Submit your queries through the Q&A function.

Please note that the webinar will be recorded.

Electricity System Operator

2023 Markets Roadmap Webinar

25 April 2023

ESO

Agenda

Introduction

Highlights of the 2023 Markets Roadmap

Assessment of ESO markets – LCP Delta

Enduring Auction Capability Timeline

Q&A
(Please submit your queries via webinar chat)

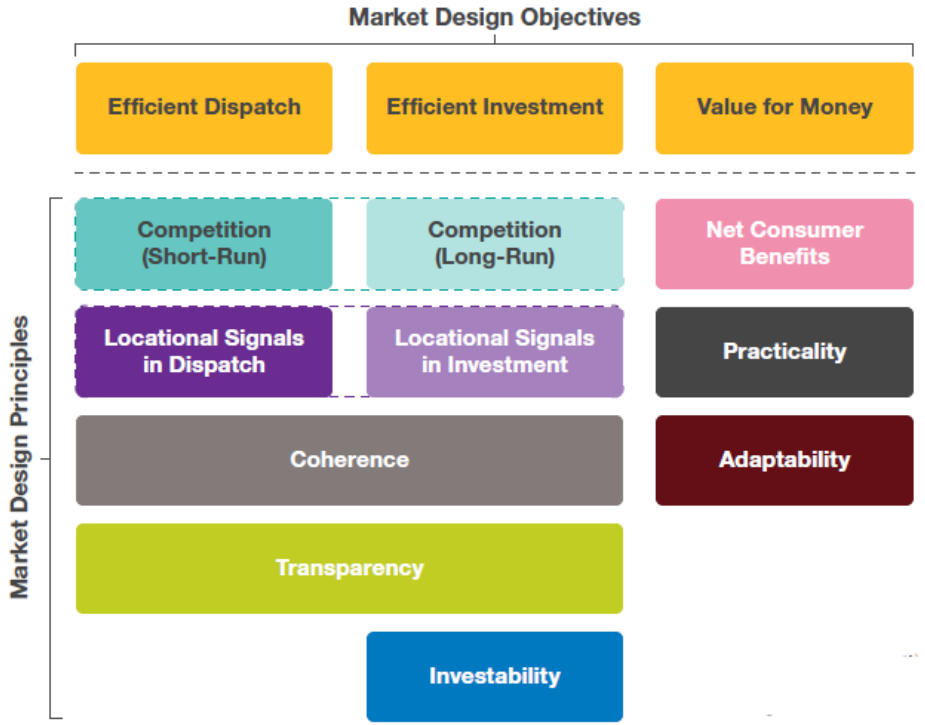
The Markets Roadmap outlines the ESO's plans to reform our markets to enable zero-carbon operation by 2025 and fully decarbonise by 2035

The markets roadmap also:

- Provides key insights into the different ESO markets as well as the key drivers for reform.
- Gives stakeholders confidence that we are making the right market reform and design decisions.
- Shares strategic questions we are currently tackling and signposts how industry can work with us to answer them.

Markets Roadmap webpage

Market Design Framework



2022 Highlights → 2023 Outlook and beyond

In 2022, we achieved a lot in challenging environment

- We rapidly responded to the energy price crisis to ensure system security over winter, by:
  - Introducing winter contingency contracts with coal generators.
  - Developing the Demand Flexibility Service to access wide-scale demand turn down.
  - Adjusting our procurement strategies to mitigate costs increases.
- We still delivered on our commitments to:
  - Make our procurement more efficient.
  - Launch new markets.
  - Improve and expand our approach to stakeholder engagement.

Some key deliverables for 2023

- Next update on our Net Zero Market Reform Programme this summer.
- Comprehensive review of the balancing mechanism.
- Launch of new reserve products in autumn.
- Launch of local constraints and stability markets, as well as EAC.

Getting ready for 2035

- Ongoing support of REMA process.
- Analysis of key strategic considerations like central dispatch, locational pricing and future of capacity markets and contracts for difference.
- Optimised and coherent procurement of ancillary services.

Frequency response markets have expanded in scope but costs have remained the same

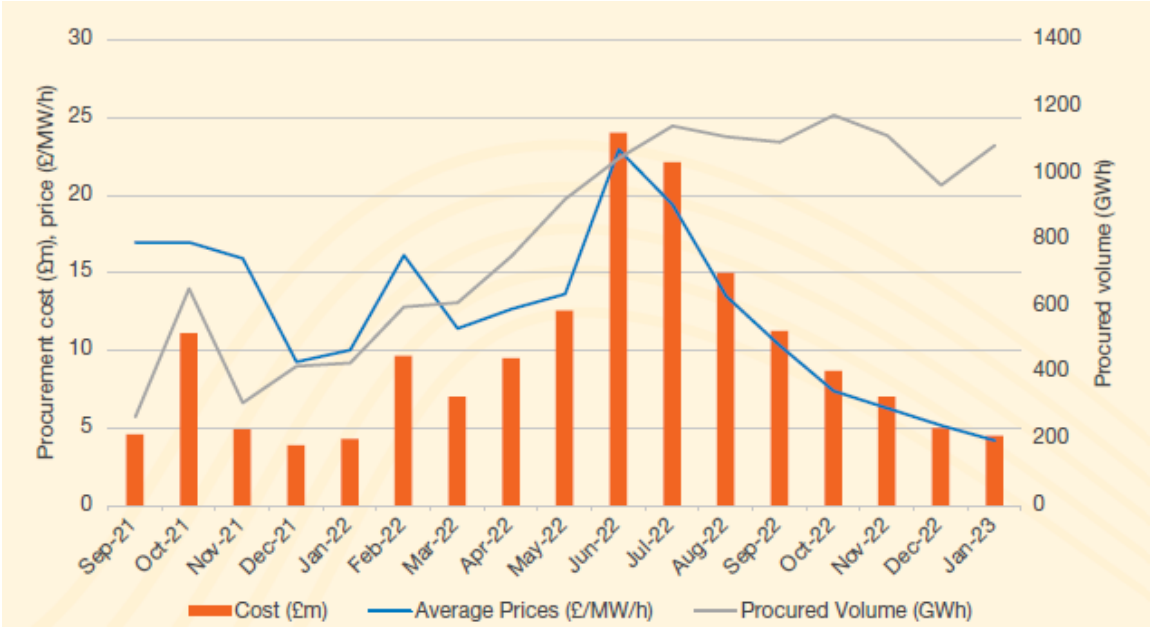
What happened in 2022:

- Launched Dynamic Regulation and Dynamic Moderation
- Reduction in MFR procured, saving almost £80m
- Growth of Dynamic Containment market to help secure losses
- Overall response volumes increased but costs remained stable

What is happening 2023 and beyond:

- Launch of our enduring auction capability for co-optimisation of products
- Removal of barriers to entry to some markets
- Introduction of Annual Development Cycle

Dynamic response markets 2021-23



Despite lower utilisation volumes, reserve costs increased significantly in 2022. New products will help to reduce costs and contain frequency more efficiently

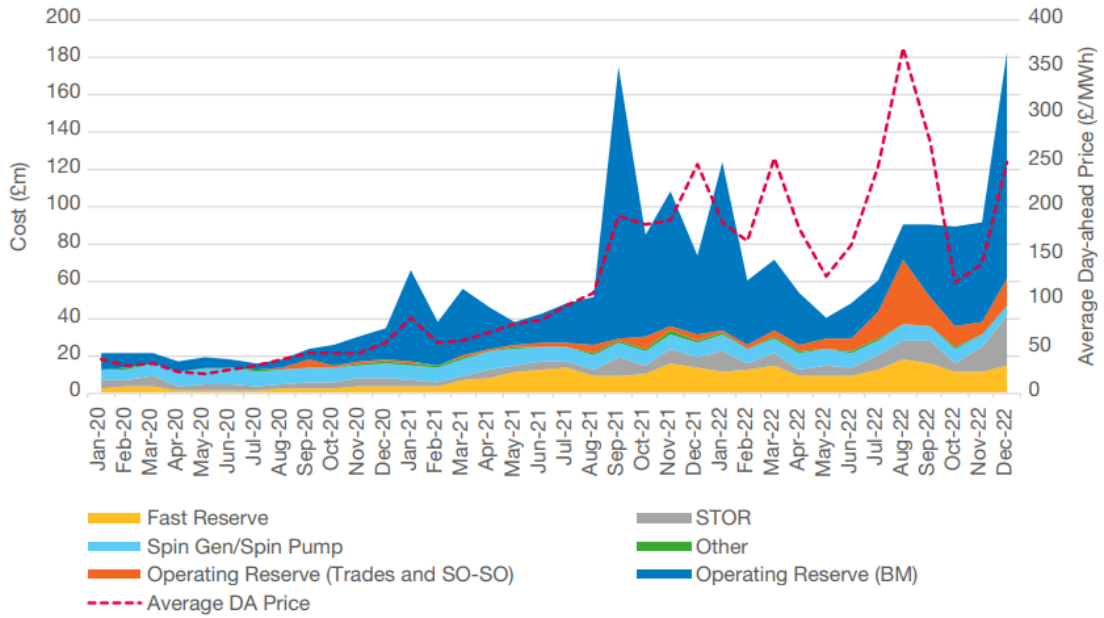
What happened in 2022:

- Reserve utilisation decreased by 11% in 2022 in comparison to previous Covid-19 affected years.
- Utilisation costs increased by 17% driven by higher fuel prices, as also observed in day-ahead markets.
- STOR volumes consistently secured the largest generation loss, including on high scarcity days due to a more dynamic ESO buy order.

What's happening in 2023 and beyond:

- A benefits case for Balancing Reserve remains well-established but the delivery plan is being revised
- Quick and Slow Reserve will also launch later in 2023 to help us to restore frequency to within operational limits more effectively.
- Negative iterations will help us to procure firm downward reserve to maintain footroom and secure large demand losses.

RV Figure 4: Reserve costs: Jan 2020 - Dec 2022



Thermal volumes and costs continue to grow, but ESO markets will reduce constraint costs

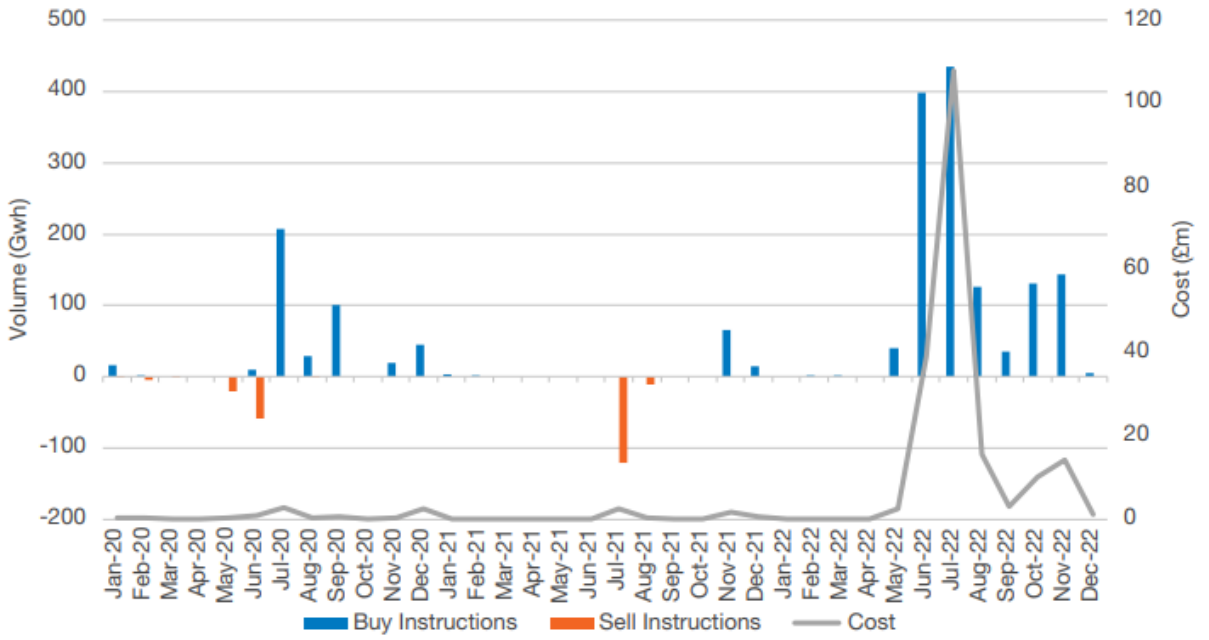
What happened in 2022:

- Volume of thermal constraints increased
- Costs rose given volume of actions required and global gas prices
- The Constraint Management Intertrip Scheme saw savings of £80million and 140,000 tonnes of carbon emissions
- Significant increase in ESO instructed interconnector trades to address an import constraint

What is happening 2023 and beyond:

- NOA forecasts an increase in thermal constraint costs up to 2030
- The MW Dispatch, Local Constraint Market and full CMIS launch
- Net Zero Market Reform project will continue to identify optimal wholesale market and policy reform to tackle rising thermal constraints.

TH Figure 6: ESO instructed interconnector trades to address thermal constraints (£m and GWh)



The volumes and costs of ESO instructed interconnector trades to address thermal constraints.

We have started to implement findings from the Distributed ReStart Project into BAU restoration practices

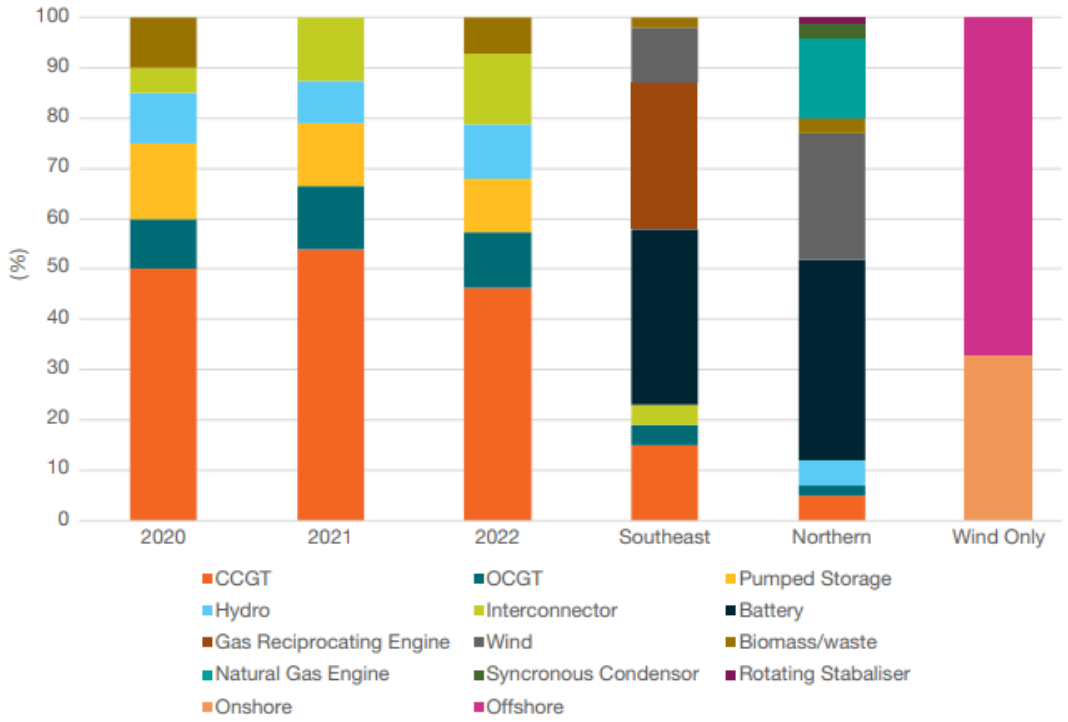
What happened in 2022:

- Costs remained relatively consistent to previous years
- Launched new tenders (Northern and South-eastern) including DER which shows potential for new and diverse technology mix
- Launch of one-off wind only tender to further diversify the technology mix and to reduce reliance on volatile fossil fuels
- Reforms driven by ESRS obligations and de-carbonisation

What is happening 2023 and beyond:

- ESO & DNO feasibility testing following the expression of interest stage
- Award contracts to a new and diverse portfolio of technologies including DER
- Incorporating these learnings in to BAU in future tenders (Southwest & Midlands)
- Launch of first distributed restart zone

RT Figure 1: Restoration Providers (2020-2022)



RT Figure 1 shows providers that came online in 2020, 2021 & 2022 as well as those who expressed interest in the three tenders launched in 2022.

Two more stability pathfinders concluded in 2022 whilst costs associated with increasing system inertia trebled in comparison with 2021.

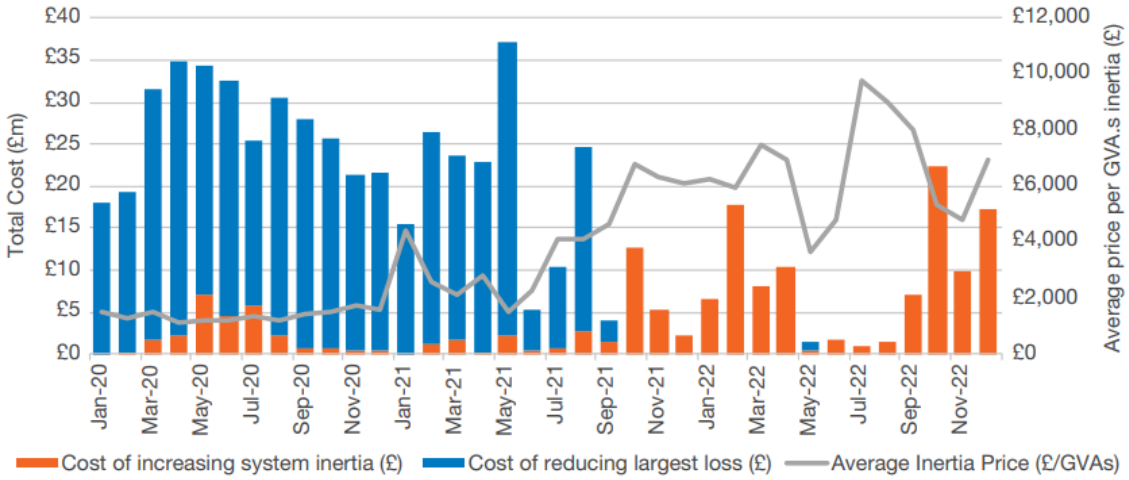
What happened in 2022:

- Actions taken to reduce the size of the largest loss decreased very significantly.
- Actions to increase system inertia doubled in volume and trebled in cost (£104m) due to greater penetration of renewables and high gas costs.
- Stability Pathfinders 2 and 3 secured >20GVA.s inertia and >23GVA effective SCL, including the first grid-forming battery storage solutions.

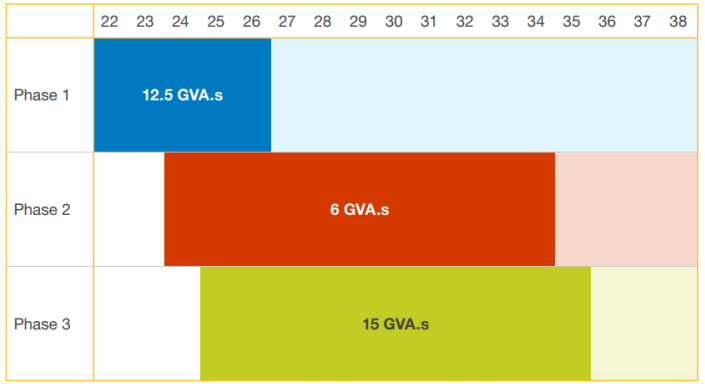
What's happening in 2023 and beyond:

- Lowering the minimum inertia threshold via FRCR will reduce the costs associated with managing system inertia.
- The Stability Market Design innovation project recommends three discrete markets – a long-term (Y-4), mid-term (Y-1) and short-term (D-1).
- A mid-term Y-1 stability market will be initiated in 2023 to access high-availability inertia as a cheaper alternative to the Balancing Mechanism.
- D-1 and Y-4 markets will be developed in parallel.

ST Figure 3: Inertia management costs: Jan 2020 - Dec 2022



ST Figure 1: Total volume of contracted inertia (GVA.s) through stability pathfinder 1, 2 and 3.



We are developing our procurement strategy as our voltage management requirements continue to rise

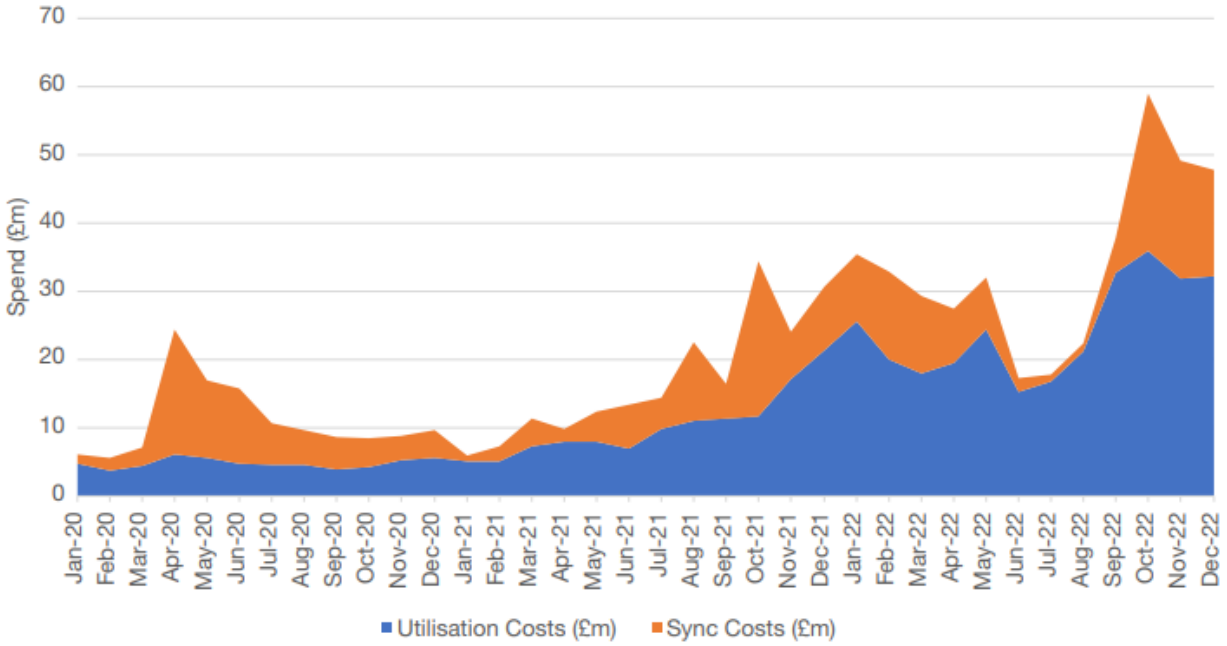
What happened in 2022:

- Voltage management requirements continued to grow
- The default payment rate increased due to gas prices
- We identified an estimated 3.4GVar of capacity from existing units
- Our Mersey Pathfinder delivered £12.6million in savings and is forecast to save £25.3m across 2023/24.

What is happening 2023 and beyond:

- Exploring how to harness this additional 3.4GVar
- Pennines New Services Procurement go-live in 2024
- Continue to develop our enduring market design

VT Figure 3: The utilisation and synchronisation costs between 2020-2022



Note: revenue recovered by the Transmission Owners related to their reactive compensation equipment cannot be identified within their overall Regulated Asset Base (RAB). The above chart, therefore, does not represent the full cost to consumers of voltage management in 2022.

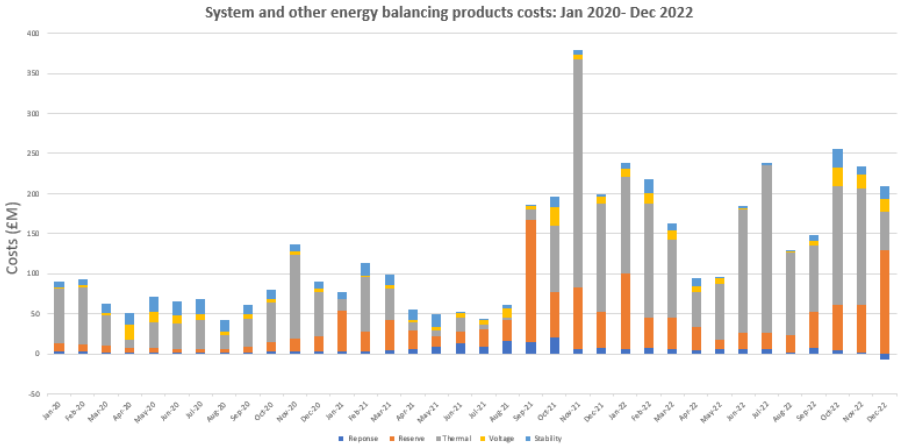
Increasing number of dispatch actions for managing energy and system constraints. BM costs rise due to tight margins and high gas prices.

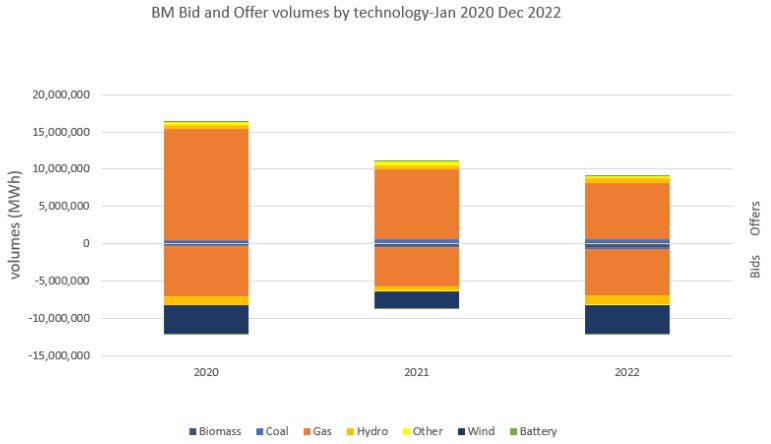
What happened in 2022:

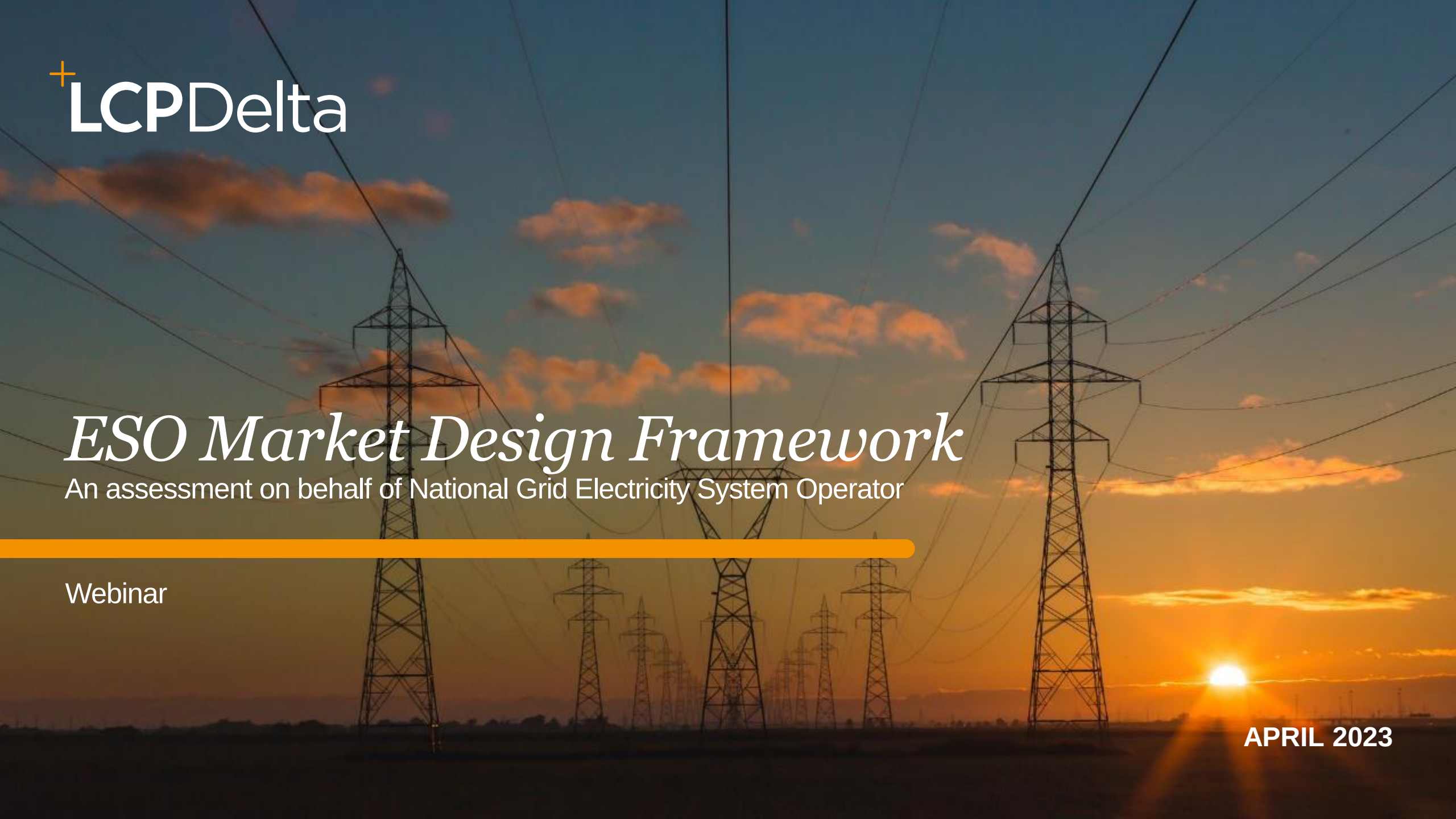
- Actions and costs for managing energy balancing, thermal and stability constraints have increased across the board.
- Winter 2021 saw several very high-cost days in the BM. In January 2022 we commissioned a Review of the BM to understand underlying cost drivers.
- BM remains largely dominated by gas plant.

What is happening 2023 and beyond:

- As we integrate higher volumes of intermittent capacity, we expect greater proportion of balancing actions and high costs to manage system requirements.
- Open Balancing Programme is developing future balancing capabilities to improve dispatch efficiency and support new markets.
- We are undertaking a review of the BM as part of a wider assessment that will feed into the government's REMA.







LCPDelta

ESO Market Design Framework

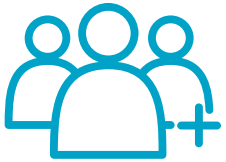
An assessment on behalf of National Grid Electricity System Operator

Webinar

APRIL 2023

Introducing LCP

- We are a financial services and analytics consultancy with offices in London, Winchester, Edinburgh, Cambridge, Dublin and Paris
- We are a partnership, founded in 1947.
- We offer independent modelling, software and advice across pensions, investment, insurance, energy and health.
- LCP Delta is our specialist energy practice, formed through the merger of LCP Energy and Delta-EE.



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700+ clients

Advising 45% of the FTSE100

Introducing LCP Delta

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LCP Delta is a specialised energy transition practice providing

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…to clients that are active in all parts of the value chain

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Power market forecasting	Energy storage & flexibility	Hydrogen	Power trading	
Distributed power	**Policy impact analysis**	System modelling	Business models	
EV charging infrastructure	Connected home & HEM	Low carbon heat	Customer decision making	Community energy

~ 100 people

Active since 2004

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ESO Markets Roadmap Assessment

LCP Delta carried outa review of the ESO's markets against its Market Design Framework

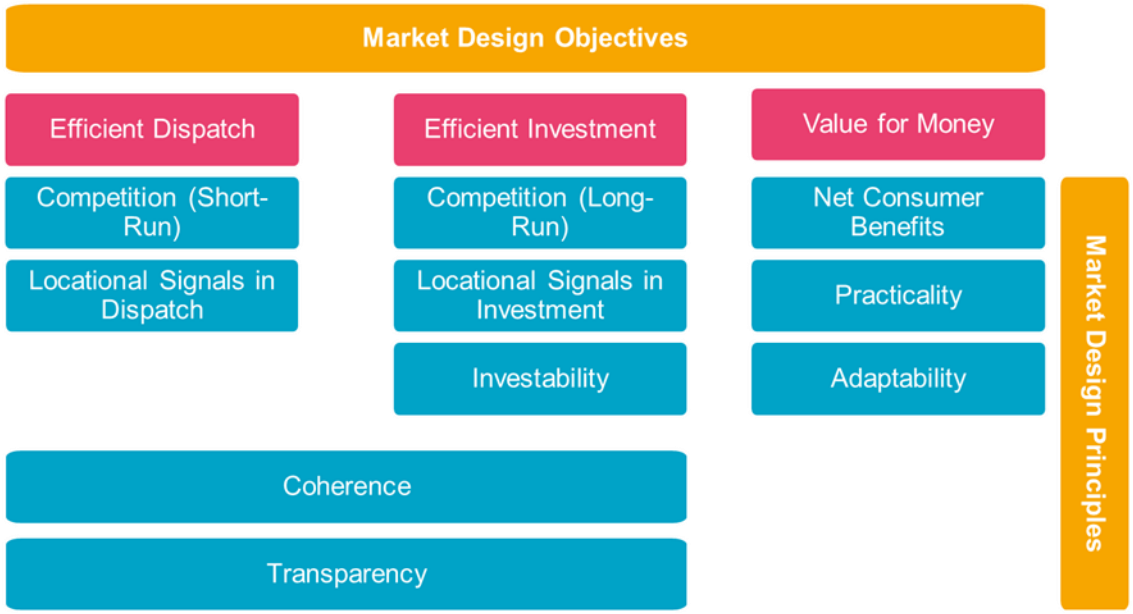
LCP Delta was commissioned by the ESO to undertake an independent review into how well aligned decisions and market developments have followed the Market Design Framework (MDF).

Where markets are being developed, the assessment will consider whether the approach taken by ESO in establishing these markets is in line with the principles.

Where markets are mature, the assessment will consider whether the way the market operates is in line with the framework and if any changes should be prioritised.

The assessment includes:

- A RAG rating against all principles (in blue);
- Analysis of the competitiveness of the auctions;
- Analysis of wholesale power market interactions.



RAG	Summary
	Market design fully aligned with the principles
	Market design is aligned with the principles
	Market design is adequately aligned with the principles
	Market design is not aligned with the principles

RAG ratings - Approach

Assessing the framework

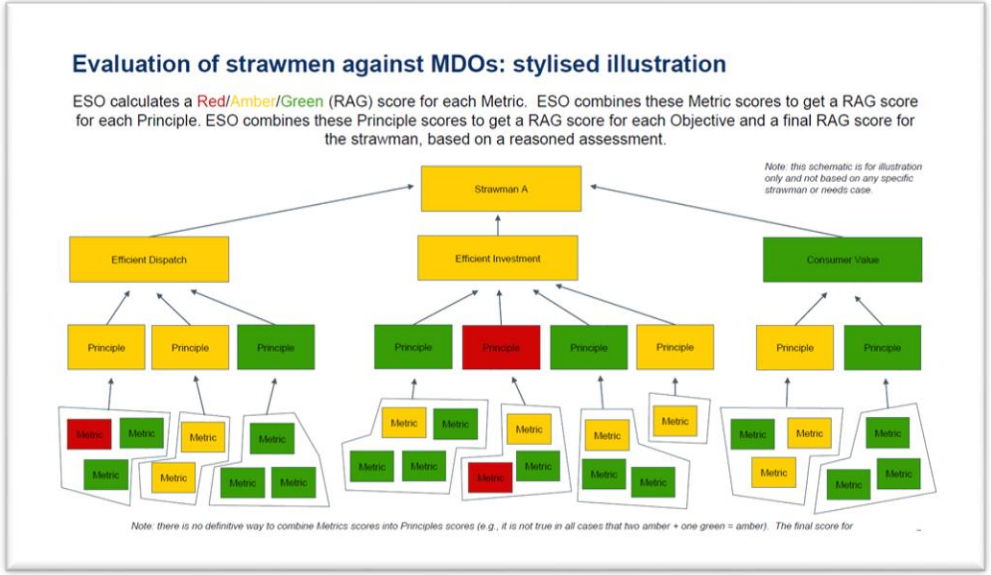
To RAG rate the ESO's markets against each principle, we utilised its own framework user guide.

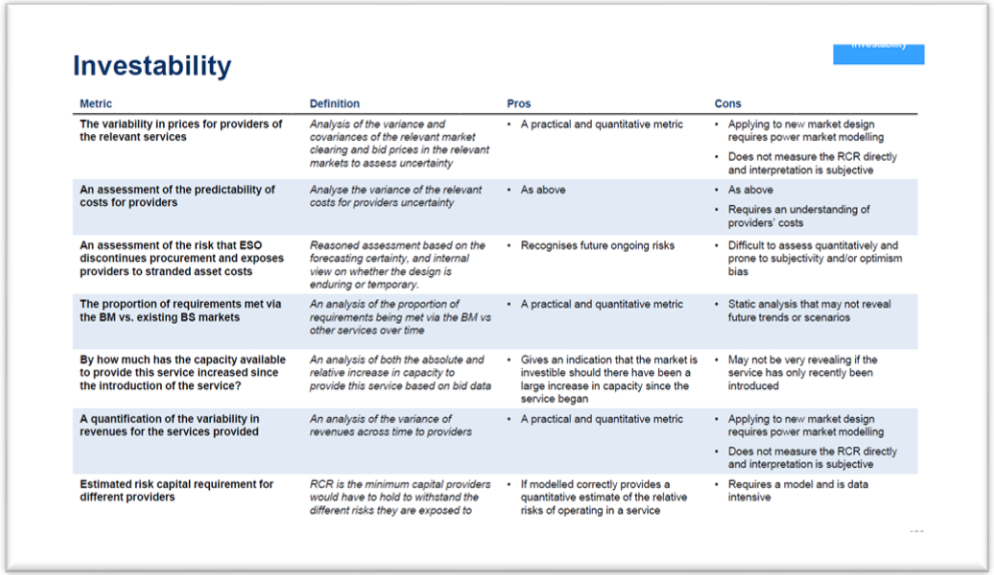
This user guide provides a number of metrics underneath each principle.

This 'long-list' of metrics fed into the written assessment of each market, which when individually assessed gave an overall RAG rating for the principle, and therefore the market design objective.

We provided a RAG rating against each principle for each market other than for *practicality.*

We agreed to not assess practicality as this focusses on an ESO perspective of the market – which was difficult for outsiders to assess.





Investability

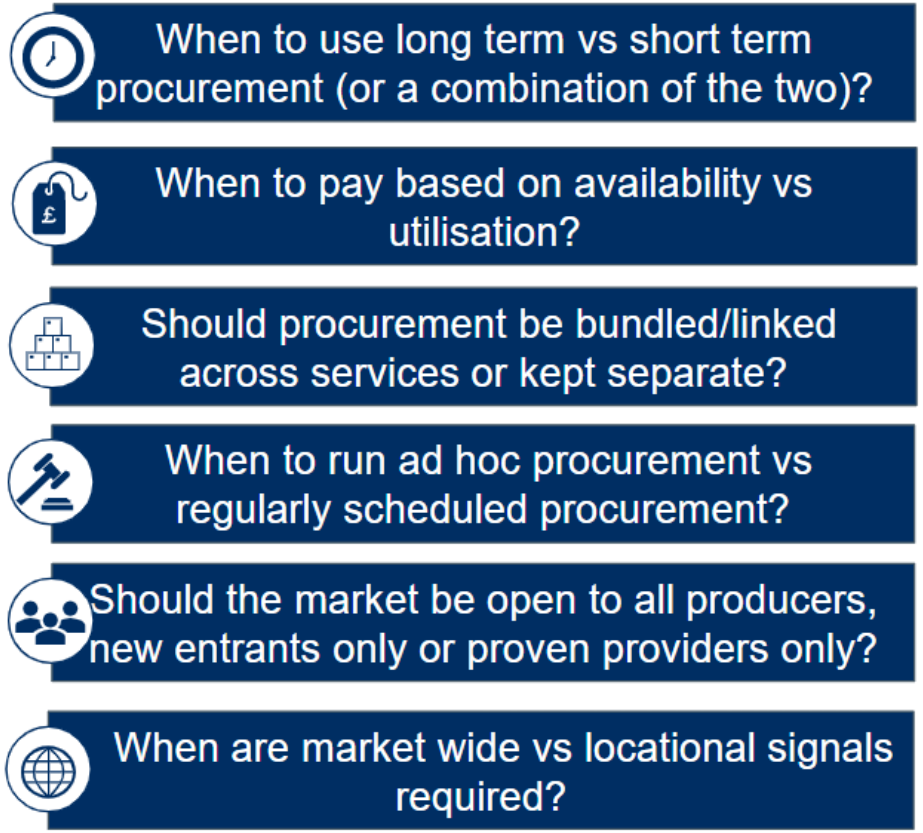
Metric	Definition	Pros	Cons
The variability in prices for providers of the relevant services	*Analysis of the variance and covariances of the relevant market clearing and bid prices in the relevant markets to assess uncertainty*	• A practical and quantitative metric	• Applying to new market design requires power market modelling • Does not measure the RCR directly and interpretation is subjective
An assessment of the predictability of costs for providers	*Analyse the variance of the relevant costs for providers uncertainty*	• As above	• As above • Requires an understanding of providers' costs
An assessment of the risk that ESO discontinues procurement and exposes providers to stranded asset costs	*Reasoned assessment based on the forecasting certainty, and internal view on whether the design is enduring or temporary.*	• Recognises future ongoing risks	• Difficult to assess quantitatively and prone to subjectivity and/or optimism bias
The proportion of requirements met via the BM vs. existing BS markets	*An analysis of the proportion of requirements being met via the BM vs other services over time*	• A practical and quantitative metric	• Static analysis that may not reveal future trends or scenarios
By how much has the capacity available to provide this service increased since the introduction of the service?	*An analysis of both the absolute and relative increase in capacity to provide this service based on bid data*	• Gives an indication that the market is investible should there have been a large increase in capacity since the service began	• May not be very revealing if the service has only recently been introduced
A quantification of the variability in revenues for the services provided	*An analysis of the variance of revenues across time to providers*	• A practical and quantitative metric	• Applying to new market design requires power market modelling • Does not measure the RCR directly and interpretation is subjective
Estimated risk capital requirement for different providers	*RCR is the minimum capital providers would have to hold to withstand the different risks they are exposed to*	• If modelled correctly provides a quantitative estimate of the relative risks of operating in a service	• Requires a model and is data intensive

Screenshots of ESO Framework User Guide

The Market Design Principles - Approach

Based on what the ESO is trying to achieve, the market design will never perfectly follow the MDF. So trade-off's are considered.

We have identify six important trade-offs ESO has to navigate in designing markets



Trade-off's from ESO/NERA's MDF 2022

Reviewing each of the markets on the same basis is difficult, as each market design is also based on a number of 'trade-offs'. This means that every market assessment is slightly different.

These trade offs are based on:

- the system need,
- Investability (or how investable the market is),
- dispatch profile,
- Stackability (can the contract be stacked with other contracts?),
- Locational need.

Essentially, a market will never meet the a rigid MDF perfectly – and this explains why some market RAG ratings may seem inconsistent.

Summary RAG assessment - Results

The ESO's markets are generally well aligned with the framework, but are areas for focus and improvement.

The table provides a summary of our RAG assessment for the MDF across all balancing services against the MDPs.

		Competition	Coherence	Transparency	Investability	Locational Signals	Net Consumer Benefits	Practicality*	Adaptability
Response	Dynamic Products	P					P		P
	FFR	P					P		P
Reserve	STOR	P					P		P
	Quick and Slow	P					P		P
Balancing Mechanism		P		P			P		
Thermal		P			P	P			
Voltage		P			P	P			
Stability		P			P				P
Restoration		P	P				P		

Key: RAG assesment of each product. 'P' denotes priority MDP

*The practicality principle hinges on the ESO's internal processes, practices and infrastructure, and therefore, LCP Delta has not assessed this principle.

Competition - Approach

Competition was a priority area, and we assessed the concentration of the markets using HHI.

The ESO has agreed with Ofgem that a threshold of greater than 1500 moderately concentrated and greater than 1800 a concentrated market.

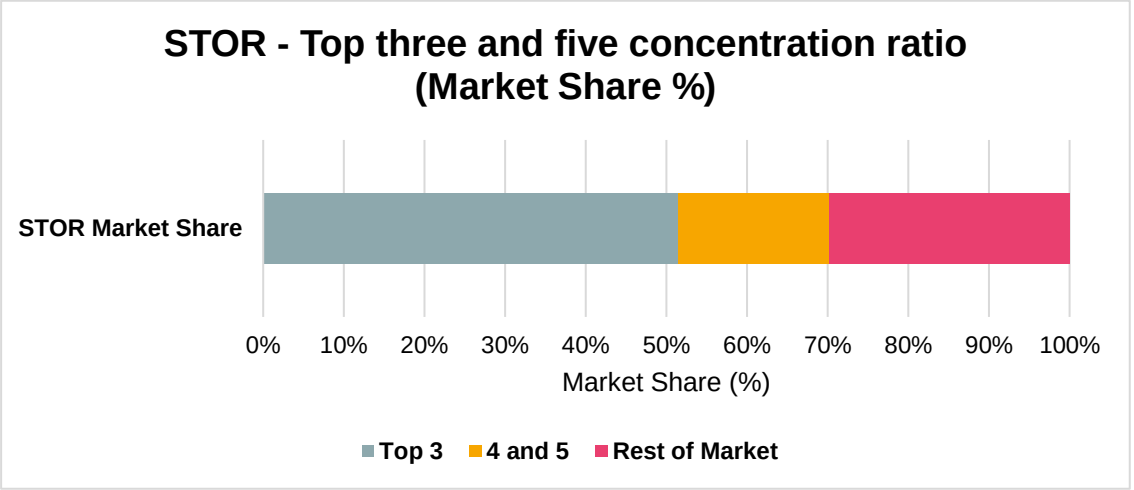
This is a commonly accepted threshold, however, LCP Delta has provided additional commentary and notes to help understand the underlying market dynamics

HHI	Screening Threshold agreed with Ofgem	LCP notes
0-1000	Not Concentrated market	Not concentrated and a competitive market place exists.
1000-1500	Not Concentrated market	Not concentrated, but imperfect competition may exist, and may exceed moderately concentrated threshold in individual auctions. Market growth and mergers and acquisitions may cause concern.
1500-1800	Moderately concentrated market	Moderately concentrated, and imperfect competition likely exists particularly in individual auctions – where it may likely exceed 1800 threshold on occasion. Market growth and mergers and acquisitions will likely cause concern.
>1800	Highly concentrated market	A concentrated market that holds competitive concern. Individual auctions will fluctuate in HHI, however, it is likely that many significantly exceed this threshold. Action should be taken. Market growth and mergers and acquisitions will cause concern.

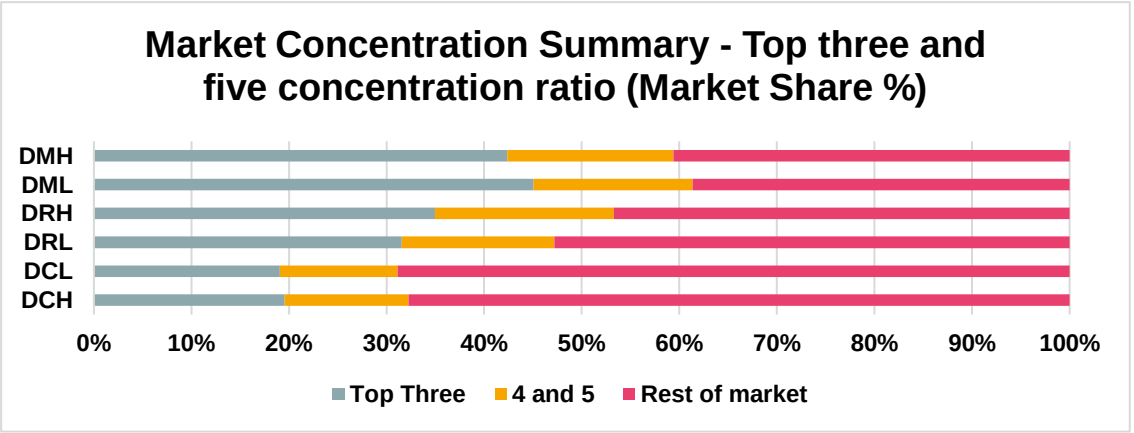
Summary of Market Concentration analysis

All ESO markets are not deemed to be concentrated, however, some are of concern and should be monitored regularly – showing signs of an oligopoly.

Balancing Services		Monthly Average HHI
Dynamic Containment	High	430
	Low	455
Dynamic Regulation	High	861
	Low	750
Dynamic Moderation	High	978
	Low	1095
STOR		1171



- All of the ESO's energy balancing markets are below 1500 HHI, and therefore, not concentrated.
- STOR and DM-Low does exhibit an HHI greater than 1000 (averaged across the year). This represents concerns of individual auctions across the year exceeding 1500.
- Using top three and five company concentration ratio, STOR, and DM has signs of an oligopoly.



Wholesale Market Assessment

The ESO requested a particular review of interactions with the wholesale market, and we identified three key overarching interactions

An impact on the wholesale market is unavoidable, but the ESO is developing good mitigations in its market design to limit any risk

As part of the coherency principle, we assessed the ESO's balancing services against its impact on the wholesale market.

We found that there is a real risk regarding the impact that the ESO's balancing services has on the GB power wholesale market, particularly from energy products. This is not a new risk and it is driven by the competition for the same energy volumes. However, the ESO has developed adequate mitigations to limit this impact.

Supply competition

- Competition between the balancing services and the wholesale market for the same volume can impact on the supply curve of the different markets, impacting on price.

Inefficient dispatch

- Day-ahead trading session is becoming more crowded and risking inefficient dispatch

System service payments supporting competitive pricing in the energy markets

- This impact is very limited, but the payment from a system service could act to support the bidding of a unit and impact on a natural merit order. Similar to the Capacity Market.

Summary - Key Takeaways

- **Most products are partially aligned with the competition principle - despite this being a priority focus for all products.** The ESO should ensure that enhancing competition (often through increasing participation) is considered further. This would ensure net-consumer benefit is maximised.

- **Through HHI and top three and five company ratio analysis the concentration of the ESO's markets suggest a competitive market place is exhibited.** However, for STOR and Dynamic Moderation, the ESO should continue to monitor its liquidity - as they show signs of imperfect competition, particularly on an individual auction basis.

- **The system services (particularly Pathfinders) show good signs of incentivising investment.** This is required for new technologies meeting system needs, as they aren't necessarily valued elsewhere (eg. the CM). Energy balancing services provide 'investability' through providing dependable short-term revenue streams that make up a blend of a providers revenues to make a viable business case. The ESO should focus on maintaining good transparency to market participants and consistent procurement that meets participants expectations.

- **The BM is least well aligned with the framework.** The BM is an imperfect marketplace, but it is a vital mechanism for managing the system. We do not propose fundamental reform, rather, the ESO should continue its reform of balancing services as per the Markets Roadmap to minimise the need for the BM to address system needs. In the interim, ESO should focus on increasing participation and competition.

- **We find clear signs of wholesale market interaction with energy balancing services as they compete for the same supply - times of significant opportunity cost leads to market exits.** Also, less of the Dynamic Response services bidding behaviour is generally linked to wholesale power market (price and spread) - and we pick up on other drivers.

- **There's a risk of inefficient unit dispatch from an increasingly congested and complicated Day-ahead trading session.** In favour of sequential auctions (multiple auctions for individual services), the ESO is looking to implement co-optimised auctions which would ease this congestion and should decrease the risk of inefficient dispatch.

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Enduring Auction Capability

Markets Roadmap 2023– 25/04/23

ESO

Enduring Auction Capability (EAC)

The current design for Response services has highlighted several challenges...

- Providers blind guess where other parties will tender – risk of oversupplying a single market when other markets are left empty
- Limited ability to split capacity and stack revenues across different services
- Limited options available to market participants (e.g., maximum of three orders per unit per delivery period, with only one child allowed for each parent order)

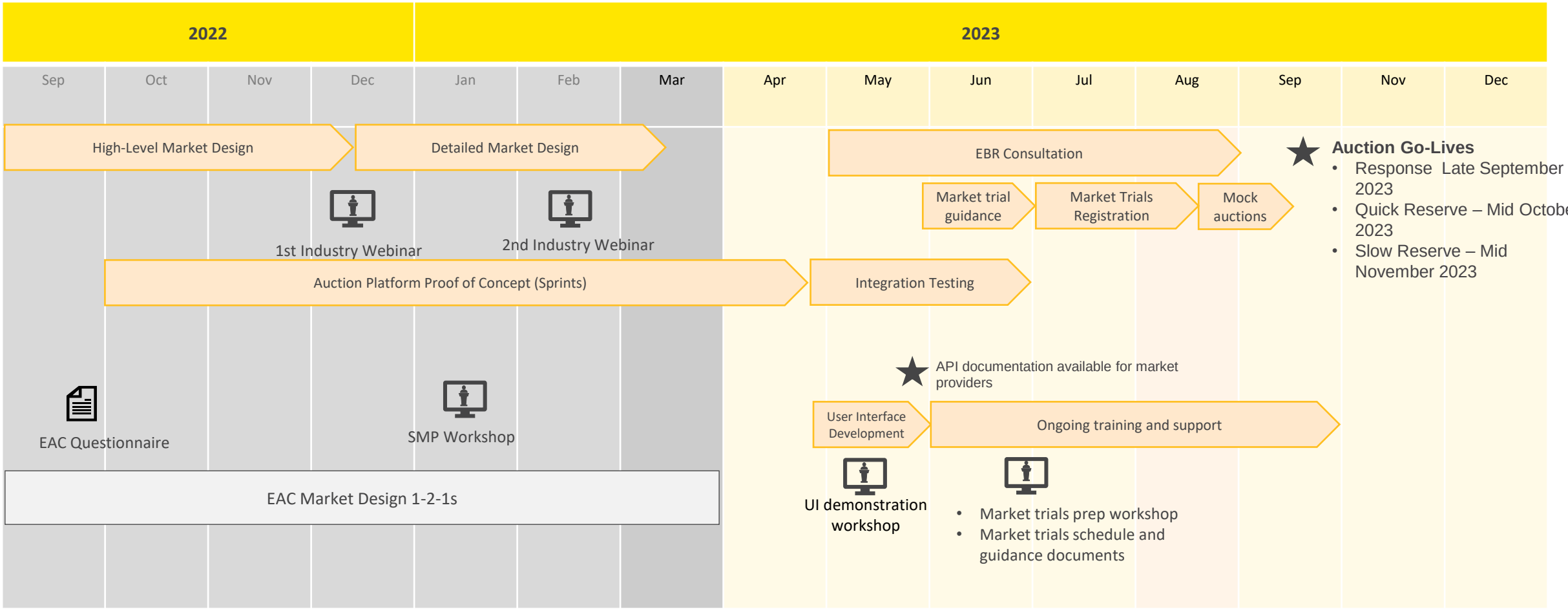
Enduring Auction Capability

The EAC will deliver **co-optimised procurement of day-ahead Response and Reserve services**, which would be **scalable** and **extendable** to new services and products

Benefits of the EAC

- Better user experience from fewer manual processes and utilisation of technology to facilitate bidding
- Closer to real-time procurement leading to increased market liquidity and participation
- Easy access across multiple markets from connected and co-optimised auctions for ancillary services
- Improved levels of flexibility and configurability to adapt to changes in service procurement

EAC Delivery Roadmap



Q&A

Please put any questions you have in the Q&A function and we'll do our best to answer them

Thanks for attending

- Please give us feedback on today's webinar and on the ESO 2023 Markets Roadmap by completing a quick survey – Scan the QR code or click the LINK in the chat.
- If you have any questions or would like to talk to us, please contact us: box.market.dev@nationalgrideso.com

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