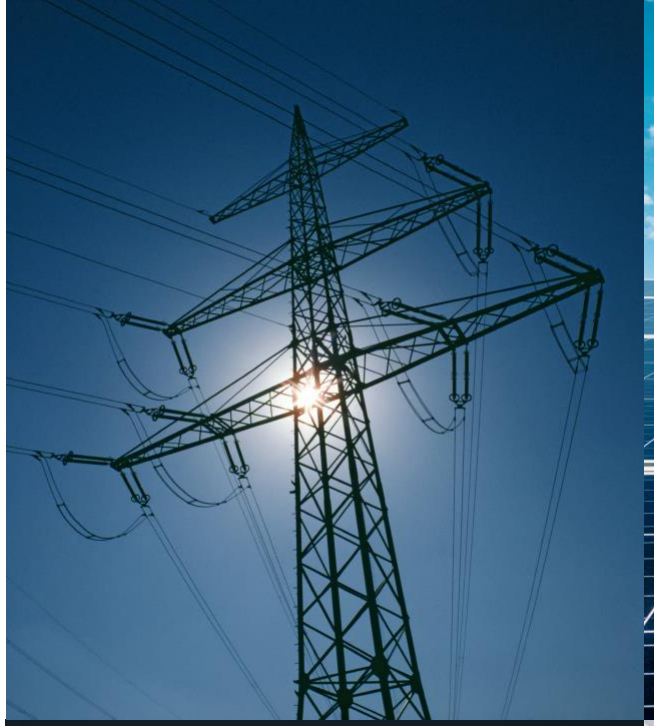
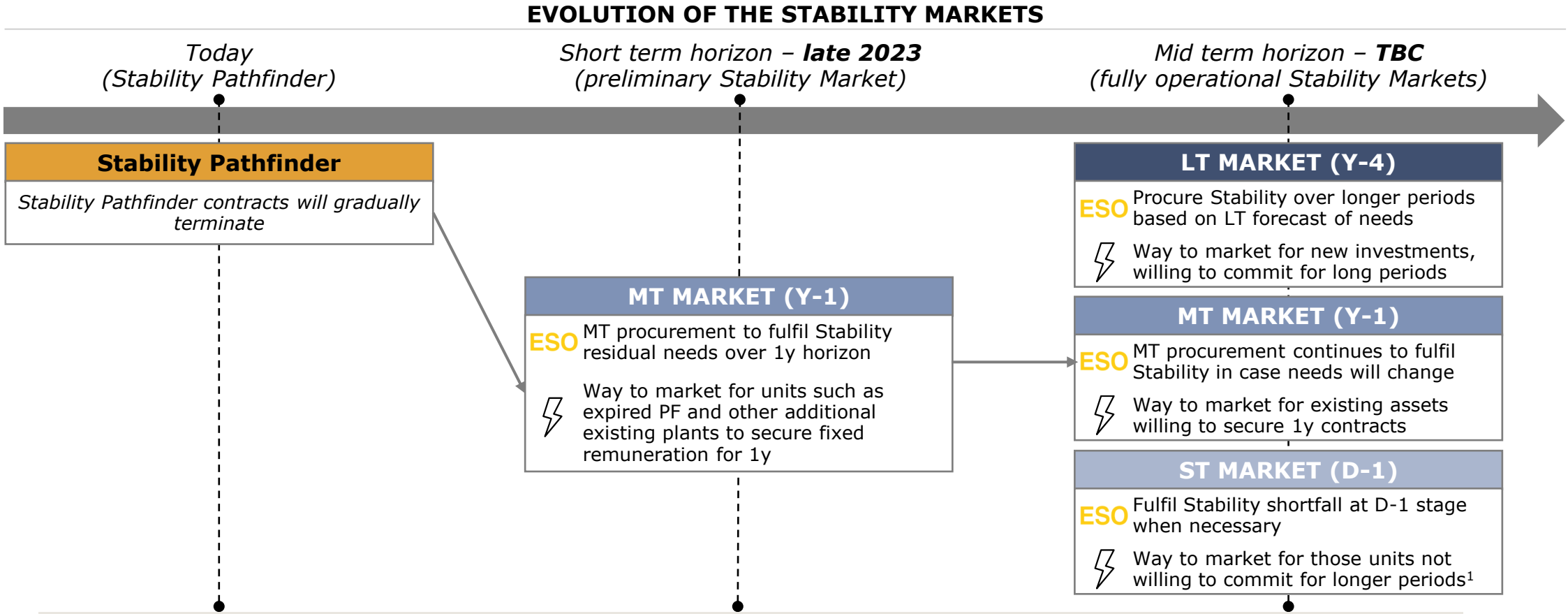


Preliminary MT market for existing capability would provide the necessary price signals for the future Stability Market



1. e.g. non dedicated battery storage, willing to stack revenues from multiple sources | PF: Pathfinder; LT: Long-Term; MT: Mid-Term; ST: Short-Term; BM: Balancing Mechanism

Legend → *Market evolving to* *Perspective:* ESO *NG ESO* ⚡ *Providers*

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Mid-term (Y-1) Stability Market Request for Information

17th July 2023

ESO

Introductions

Mid-term (Y-1) Stability Market Project Team

Today's Speakers

Ed Farley

Senior Market Development Lead

Kelly Larkin

Senior Operability Analyst

Alex Millar

Senior Category Lead

Stability mid-term (Y-1) market

- The first step in launching our stability markets is to initiate the Mid-term (Y-1) Stability Market, with the intention to undertake the first mid-term (Y-1) tender round later this year (2023).

- This decision has been taken for several reasons:
  - To access high-availability stability services to meet our requirement
  - To offer a regular route to market which provides confidence to investors and market participants
  - To avoid overloading the market by launching all three stability markets at once
  - To allow time to create a detailed plan for implementing Y-4 and D-1 stability markets

- Prior to the launch of a mid-term (Y-1) market, ESO are seeking industry perspectives on a variety of topics that will help ESO to design the tender process for the mid-term (Y-1) market.

Purpose of the Request for Information (RFI)

- This webinar marks the launch of a Request for Information.
- The RFI represents a further step in our evolution from ad-hoc Pathfinder tenders to a more regular, structured Stability Market.
- ESO are particularly interested to hear from parties that can provide stability services and are interested in a mid-term (Y-1) stability market.
- The information received will be used to refine ESO's understanding of the assets that can provide stability in the market and to support the design of the tender process for a mid-term (Y-1) market.
- **Please Note:** This is a Request for Information (RFI) only and not part of a formal tender process.

How many assets do you have?

What technology type is your asset?

What inertia capacity do your assets have?

Where are you connected?

How do you meet the eligibility criteria?

A contract will not be awarded through a response to this RFI.

What we want to know

System needs and eligibility criteria

System needs (indicative)

- Initially the mid-term (Y-1) market will be focused on **procuring inertia** only as the primary product.
  - In future years the scope might be expanded to include short circuit level (SCL) based on system studies and identified requirements.

- Target inertia requirement for the first delivery year is 7GW.s (indicative)
  - We do not intend to procure any redundancy but may procure above or below this volume according to the bids received and the assessment criteria.

- The technical specification will be on a technology agnostic basis, though all solutions will be required to satisfy the technical requirements.

Eligibility criteria (indicative)

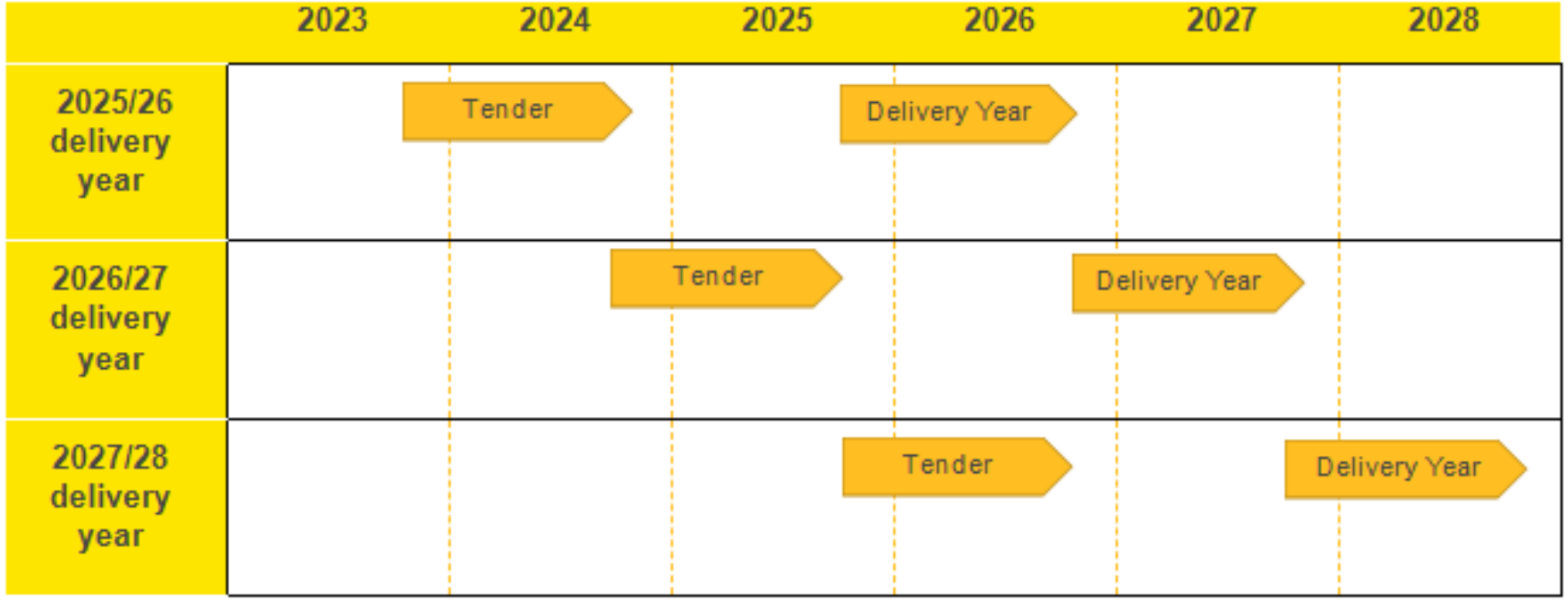
- Solutions must provide the service at 0MW export.
- Solutions must be capable of 90% availability (7,884 hours).
- Solutions must have an existing connection agreement (whether already connected or due to connect in time for contract start).
- Solutions must either be directly connected to the transmission system or if embedded have a User System Entry Point of 132kV.

Please note the information in this slide is indicative and subject to change before any launch of a stability mid-term market

What we want to know

Your thoughts on the tender process and timeline

- **We expect the first delivery year to commence from 1st October 2025**
- The intention is each tender will focus on one delivery period at a time
- We expect that each tender round will be open to new bidders and/or new solutions/assets. It would not be a requirement to take part in the first tender round to be able to take part in subsequent rounds.



Please note this information is indicative and subject to change based on system needs.

What we want to know

Your thoughts on the indicative contract design

Contract Format (indicative)

- It is expected that contracts would be issued on a per-solution basis rather than a per-company basis.

- This would likely be an enduring framework agreement, with individual “call-offs” from that framework agreement for each service delivery year.
    - This means that the overarching terms and conditions would only need to be agreed once

    - Only requiring the call-off to be agreed for each delivery year.

Payment Structure (indicative)

- Pay-as-bid

- Bidders will be requested to submit two prices:
    - An availability fee
    - A delivery fee

- Prices will be fixed for the delivery year in question.

- No indexation

The Role of TOs and DNOs

As a connection provider

- For this tender, participants are required to already have connection agreements

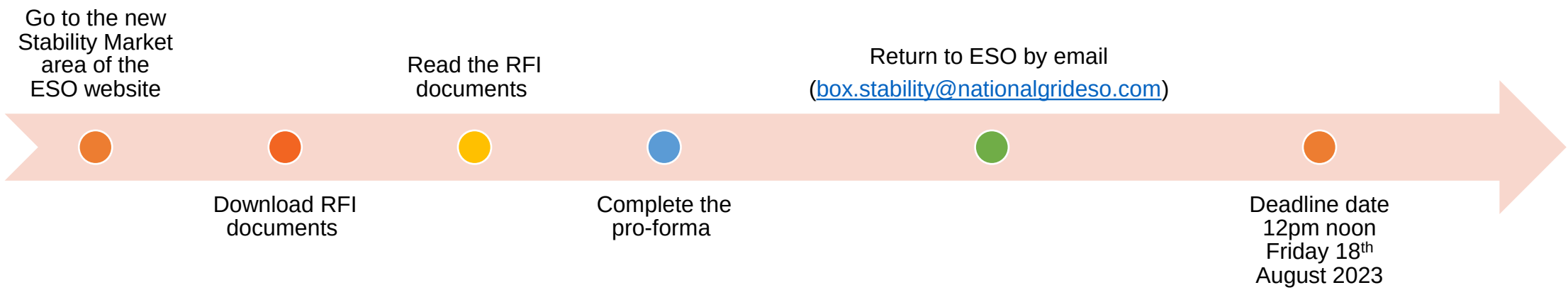
- This means:
  - There will be no use of ‘bay reservation’
  - There will be no ‘proxy’ TO connection studies or DNO connection studies to verify whether or not the solution is feasible for connection

- TOs and DNOs will provide BAU connection services through the usual connections process for their connection customers

As a market participant

- We do not expect TOs or DNOs to participate directly in the Mid-term (Y-1) Stability Market

How to participate



Milestone	Date
RFI Launch	Today 17 July 2023
RFI Close	18 August 2023 12pm noon

- A copy of these slides will be available on the ESO website shortly
  - https://www.nationalgrideso.com/industry-information/balancing-services/stability-market
- We will contact all attendees by email after the webinar with links to the Stability Market webpages.
- Please specify if you do not wish to be contacted by ESO about the Y-1 market.
- If you have any questions, please contact box.stability@nationalgrideso.com
- If you are interested in a one-to-one conversation with ESO, please contact with box.stability@nationalgrideso.com to organise a meeting

Any questions?