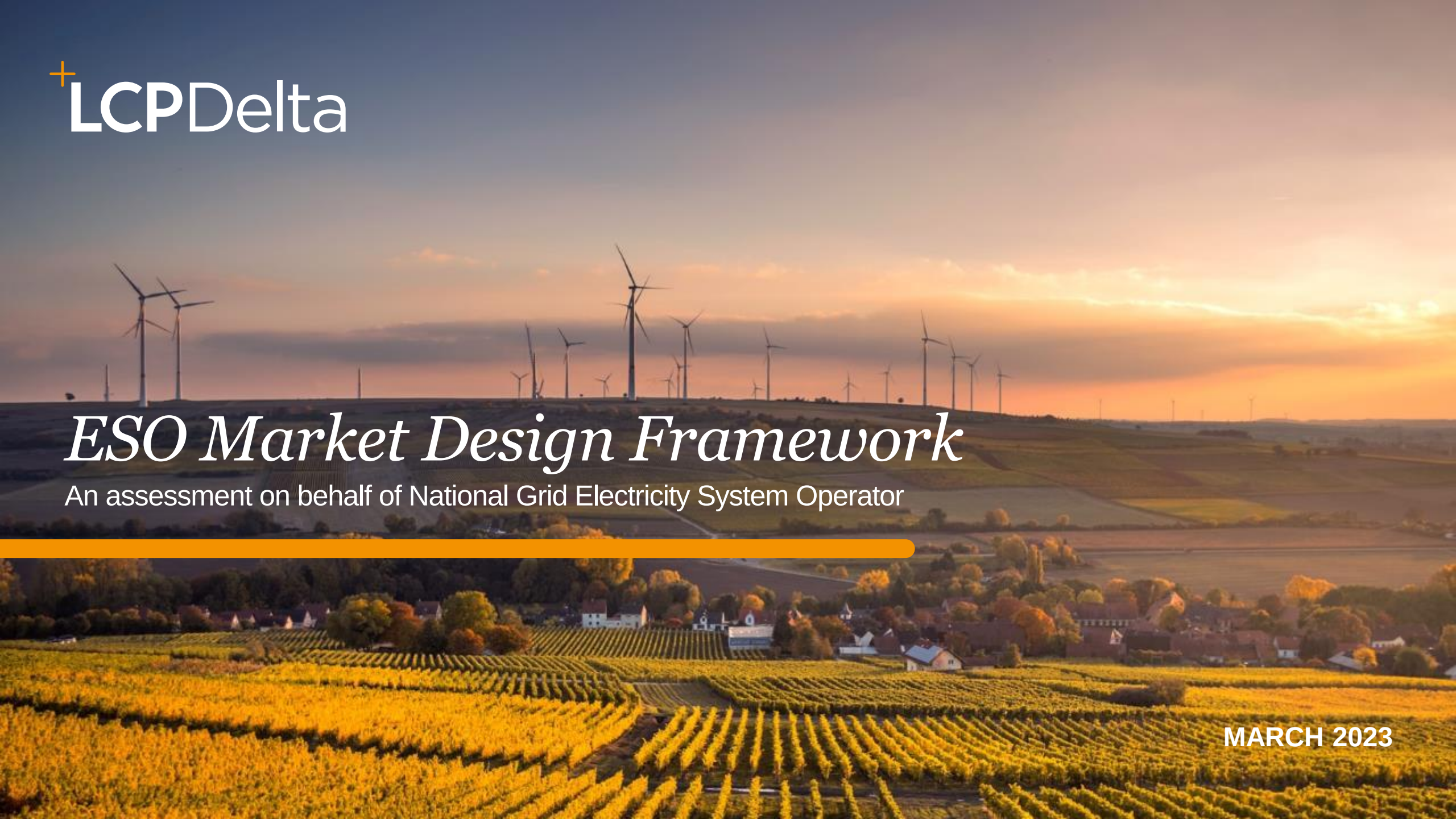


LCPDelta

ESO Market Design Framework

An assessment on behalf of National Grid Electricity System Operator

MARCH 2023

Contents

Introduction and Approach 03

Summary Results 08

Assessment of Developed Markets 17

Response 21

Dynamic Response Products 23
Assessing the Market Design Principles 37

Firm Frequency Response 45
Assessing the Market Design Principles 51

Reserve 56

Short Term Operating Reserve 60
Assessing the Market Design Principles 65

Quick and Slow Reserve 73
Assessing the Market Design Principles 79

Balancing Reserve 86

Assessment of Developing Markets & BM 89
Balancing Mechanism 91
Thermal Constraints 98
Voltage 102
Stability 106
Restoration 110

Wholesale Market Impact Assessment 114
Energy Balancing Services 117
System Services 125

Annex 127
LCP Delta and the Project Team 128
NG ESO – Market Design Framework metrics library 131

Introduction and Approach

Introduction

An independent assessment of the Market Design Framework

- **National Grid Electricity System Operator (ESO) published its annual Markets Roadmap which covered how the ESO plans to reform its Balancing Services Markets. These reforms are required to be in line with the Market Design Framework (the "framework").**
- The framework sets out Market Design Objectives (the "objectives"), and within these objectives also identifies the Market Design Principles (the "principles") that the ESO should consider when designing and maintaining its market framework.
- LCP Delta was commissioned by the ESO to undertake an independent review into how well aligned decisions and market developments have followed the framework.
- Where markets are being developed, the assessment considered whether the approach taken by ESO in establishing these markets is in line with the principles.
- Conversely, where markets are mature, the assessment considered whether the way the market operates, and the market developments are in line with the framework and if any changes should be prioritised.
- The ESO have defined a set of objectives (Efficient Dispatch, Efficient Investment, Value for Money) that reflect what outcomes they expect from market procurement and to make market design decisions that are "robust, well-evidenced, and justifiable".
- The ESO expects that this framework will enable the assessment of the effectiveness of current market design considerations, and identify where they can be improved.
- Within this report, LCP Delta provides an assessment of the main products within the suite of ESO ancillary services through the lens of the established principles.

Explainer:

- *Market Design Objectives reflect what outcomes ESO expect from market procurement.*
- *Market Design Principles break down the objectives into testable concepts that are mutually exclusive and collectively exhaustive.*

Overarching Approach

Using the Market Development Framework to assess products

- **Using the ESO's internal guidance framework, LCP Delta reviewed each product against the individual principles.**

- This framework was developed to support ESO in thinking about market design by providing a consistent framework for developing procurement methods across its markets and forms the basis of this assessment.

- LCP Delta used a RAG rating to assess how aligned product development is to the framework, whether decisions taken have been suitable, and, for mature products, whether these meet the principles.

- We utilised ESOs internal Market Design Framework User-Guide in the assessment to review each product against the principles. This User-Guide set out suggested metrics that provided a 'long-list' of questions to guide the user to appropriately assess and apply the framework. These have been used by LCP Delta in its assessment and are provided in the annex.

- We provided a RAG rating for each market principle based on:
  - The alignment of the market product with the principle; and
  - Whether the developed approach is justified
  - What should be priority principles within framework

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

- **LCP Delta reviewed the markets that have already been implemented, as well as those in development**

- Where products are in development, we assessed the emerging approach determining whether it aligns with the principles
  - A policy-based assessment will consider information available on Pathfinder projects, tender results and developments as appropriate.
  - Products in development are: Stability, Voltage, Thermal, Reserve (Quick and Slow), and Restoration.

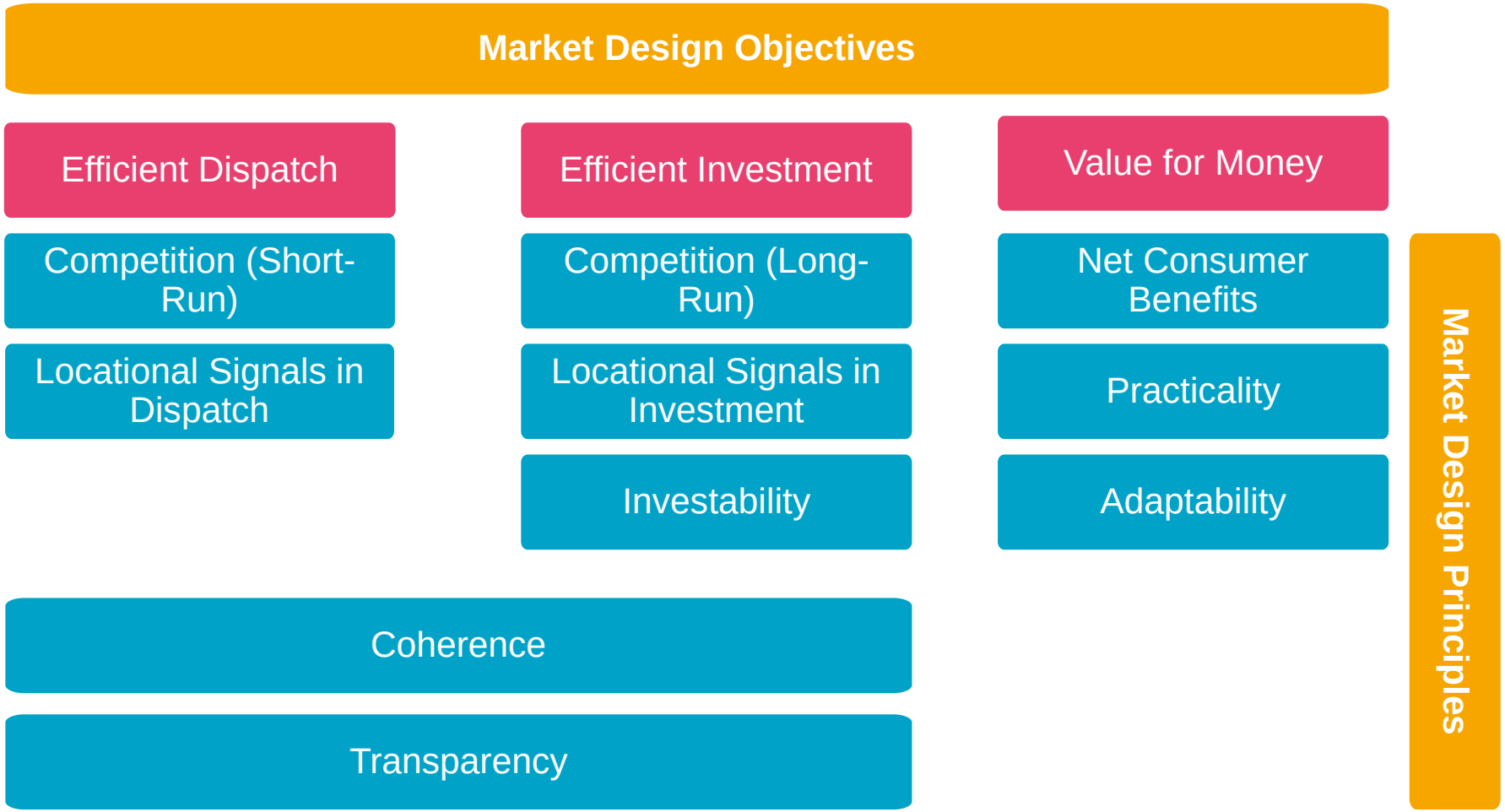
- Where markets are more developed, we provided a data-based assessment on how these markets align to the principles
  - We reviewed these markets for their pricing on an average basis over a month, and assessed them against the wholesale market. We analysed their fuel mix, excess volume, and market concentration. We employed backward-looking quantitative analysis to inform our qualitative analysis where appropriate.
  - Products in operation: Dynamic Containment, Dynamic Moderation, Dynamic Regulation, Reserve (STOR) and Frequency Response.

- The BM has a number of imperfections in its market design that is necessary for its operation. For example, the BM draws on a pool of providers to supply a number of differing products, of which the provider does not know what it is providing these for ahead of time; this will impact market price discovery. Given this, we applied the framework as appropriate, and focus on market developments rather than performance.

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

The Market Design Framework

National Grid ESO's Market Design Framework provides the basis of this assessment



The Market Design Principles

Using the principles from 'The Market Design Framework'

The table (ESO Markets Roadmap March 2022) provides a description of the principles.

For the purpose of this assessment, we have streamlined our review into the principles as shown to the right.

We did not provide an assessment on Practicality as this hinges on ESO's internal processes, practices and infrastructure, of which LCP Delta is not in a position to assess.

Principle	Description
Competition	The procurement method creates a market in which multiple current or potential participants seek to offer better terms (prices and quantities) than those offered by other participants, which is open to all providers technically capable of providing the service. That is, the market does not discriminate between technologies or providers. ▪ Short-run competition considers only existing assets. ▪ Long-run competition considers the assets expected to exist in future, given expected new build and retirement decisions.
Coherence	Across all of ESO's markets, the procurement methods enable market participants to make decisions about where to bid, which are efficient for both the market participants and the system. The procurement decisions are aligned with the evolution of government policy and other markets.
Transparency	Information is provided to market participants and procurement decisions are made in a clear and predictable way to minimise information asymmetries and uncertainty around ESO's decision making.
Investability	The procurement method provides investment signals which market participants and investors can respond to and rely on.
Locational Signals	The procurement method ensures that capacity is constructed and that services are procured in the right places.
Net Consumer Benefits	The costs to consumers do not outweigh the benefits conferred by the procurement method.
Adaptability	The procurement method is flexible to changes in balancing service requirements and the technology mix.
Practicality	The procurement method is practical to implement, transition to and operate. [Note: The practicality principle hinges on the ESO's internal processes, practices and infrastructure, and therefore, LCP Delta has not assessed this principle.]

Description of principles taken from: NG ESO Market Design Framework user-Guide, unpublished

Summary Results

Summary RAG Assessments
Summary of Market Concentration analysis
Product Assessment Summary
Summary of Wholesale Market Assessment

Summary RAG assessment

Competition is a key priority for all markets, but not always aligned with the framework

- **The table provides a summary of the RAG assessment for balancing services against the principles. Key conclusions are:**
  - Most products are partially aligned with the competition principles - despite this being a priority focus for all products. The ESO should ensure that enhancing competition (often through increasing participation) is considered further.
  - Most products have are well aligned with the adaptability principle and are flexible to changes in balancing service requirements and technology mix. This is reassuring given the energy transition.
  - We found that the BM is least well aligned with the framework. As discussed earlier, even though the BM is an imperfect marketplace, 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.
  - We find all principles are aligned in Voltage and Quick & Slow Reserve.

		Competition	Coherence	Tranparency	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.

Summary of Market Concentration analysis

Whilst markets are not currently deemed to be concentrated, they should continue to be monitored regularly and in light of any significant market developments

- **None of the ESO's markets are deemed to be concentrated according to analysis using the Herfindahl-Hirschman Index (HHI)*. However, this does not fully describe the risk to the ESO of individual auctions being concentrated or risk to competition through market growth and mergers and acquisitions. Therefore, we recommend the ESO continues to monitor the markets, especially DM-Low and STOR.**

- The table provides a summary of HHI results across Dynamic Response products and STOR services. We utilised both the ESO data and LCP Delta's Enact platforms analytics, which has allowed us to analyse what overarching owners market share is. This may result in some inconsistencies between the ESO data and the findings in this report.

- The ESO's new markets utilise new types of technologies – particularly battery storage. This market is a particular growth sector at present, where we are observing a good number of investments being made in both the primary (i.e. new build) and secondary (i.e. mergers and acquisitions) markets. This does seemingly increase the risk of a market becoming concentrated, and therefore there is a higher need to contextualise the HHI results of the market. Top three (CR3) and five firm (CR5) concentration ratios have been used here to better explain the market.

- Although below the 1500 HHI threshold agreed with Ofgem, the ESO should monitor DM-Low and STOR carefully for individual excursions into concentrated markets. Although a lot of this for DM-Low can be explained by the immaturity of the market, STOR should be considered in the context of the read across to reserve reform markets (particularly Slow reserve).

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

*The Herfindahl-Hirschman Index (HHI) is a metric used to measure the concentration of a market and deem its competitiveness. It is used across power markets and in wider market analysis.

Product Assessment Summary

Dynamic Response Product Suite

- **ESO has a licence obligation to control system frequency at 50Hz plus or minus 1% with different dynamic response products to meet that requirement.**
- The dynamic frequency response markets continue to mature and develop following phased implementation over the last couple of years. The ESO seeks to further their application, gradually taking over from existing response services. Dynamic Containment (DC), launched in October 2020, is the most liquid and mature market exhibiting good levels of competition which has driven down its price. Despite being newer products, Dynamic Moderation (DM) and Dynamic Regulation (DR) also have an unconcentrated market which is showing good signs of development.
- The services have not attracted any assets other than batteries to participate in the dynamic services. The ESO should ensure that there are no market barriers to other technologies that could provide the system need, as the more diverse fuel mixes can increase competition and therefore more market reflective pricing.

Priority	Assessment rational
Competition	There is a significant lack of diversity of fuel mix in the dynamic products - solely batteries. The ESO should review as to whether any of its technical requirements unnecessarily preclude other technologies capable of meeting the system need.
Net Consumer Benefits	Net-consumer benefit would be improved if the ESO focussed on increasing market depth and competition.
Adaptability	The dynamic products are all procured at day-ahead stage and split into six EFA blocks for committed delivery making them highly adaptable.

Firm Frequency Response (FFR)

- **Demand / Supply imbalances can cause large deviations in system frequency. FFR uses pre-approved assets to rapidly reduce demand or increase generation to keep frequency of the system within prescribed limits.**
- With Dynamic FFR due to be phased out over the coming financial year, we have reviewed only Static FFR in detail.
- The daily Static FFR procurement is highly adaptable, with delivery windows within-day and pricing set on a pay-as-clear basis in a day-ahead auction. These developments will increase participation in Static FFR as new technologies, particularly Demand Embedded Resources (DER), are attracted to the ability to optimise at day-ahead stage. This will also enable optimisation across ESO's day-ahead auctions and the wholesale market – likely increasing participation across the markets and possibly reducing total ESO expenditure if all markets have good liquidity. With Static FFR expected to be phased out in due course, the ESO would do well to ensure good transparency is provided of the future of the service.

Priority	Assessment rational
Competition	The changes that have been made to the Static FFR procurement framework, and indicative mock results, means that the market may enable the participation of new, non-conventional assets such as interconnectors.
Net Consumer Benefit	Moving to day-ahead procurement has opened the possibility for a service provider to co-optimise across all response markets.
Adaptability	The day-ahead procurement and EFA block commitment window enables the ESO to vary its requirement on a daily basis and throughout the day

Product Assessment Summary

Short Term Operating Reserve (STOR)

- **The ESO procures sources of extra power ahead of time through the STOR service to help manage actual demand on the system being greater than forecast or unforeseen generation unavailability.**
- Despite expectations that STOR would be phased out due to the ESO's issues with operating it at net zero, it has proven to be a resilient balancing service.
- Although a significant portion of the market is held by the top three and five asset owners, we found that STOR is not a centralised market – but we note signs of imperfect competition existing. As this product is phased out, the ESO should prioritise competition and net consumer benefit to ensure that a fair price is paid and no market power is exhibited as the risk of assets exiting the market increases.

Priority	Assessment rational
Competition	The market is moderately concentrated which could provide an opportunity for market power to be exercised and inflate costs outside of a rational market when the requirement increases. The market also has a limited fuel mix.
Net Consumer Benefits	The cost of the ESO not holding a STOR product is significant, as one of the last interventions it can make to maintain security of supply in the event of pre- and post-fault incidents. Net-consumer benefit could be improved by improving market depth and seeking to reduce market concentration from the three largest providers.
Adaptability	STOR auctions run on a daily basis with two windows: one over the morning and the other over the evening peak. This allows for a flexible and adaptable market procurement approach.

Quick/Slow Reserve

- **Quick and Slow Reserve are the ESO's long-term enduring solution to meet the reserve need for the system. Over time, these two products will replace STOR and Optional Fast Reserve.**
- We have found that the design principles of Quick and Slow Reserve are well aligned to the framework, however, it will be easier to assess once active. The Quick and Slow Reserve products are well designed to enable high levels of participation while achieving the base requirement far enough ahead of real time for ESO control room planning. This should ensure a deep pool of providers that will promote competition and lead to positive net consumer benefits.
- We believe that new products must be highly adaptable, to allow for adjustments to be made once implemented, and the ESO should focus on ensuring that as much competition is possible to keep prices low and ensure net-consumer benefit is high.

Priority	Assessment rational
Competition	We have identified a significant and growing capacity capable of providing both Quick and Slow reserve
Net Consumer Benefits	The cost of not reforming could bring about very real risk to security of supply in the future. As zero cost generation increase in system penetration it is important that the ESO has tools ready to manage the system.
Adaptability	The ESO also has the option of not procuring windows, and also opting to not procure firm reserve over windows where the requirement is low. This means that an availability fee is not provided and only a utilisation fee is paid out in the event of dispatch

Product Assessment Summary

Balancing Mechanism

- **The Balancing Mechanism (BM) is the ESO's primary tool to balance supply and demand, manage constraints, ensure system stability and maintain real-time security of supply.**
- The BM is an unusual marketplace. The ESO uses the BM to procure multiple services; implicitly stacking energy products with system services (i.e. for thermal congestion as well as energy balancing). It therefore does not procure a single homogenous product from the market (which is inconsistent with economic theory of an efficient marketplace).
- As a heterogenous product, it is not designed to give forward signals to market participants to price their supply ahead of time. Therefore, to ensure as effective a market place as possible within these limitations, the ESO should focus on encouraging as much competition as possible by enabling greater levels of participation and transparency. This provides more reflective price formation of the cost of a service and improved net consumer outcome.

Priority	Assessment rational
Competition	Despite the ESO's attempts to encourage market participation, large gas-fired generation continues to be the dominant provider in the BM.
Net Consumer Benefits	Costs to balance the GB power system rose to £1.5 billion between November 2021 and February 2022
Transparency	The BM is typically transparent on an operational basis. However, the ESO should prioritise providing suitable levels of transparency to enable greater participation and competition.

Thermal constraints

- **The ESO is required to take action if there is a risk of exceeding the physical limit of power which can be transmitted through equipment in order to avoid overload or overheating.**
- The BM is the primary market the ESO has to manage thermal constraints. For the reasons given earlier, the BM is limited in sending clear useful signals for thermal constraints. To mitigate this, the ESO is developing market solutions including Constraint Management Intertrip Scheme (CMIS); the Local Constraint Markets (LCM) and MW Dispatch Service.
- The tenders for CMIS showed a relatively illiquid market. The ESO should identify any entry barriers, or explore why many that expressed interest did not tender so as to maximise competition in future.
- When designing MW Dispatch Service, the ESO should ensure that the infrastructure required is not overly-costly or burdensome to install; this would otherwise reduce participation.

Priority	Assessment rational
Competition	There have been two tenders for the B6 Pathfinder with little apparent competition despite expressions of interest. The ESO should explore whether capability rules were appropriately applied. The MW dispatch service has specific requirements that will necessarily limit access and this should continue to be considered as whether appropriate by the ESO. LCM provides a route to market for non-BM Units which is positive.
Investability	There is significant spread in the service cost of the contracts awarded and considerable variation within the B6 tenders. Whilst the value / price of service remains unclear, this may cause investment challenges
Locational Signals	Products are for a local solution. The ESO continues to consider providing other market signals to alleviate constraints.

Product Assessment Summary

Voltage

- **To keep voltage stable, the ESO can increase it by injecting reactive power and decrease it through absorption of reactive power.**
- The ESO are carrying out long-term reforms under the 'Reactive Reform - Market Design' programme to enable more participants across different technologies and connection types to provide reactive power in the right locations. This assessment also considered some of the interim arrangements made, for example the Merseyside and Pennines Pathfinders.
- Proposals recommended under the Reactive Market Design Reform are well aligned with the framework. The ESO's minded-to position is to create three markets across different time periods (longer-term, mid-term, and day-ahead) that will promote investment and encourage competition. As assets in one region are less effective at meeting the need in a different region, the ESO is minded to establish nodal markets to provide locational signals.
- Regarding the two Pathfinders; competition was adequate in both auctions (stronger in Merseyside). However, investment signals may have been affected by changes in contracts post tender within Merseyside Pathfinder.

Priority	Assessment rational
Competition	Recommendations in the Reactive Reform Market Design focus on including all possible assets to promote competition and avoid market power. Interim arrangements to 2026 have not (yet) provided detail to assess if sufficiently competitive and at what cost.
Investability	Long and short term markets are to be established which provides multi-year contracts for those that require additional investment and certainty within the Reactive Market Design. However, investment signals may have been affected by changing contractual terms.
Locational Signals	Nodal markets are to be established that provides market information and signals to service providers.

Stability

- **To keep the power system stable, the ESO needs to maintain sufficient amounts of inertia, Short Circuit Level (SCL) and dynamic voltage support.**
- As the power system transitions, the need for more stability products from non-traditional sources will be required. The ESO is preparing reforms through the Stability Market Design project to assess eligibility rules, contracts and procurement approach. To date, the ESO has completed three long-term pathfinders.
- Introducing competition into these markets is key, the first Pathfinder attracted bidders for stability from rotating stabilisers, synchronous condensers, re-purposed thermal generators and pumped storage. For the second and third pathfinders, the ESO was expecting a wider range of technologies to take part. According to the results of the two tenders, these additional technology providers have not materialised outside of battery storage. The ESO should assess potential technology providers and ensure that there are not barriers to entry that prevent assets from tendering.

Priority	Assessment rational
Adaptability	The core recommendation of the Stability Market Design innovation project is to develop a combination of a dedicated short-term market (day-ahead) with a long-term market
Competition	Limited range of technologies have come through the pathfinder despite a stated objective by the ESO following the first Pathfinder to increase the diversity of assets and promote innovation.
Investability	The ESO is proposing to procure stability services with a dedicated market across several timescales with an initial focus on procuring inertia services.

Product Assessment Summary

Restoration

- **Restoration is the process used to restore power in the event of a total or partial shutdown of the national electricity transmission system**.
- The historic approach to restoration relies on transmission connected thermal generation. The Distributed ReStart project explored how distributed energy resources can restore power through a competitive tender process. These learnings have now been incorporated into BAU following two regional tenders to date and with additional regional tenders to follow.
- The ESO (Market Roadmap, March 2022) expects to see an overall increase in Restoration services costs going forwards compared to the existing framework. This has been mitigated to some extent with a more competitive tender process, pay-as-bid mechanisms, and more potential providers.
- Gas based technologies are still applying in both the SE and Northern Tender but there is a healthy number of other DER technologies competing.

principle	Assessment rational
Competition	Gas based technologies are still applying in the SE and Northern Tender but there is healthy numbers of other DER technologies to compete with
Coherence	Bringing in learnings from the Distributed ReStart project has been necessary in response to the energy transition and increasing intermittent and local sources of generation.
Net Consumer Benefits	Annual costs are due to increase in the baseline scenario, so a cost-effective solution is required, especially given the nature of power outage services as a public good insurance product in the event of a need for a system restart. It is anticipated to save at least £115M through increased competition by 2050

Summary - Wholesale Market Assessment

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.

- Following our assessment, we have the following three conclusions:

- **(1) Balancing services compete for volume in the wholesale market**
  - The day-ahead energy auctions and balancing services compete for the same supply, which will likely impact on the price outcomes of the different auctions as the supply profile and additional risk premia are considered.
  - In recent years, asset owners have started using the ESO markets – particularly the Balancing Mechanism (BM) – to access scarcity and achieve higher revenues than what could be offered in the wholesale markets.
  - The UK Government, Ofgem and the ESO has taken steps to try and address these issues. We particularly note the recently rejected the ESO proposal to implement the Balancing Reserve product which would have removed the need for the ESO to maintain regulating reserve through the BM.

- **(2) Day-ahead trading session is becoming crowded, which poses a risk to efficient dispatch**
  - Auction timings taking place so closely together poses risks based on how they influence and correlate with one another's price. Overarching risks from the sequencing of auctions exist particularly in the form of market fragmentation; where different prices (and values for energy) may emerge in different auctions based on sub-optimal information.
  - Conversely, auctions that occur at similar timeframes may experience price convergence or correlation where a preceding auction directly impacts bidding behaviour in a subsequent auction.
  - The ESO's proposals to proceed with the Enduring Auction Capability (EAC) for new products, and apply a co-optimised procurement approach in favour of sequential auctions is a positive step. This should mitigate risks through increasing simplicity in the trading day.

- **(3) System services interaction with the wholesale power market is limited, but could influence supported units bidding behaviour.**
  - System services do not compete with energy markets (such as the wholesale market) for the same supply. Rather, system services are delivered by providers as either a by-product of producing or consuming active energy, or they do not produce or consume active energy to deliver the system requirement (such as flywheels or synchronous condensers).
  - Stacking system service revenue streams with energy contracts is generally permissible. For assets that can be paid for system services and commercially selling energy, the additional system service revenue stream would support their participation (financially) in energy markets. In some scenarios (especially if a unit is in receipt of CM payments too), less efficient units could displace more efficient units in the merit order.

LCPDelta

Assessment of Developed Markets

Response (Dynamic Response Products and FFR)
Reserve Markets (STOR and Quick & Slow)

Assessment approach to developed markets

We have performed a deep-dive analysis of the market performance to date on several markets, coupled with a policy assessment for other markets

- **We have performed thorough analysis on the historic market performance of the following markets to allow the ESO to identify priorities for its future market design:**
  - Dynamic Response products
    - Dynamic Containment;
    - Dynamic Regulation; and
    - Dynamic Moderation
  - Short Term Operating Reserve (STOR)
  - Static Firm Frequency Response (FFR)
- We reviewed these markets for their pricing on an average basis over a month, and assessed them against the wholesale market. We also analysed their fuel mix, excess capacity, as well as market concentration. We have employed backward looking quantitative analysis to inform our qualitative analysis where appropriate (until the end of January 2023).
- We carried out analysis on market concentration using the Herfindahl-Hirschman Index as per the Market Design Frameworks metrics library (annex). This is complemented with a top three (CR3) and five (CR5) company concentration ratio using LCP Delta's own analytical platforms (*further details on subsequent slides*). This provides information and context of the concentration, depth and liquidity of a market.
- These products were analysed more closely due to their:
  - Priority,
  - Available data, and
  - Expected continued procurement for the foreseeable and robust read across into new products (in the case of STOR and Slow reserve).
- We did not perform full detailed analysis of historic Static FFR results, as we expect the changes to the procurement framework could create material differences in the market make up and bidding behaviour. For example, moving to day-ahead procurement should further incentivise optimisation across FFR from non-conventional units, such as interconnectors and storage assets. Dynamic FFR has not been analysed in detail as it is due to be phased out by the end of financial year 2023/24

Assessment approach to developed markets

Assessing market concentration using the Herfindahl-Hirschman Index (HHI)

- **For market concentration, we have used the Herfindahl-Hirschman Index (HHI). This metric is recommended within the principle metric library, and is widely used across electricity markets to assess the competitiveness of the market.**

- We understand that the ESO has agreed with Ofgem that it should consider:
  - <1500 – not concentrated;
  - 1500-1800 – moderately concentrated; and
  - >1800 – highly concentrated

- We have taken an average approach across the time observed in each market in this report which could hide some circumstances of the market breaching 1500 or 1800 HHI on individual occasions. As a result, we have taken a blended approach to advising the ESO of market concentration with other market dynamics (see table on our assessment approach).

- We have complemented the HHI analysis with top three (CR3) and five firm (CR5) concentration ratios. This is not required in the framework, but helps to contextualise the HHI and understand whether <1500 is still of concern – particularly in the context of a merger or acquisition and risk of oligopoly. This approach will support our assessment to the risk to market competitiveness – particularly if an oligopoly (CR5 of >60%) is identified.

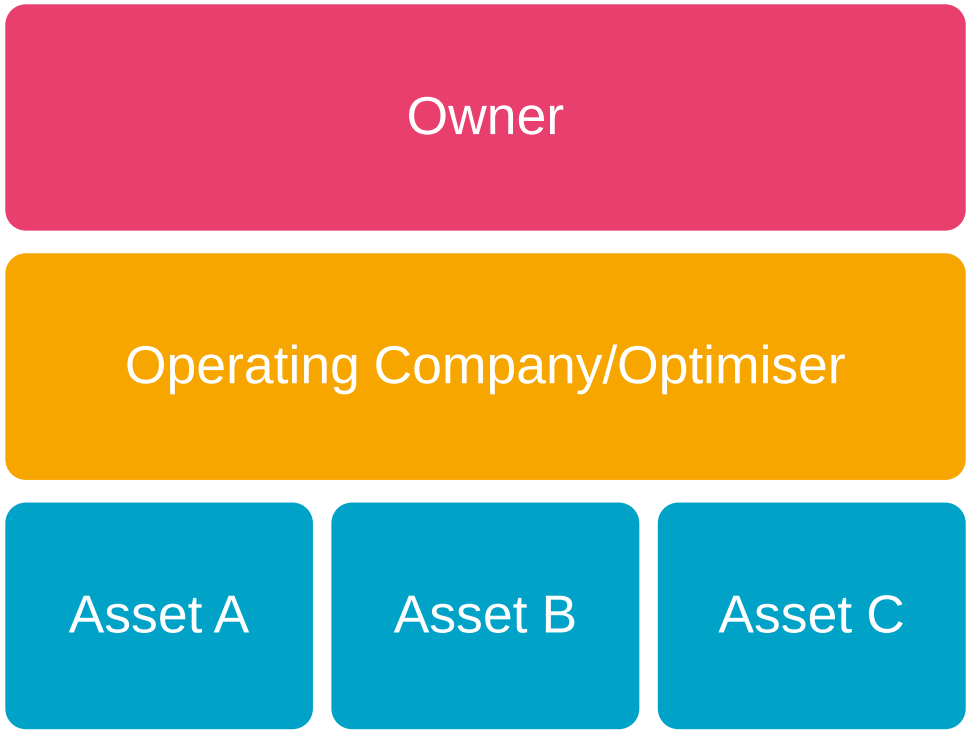
- NB - Some economists deem that a HHI >1000 demonstrates a moderately concentrated market as this makes the market susceptible to concentration through market exits or mergers and acquisitions. If the latter were to increase HHI by 200, this raises competitive concerns. Where markets are >1000 HHI, we note the need to monitor note this risk appropriately.

HHI	Screening Threshold	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.

Assessment approach to Developed Markets

Assessing market concentration

- **We have analysed the concentration, depth and liquidity of the balancing services by using LCP Delta's analytical platforms: Enact and StoreTrack. We have been able to consider the owners of each individual asset, and the concentration of the market.**
- By using LCP Delta data to review market concentration by owner, we are able to consider the make up of the market based on the company that actually owns the asset, and remove uncertainty around whether a company bidding into the markets (as seen by the ESO) actually owns the asset or is operating or optimising it on behalf of an asset owner.
- This will give a better understanding of holders of market share. However, a shortcoming of this approach is that there are varying levels of intervention in the optimisation of an asset based on the owner's appetite for involvement in the operations of the asset. The higher this involvement is, the higher chance there is for a larger market shareholder exercising market power, and vice versa.
- A limitation of this approach is that it does not consider the market power that an optimiser (acting on behalf of the owner) or a single asset could exhibit on the market.
- The results of this analysis are presented in the Summary Results section.



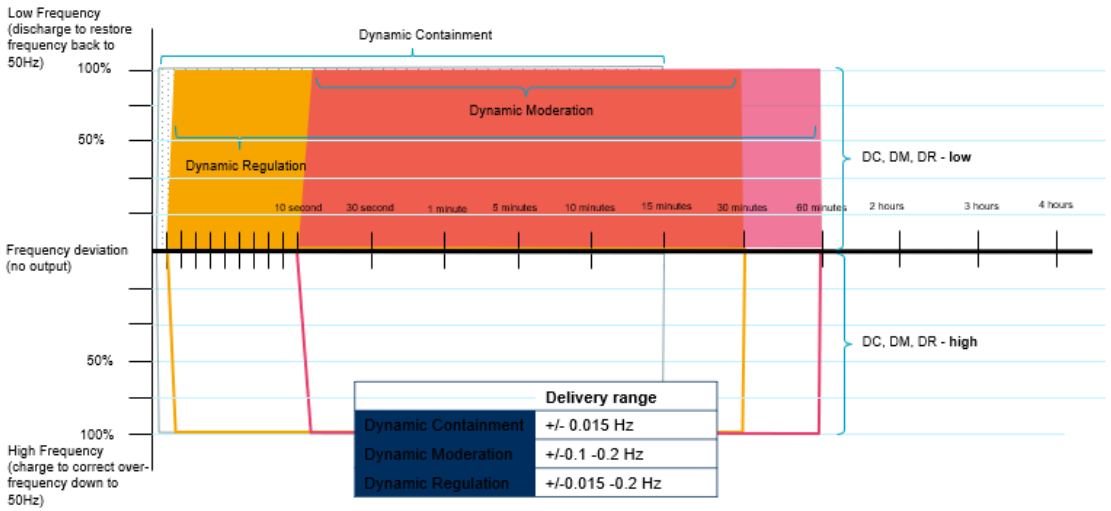
Response

Dynamic Response Products

Firm Frequency Response

Response

The way in which the ESO manages the frequency is changing



- **Frequency Response (or "Response") is a holding of electricity consumption or generation which operates over its committed windows to maintain the electricity systems frequency within operational and statutory limits.**
- There are five products for frequency response:
  - Mandatory Frequency Response (MFR) - procured within day, P/S/H;
  - Firm Frequency Response (Dynamic – P/S/H, and Static);
  - Dynamic Regulation (DR) - procured day-ahead, High/Low;
  - Dynamic Moderation (DM) - procured day-ahead, High/Low; and
  - Dynamic Containment (DC) - procured day-ahead, High/Low.
- DC procures the largest volume of response. It is used to prevent frequency deviations outside of -0.8HZ/+0.5Hz following a large loss in generation (typically DC-low) or demand (typically DC-high). Because of this requirement, the largest loss on the system dictates the DC requirement.
- The dynamic product suite (DC, DM and DR) are entirely met using battery storage assets. Both DM and DR are new markets that are being closely controlled by the ESO as they are developed, as such the volume procured is small (c.300MW).

Dynamic Response Products

Dynamic Containment (low and high)
Dynamic Moderation (low and high)
Dynamic Regulation (low and high)

Dynamic Response Products

Introduction

- **The way in which the ESO is managing the electricity system is changing. With an increase in non-synchronous generation and moves to reduce the required inertia holding from 140GVA/s to 102GVA/s (with an interim level of 120GVA/s) the ESO has brought forward a new suite of response products to manage frequency within operational limits and recover the frequency under large deviations from operational limits. For simplicity, we refer to this suite of products as Dynamic Response, and it includes:**
  - **Dynamic Containment (DC)** is the most mature of these markets. Launched in October 2020, the product pays an availability fee to providers who can recover the electricity system frequency quickly following a sudden and significant deviation from operational limits.
  - **Dynamic Moderation (DM)** launched in May 2022. Providers of DM self-dispatch once a sudden frequency deviation is observed and moves towards the operational limits.
  - **Dynamic Regulation (DR)** launched in April 2022. DR is a pre-fault service where providers continuously monitor the frequency and respond to changes, slowly correcting these deviations.
- The dynamic response products have attracted a lot of attention from market participants since their first inception, and have provided an important route to market for battery storage providers following on from the success of Enhanced Frequency Response (EFR). It has led to a significant step change in how the ESO manages the GB electricity system.
- We have performed a deep dive analysis on the dynamic response products to date, reviewing the market outcomes and also reviewing the market policy against the framework. It is important to note that all of these products – even DC - would be deemed as immature so learnings should be considered in this context.

Dynamic Response Products

Summary of Technical Requirements

The new Dynamic Response suite of products are designed to facilitate the ever increasing amount of non-synchronous generation on the electricity system – supporting net zero targets.

Dynamic Containment is the post-fault service in this product suite, responding quickly to large frequency deviations. Dynamic Regulation and Dynamic Moderation are both pre-fault services, maintaining the frequency around 50Hz.

Dynamic Containment (DC)

- **Volume:** C. 1000MW, based on single largest loss, inertia (and stability pathfinders), and FFR procurement.
- **Unit cap:** 100MW individual unit cap.
- **Deadband delivery:** +/- 0.015Hz (0%)
- **Small linear delivery:** 0.015Hz - 0.2Hz
- **Knee point activation:** +/- 0.2Hz is 5%
- **Full delivery:** +/- 0.5Hz is 100%
- **Linear delivery knee point:** 0.2Hz
- **Full activation:** 0.5Hz
- **Full delivery:** 1s

Dynamic Regulation (DR)

- **Volume:** C. 1000MW, based on single largest loss, inertia (and stability pathfinders), and FFR procurement.
- **Unit cap:** 100MW individual unit cap.
- **Speed of Response:** 10 seconds
- **Deadband delivery:** +/- 0.015Hz (0%)
- **Delivery range:** +/-0.015 -0.2 Hz
- **Deadband (delivery %):** +/-0.015Hz (0%)
- **Initial linear range (delivery %):** +/- 0.015 -0.2 Hz (100% at +/-0.2Hz)
- **Second linear range (delivery %):** n/a
- **Full delivery point:** +/-0.2Hz
- **Max ramp start:** 2 seconds

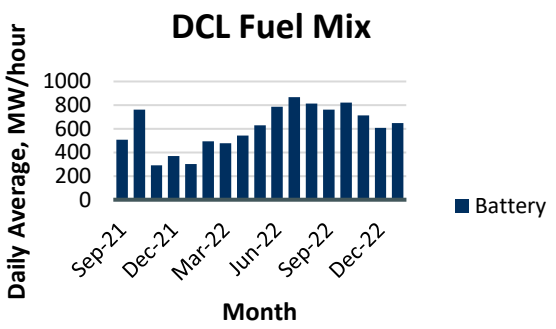
Dynamic Moderation (DM)

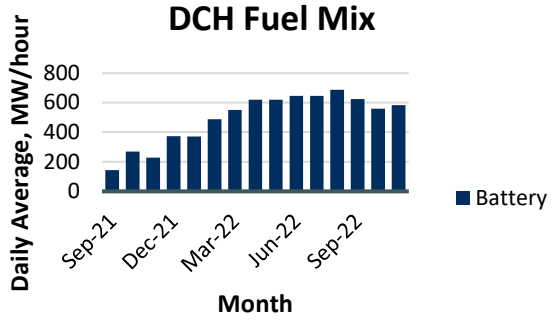
- **Volume:** C. 1000MW, based on single largest loss, inertia (and stability pathfinders), and FFR procurement.
- **Unit cap:** 100MW individual unit cap.
- **Speed of Response:** 1 seconds
- **Deadband delivery:** +/- 0.015Hz (0%)
- **Delivery range:** +/-0.01 -0.2 Hz
- **Knee point:** +/-0.1Hz
- **Deadband (delivery %):** 0% (+/- 0.015Hz)
- **Initial linear range (delivery %):** +/- 0.015 -0.1 Hz (5% at +/-0.1Hz)
- **Second linear range (delivery %):** +/- 0.1 -0.2 (100% at +/-0.2Hz)
- **Full delivery point:** +/-0.2Hz
- **Max ramp start:** 0.5 seconds

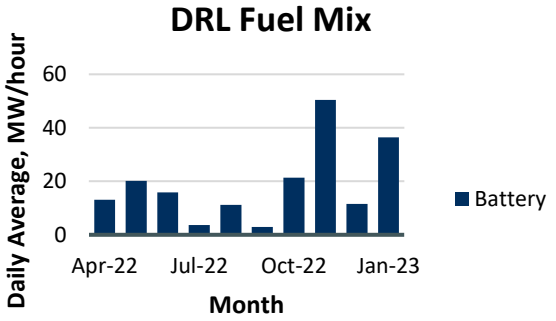
Dynamic Response Products

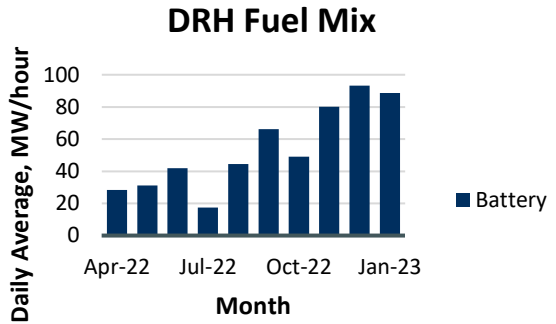
The market has been dominated by batteries since its introduction

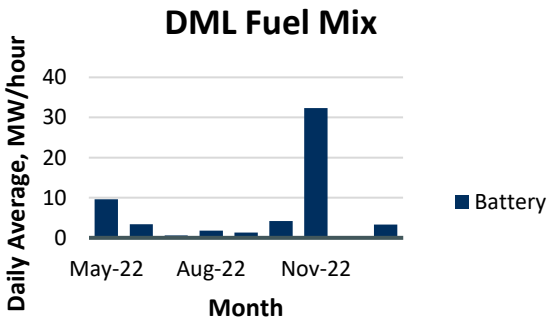
- **The graphs to the right show the fuel mix across the dynamic suite of products on a daily average basis across each month. This shows that it has been entirely dominated by batteries since its implementation.**
- The technical requirements of the dynamic products preclude almost all other forms of technologies from providing the system requirement other than battery storage. The ESO could improve the services by thoroughly reviewing if alternative technologies, including existing conventional assets should be able to provide this service – however, we acknowledge that it is unlikely that many other technologies could meet this system need.
- In the coming pages, we review the liquidity and concentration of the Dynamic suite of products, finding that the most mature market – Dynamic Containment – is the most liquid, with other products experiencing varying levels of concentration.
- Generally, participation in the markets has increased overtime, linked to the increasing penetration and development in the GB battery storage market. When considering the battery storage pipeline, both merchant and clearing through the Capacity Market (CM) auctions, we expect this market to increase in participation and depth.

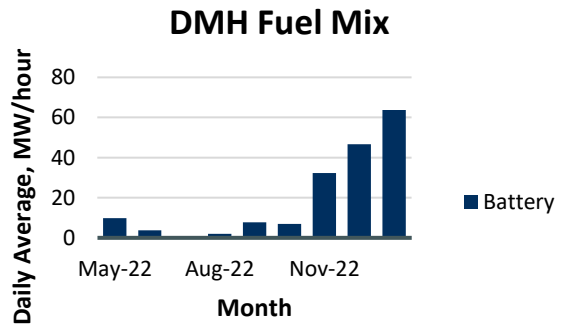






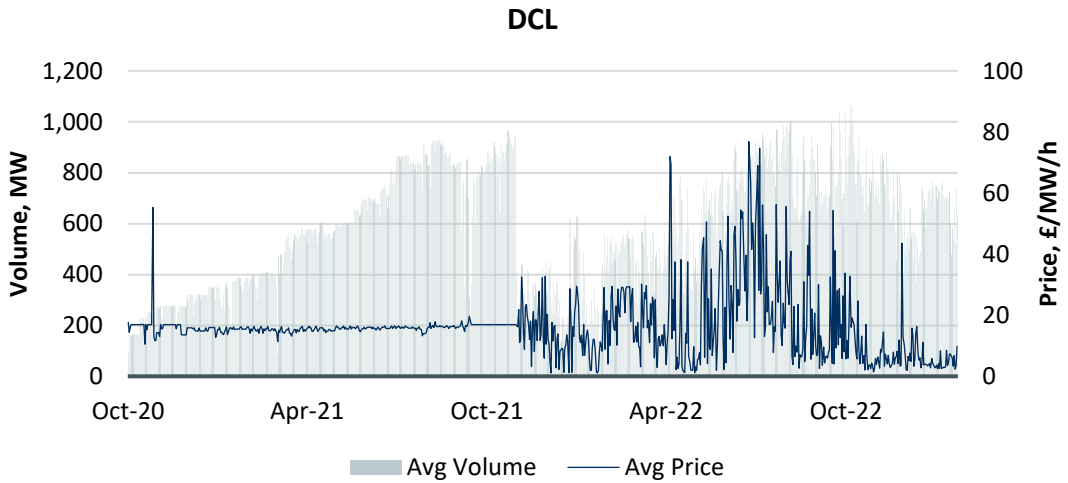


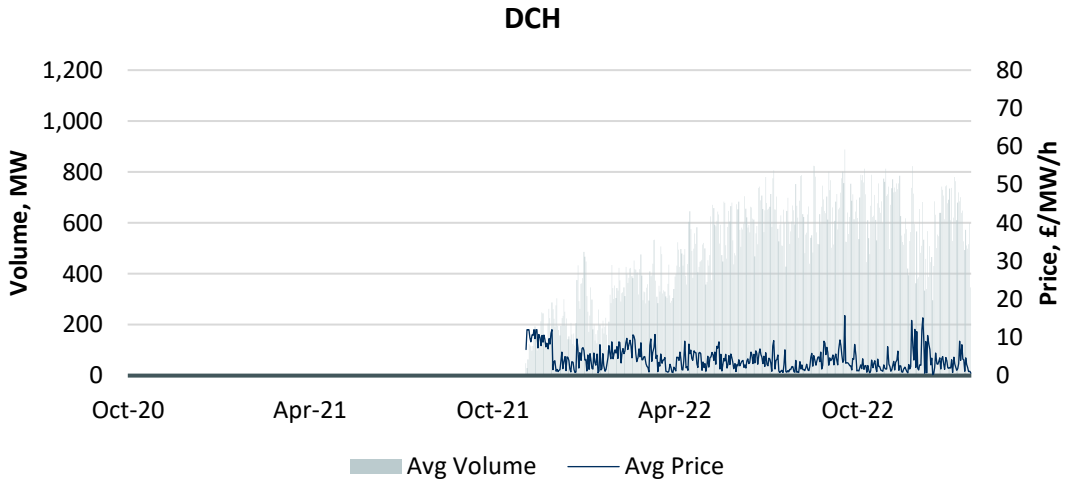




Dynamic Response Products

DC is the most mature market and showing signs of saturation





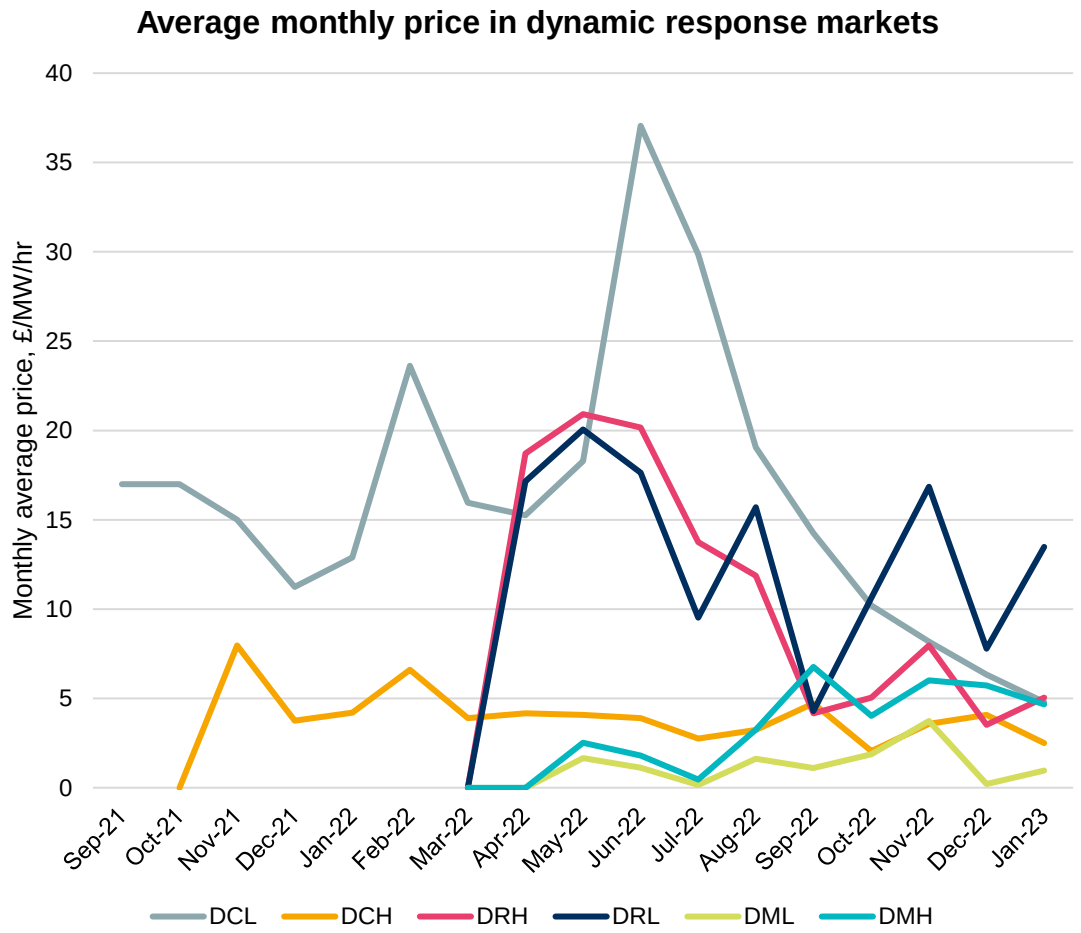
- **DC is the most mature Dynamic product, which provides a good indicator for what could be expected for DM and DR, and lessons learnt for the ESO to consider and action if necessary. Analysis of DM and DR needs to be considered in the context of market immaturity and small number of observation points.**
- From a unit perspective (i.e.. the actual asset being bid into the market), participation in DC has increased to over 120 units, with over 2GW of available capability. This 2GW already exceed the future requirement of EuroLink in 2029 (1,800MW).
- The DC market has already exhibited signs of saturation from the market capability exceeding the requirement. The DC requirement is driven by forecast demand, inertia, largest loss (including loss of mains protection) and the procurement strategies for FFR and stability pathfinders. This is why we have observed higher DC requirement over the summer period when lower inertia levels are experienced in the system.

Note: In Nov-21 the DC requirement was updated to account for:

1. Reduction in risk of generators tripping on RoCoF (loss of mains) protection
2. Launch of EPEX platform - prior to this NGESO procure daily contracts for the peak volume requirement for a given month, can now procure specific 4-hour blocks allowing requirement to be shaped across a day

Dynamic Response Products

Costs have changed significantly since implementation largely due to the development of these new markets over time



- **The average monthly price of DC-High has remained fairly stable since it was brought into operation.**
- The average monthly price of DC-High has fluctuated between a monthly average daily price of £2/MW/hr and £7/MW/hr (standard deviation of 2.81). This hides periods of volatility, however, with a standard deviation of 9.3 over November 2021, for example.
- In contrast DC-Low has fluctuated significantly. The monthly average daily price for DC-Low peaked in June 2022 at £36.85/MW before declining to low prices in 2023 of around £5/MW/hr.
- DC is the only product so far that has not cleared at £0/MW/hr. DR and DM prices have experienced a number of occasions of £0/MW/hr clearing prices since implementation. DM has been the cheapest product.
- Since implementation there has been reasonable volatility in prices. The markets are not particularly volatile when comparing to alternative markets, such as the D-1 (N2EX) baseload wholesale market which has a standard deviation across the same period at c.90.

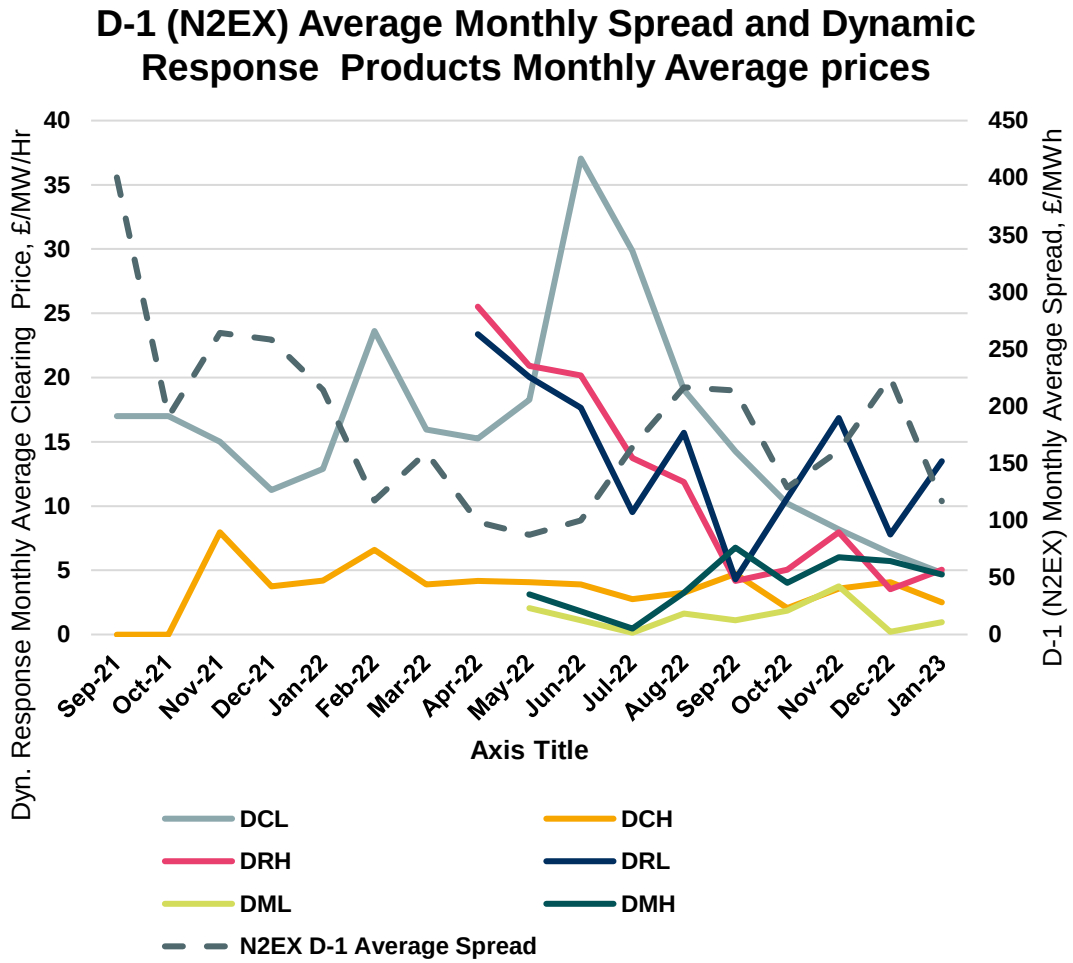
Dynamic Response Products

Dynamic products are not significantly linked to day-ahead price

- **When testing the Dynamic products average daily pricing, using simple regression we found that dynamic products are not explicitly explained by the D-1 N2EX price or its spread between minimum and maximum daily prices. Typically, the day-ahead market and its spread is an indicator for other revenue streams and therefore opportunity cost for participating in an the ESO market.**

- There are additional factors considered when bidding into the dynamic product auctions, which will explain much of the unexplained bidding behaviour. These include:

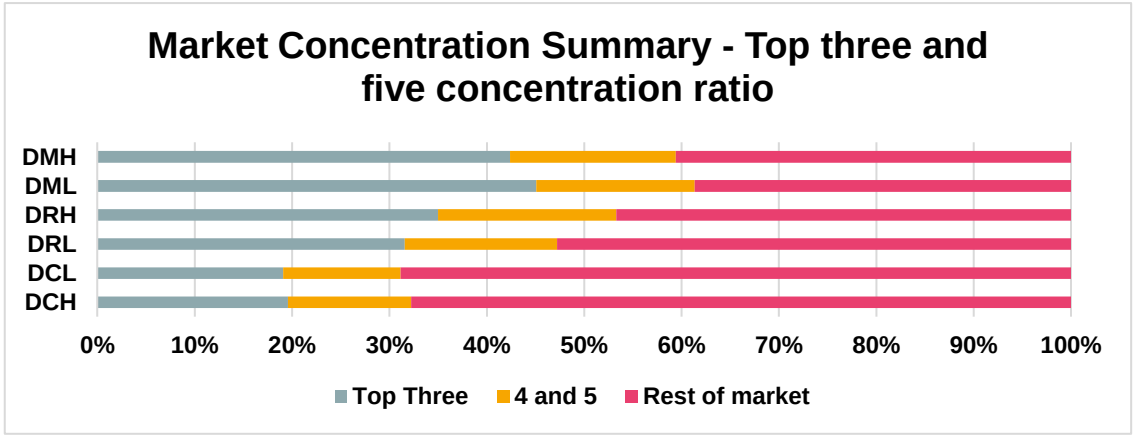
  - Increases in demand from the ESO (i.e. an increase in volume required)
  - Services being new and changing, causing pricing to be reactive;
  - Increasing volumes bidding into the market;
  - The assets ability to charge for free or be paid for the High services,
  - At what cost the assets were charged at to be available for the service.
  - Speculative bidding; and
  - Risk premia:
    - Opportunity cost: imperfect foresight of opportunity cost of committing to dynamic product delivery and missing out on greater returns in other revenue streams;
    - Variable Operating Maintenance costs: expect lower cycling for a known return – but risk of high cycling over Grid Code OC6 events. Increased cycling in the wholesale market could also significantly increase returns compared to dynamic price.

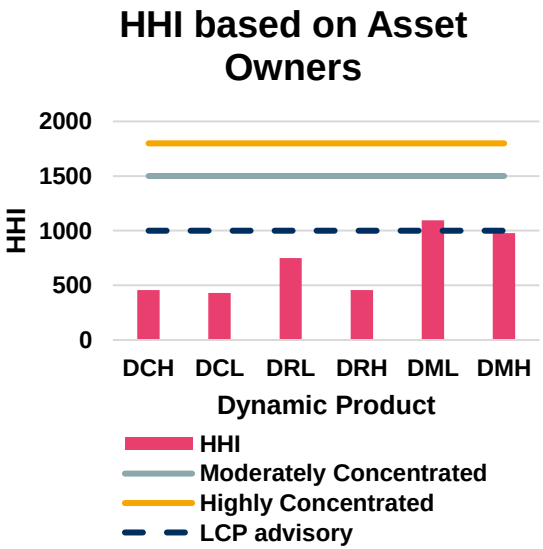


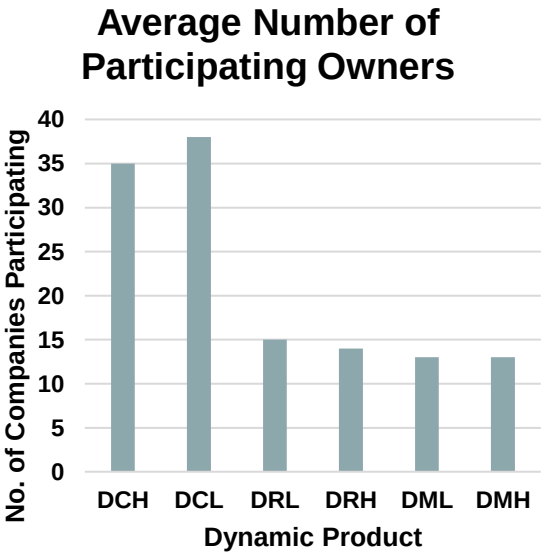
Dynamic Response Products

Markets are not concentrated, but some aspects should be monitored

- **The dynamic products generally show low levels of market concentration with the top three providers holding under 20% of the market share in DC (low and high) and up to c. 45% in DM low. The DM markets is considered an oligopoly with c. 60% top five company ratio.**
- We have utilised LCP's in house data services to attribute an owner to each asset. This sometimes misaligns with the company that the ESO is engaged with for the optimization of the asset. This demonstrates a truer reflection of market concentration, it should be considered that the owners of the assets will have differing levels of engagement on a day-to-day basis of their portfolio, and as such, that would demonstrate the levels of market power that could be exercised over the market.
- Using the Herfindahl–Hirschman Index (HHI) - a commonly used measure of market concentration - with threshold of 1500 for 'moderately concentrated' – none of the Dynamic products would be considered concentrated. Some approaches consider that an HHI greater than 1000 should raise concern, and a merger or acquisition that increases HHI by 200 should raise antitrust concerns. This risk exists in some dynamic products.
- The DM products should be monitored by the ESO for their depth and liquidity given DM-High HHI score just below 1000 and DM-Low score above 1000. This could enable the largest market share holders to exhibit market power in the product as this market develops. These findings should be considered in the context of the DM products being new, and the market needs time to develop and mature. DC shows particularly low levels of market concentration, which is to be expected as it is the most mature dynamic market – commencing competitive procurement in Sep '21.



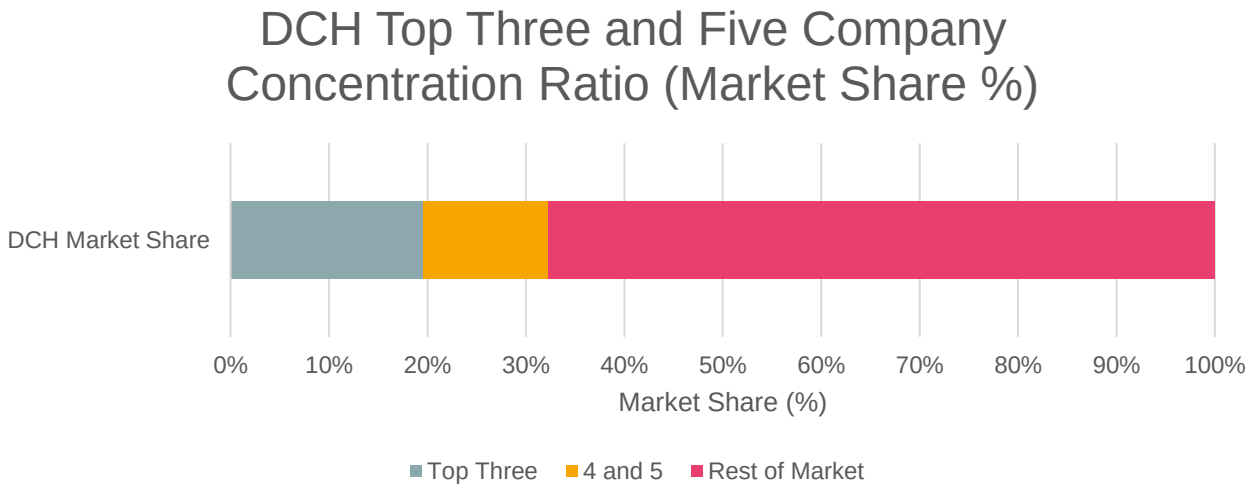


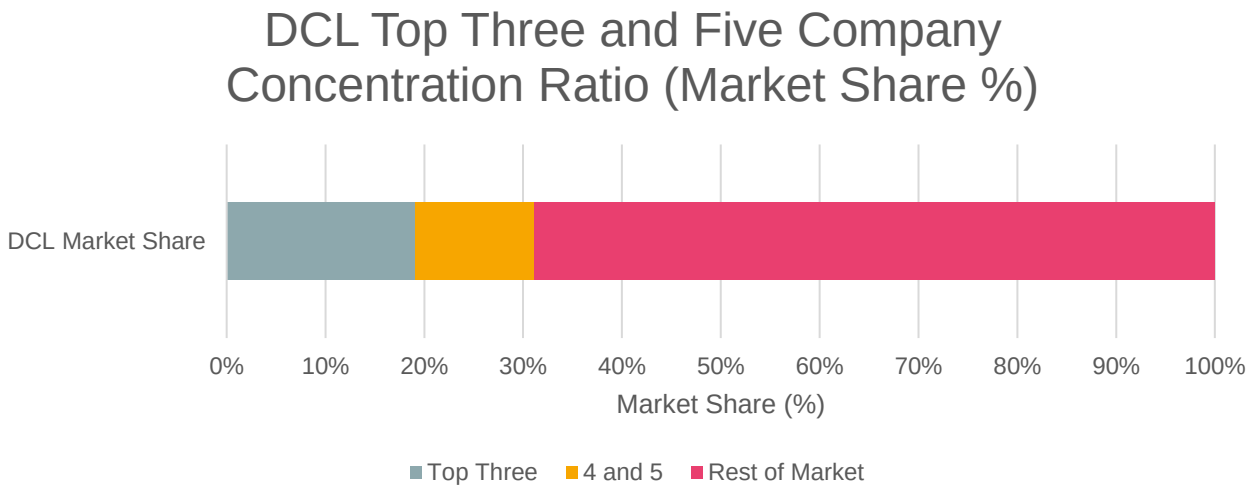


Dynamic Response Products

HHI across the DC products suggests a competitive market place

- **The DC products are well developed, with low market concentration. This allows for a competitive market where a single owner can not impose market power on an average basis.**
- Both DC-Low and DC-High present good levels of competition and an unconcentrated market, with an HHI of 455 and 430 respectively.
- These charts show the market share held by the top three asset owners in the Dynamic Containment products.
- The three firm concentration ratio is under 20% and five firm concentration ratio below 40% of the overall market for both DCH and DCL. This adds further context to the HHI calculation that this is a well distributed market. There are low levels of concern of a uncompetitive, or potentially uncompetitive market.

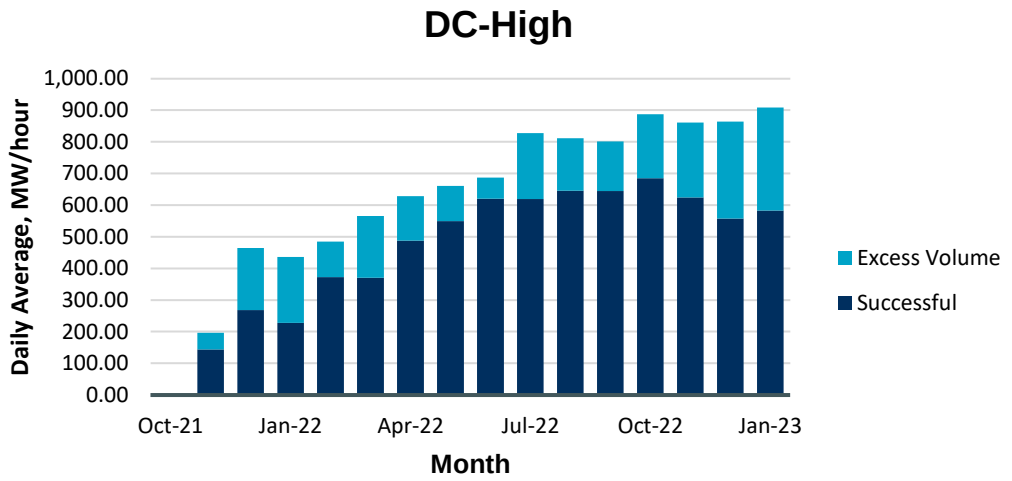


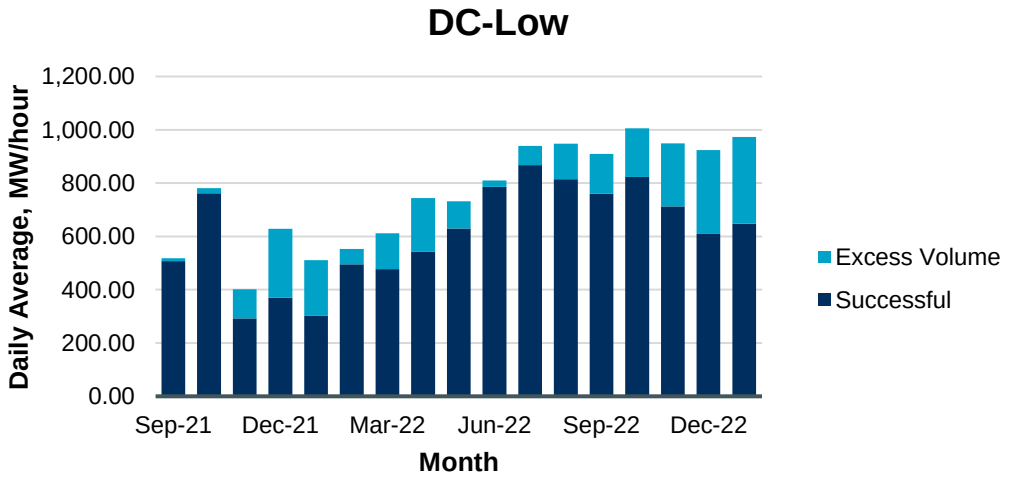


Dynamic Response Products

Dynamic Containment markets are increasing in depth

- **Dynamic Containment is a well distributed market, where on a month average basis, the total daily capacity achieving a contract could be entirely replaced by excess capacity**
- Both DC-Low and DC-High have experienced an increase in participation since their introduction.
- The monthly average of daily excess capacity for DC-Low and DC-High is 24% and 36% of those bidding into the market. This allows for the excess volume, on a month average basis to cover a good amount of the volume achieving a contract. This market is showing signs of saturation, as battery storage GB fleet continues to grow.
- We observed a drop of capacity in DC-Low after October 2021. This followed the introduction of dynamic 'breakpoints' that replaced the £17/MW/Hr market price cap which had initially introduced some market uncertainty that has now recovered.
- Since mid-2022 we have observed prices falling as a result of early signs of market saturation.



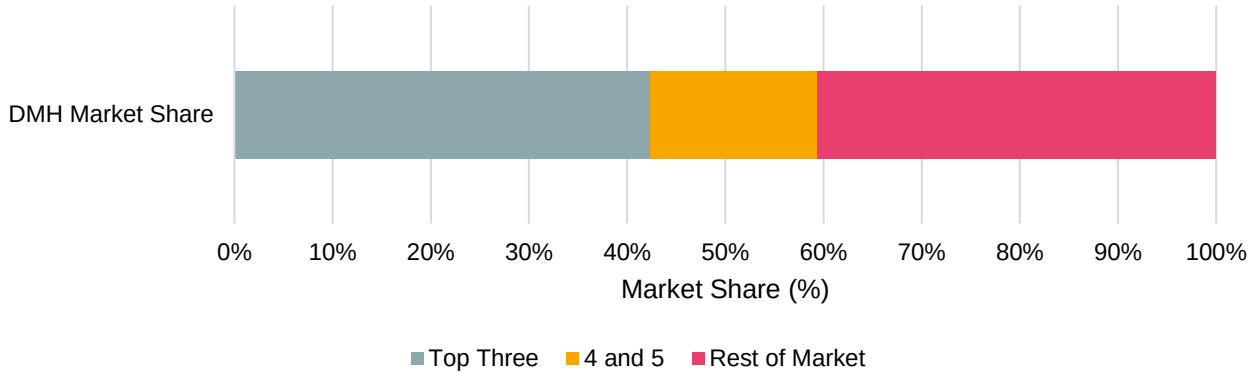


Dynamic Response Products

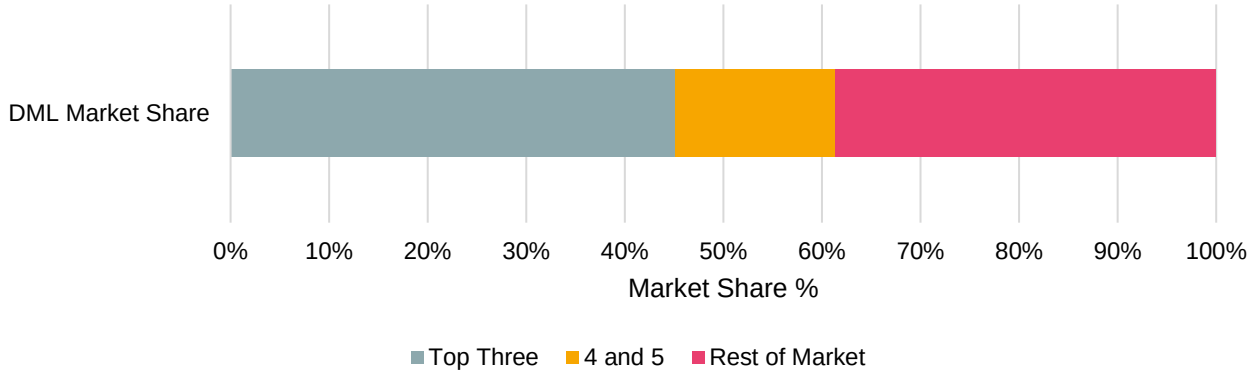
The top three providers command a market share of between 40% and 45%

- **Market concentration in DM is analysed through HHI as low; however, it is close to the moderate HHI threshold. Of concern may be that the top three providers all own over 40% of both Low and High.**
- Based on asset owners, Dynamic Moderation is a moderately concentrated market, with a top three concentration ratio of between 40% and 45% and an HHI of 1095 for DM-Low, and 978 for DM-High. This is more of a concern when we consider a top 5 market concentration ratio of c.60% for both markets – this could be considered an oligopoly.
- The high levels of top three market share does indicate some concern of potential large increases in HHI if there are mergers or acquisitions in the market which could then impact the concentration of this market.
- This is likely largely due to the immaturity of the market, having only been launched in May 2022. We would expect that over time more participants seek to utilise Dynamic Moderation as a way of optimising its portfolio and also with the introduction of the ESO's Enduring Auction Capability (EAC).
- The product may struggle to attract appropriate levels of liquidity without EAC enabling easy stacking. DM market prices remain modest due to the market parameters, and intervention from the ESO to provide false liquidity and keep costs down (such as individual unit caps).

DMH Top Three and Five Company Concentration Ratio (Market Share %)



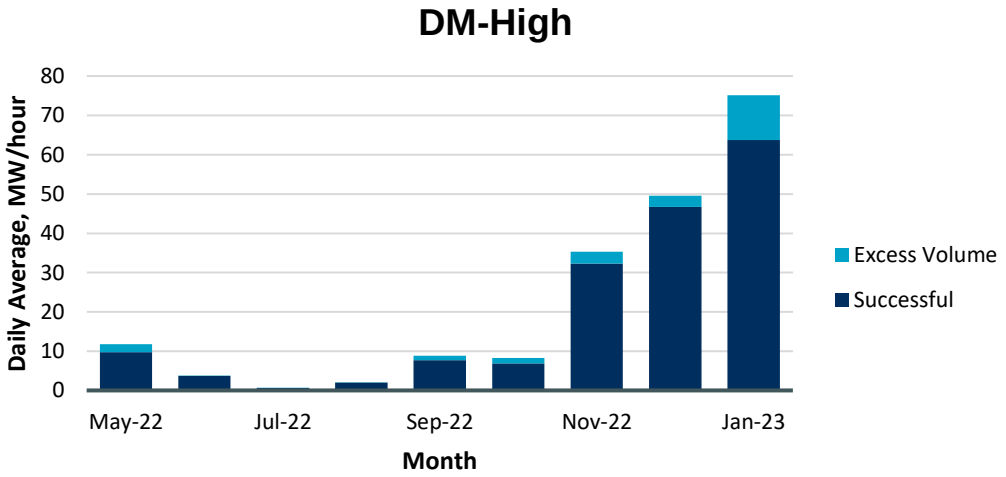
DML Top Three and Five Company Concentration Ratio (Market Share %)

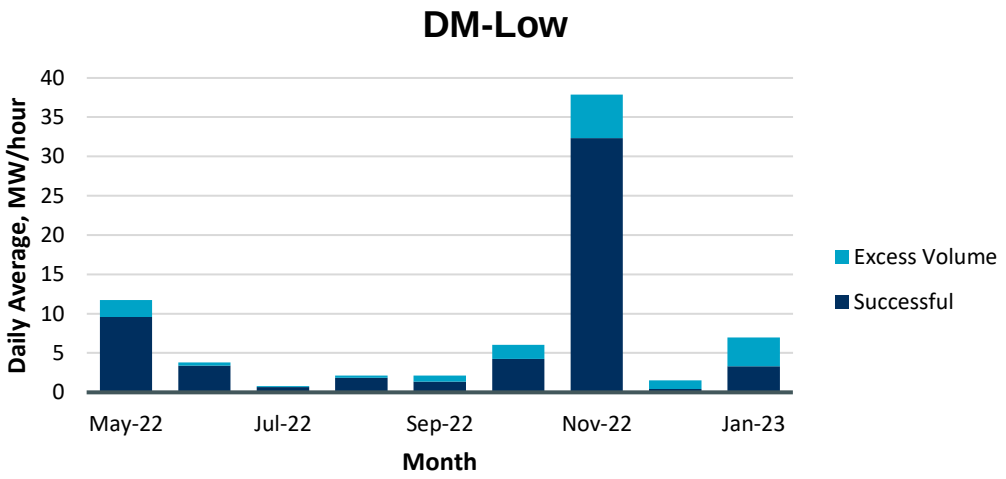


Dynamic Response Products

Volumes being bid into the Dynamic Moderation market are low, with inconsistent interest participation levels

- **The DM markets remain small, with low levels of headroom available to the ESO. This should not be considered a characteristic of the market though due to its immaturity.**
- The DM product launched under a year ago (May 2022), and has been characterised by capped procurement levels, and low clearing prices. The headroom of DM-High and DM-Low is quite low, with 13% and 28% respectively. The DM market is immature, and therefore it is too soon to take these findings as characteristic of the market.
- November exhibited unusually high participation in DM-Low and the average procurement targets responded as such. November marked increasing levels of participation and procured capacity in DM-High.
- In November 2022, we observed two large owners enter their assets into the DM-Low auction, before exiting in December. This could be a combination of revenue opportunity and gaining market experience. There was also readiness testing of enhancements to the ESO's Ancillary Services Dispatch Platform (ASDP) moving dynamic products onto ASDP v3 – demonstrating the need for the ESO to hold suitable infrastructure to encourage market participation for new units.

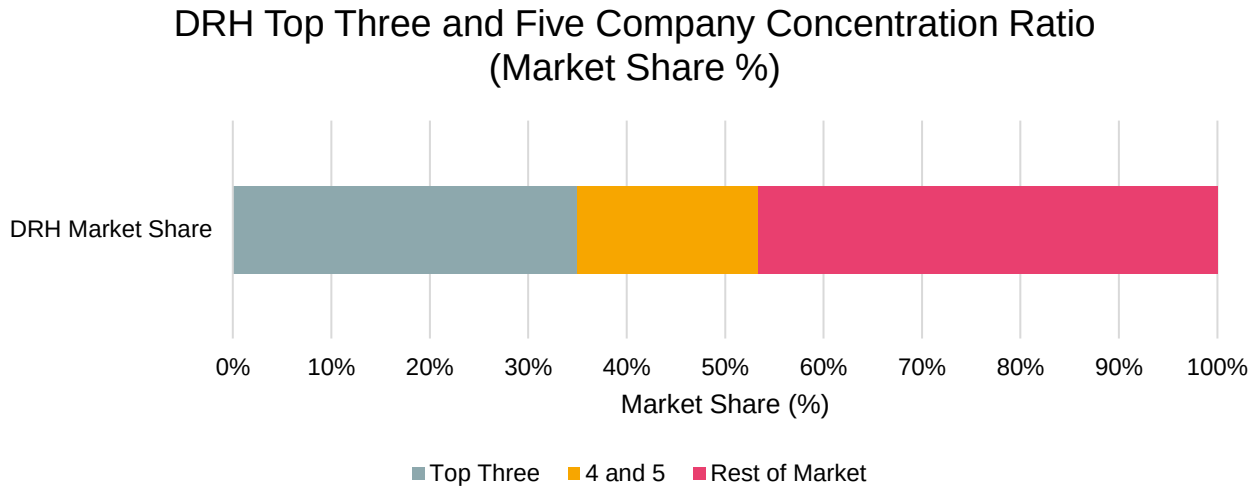


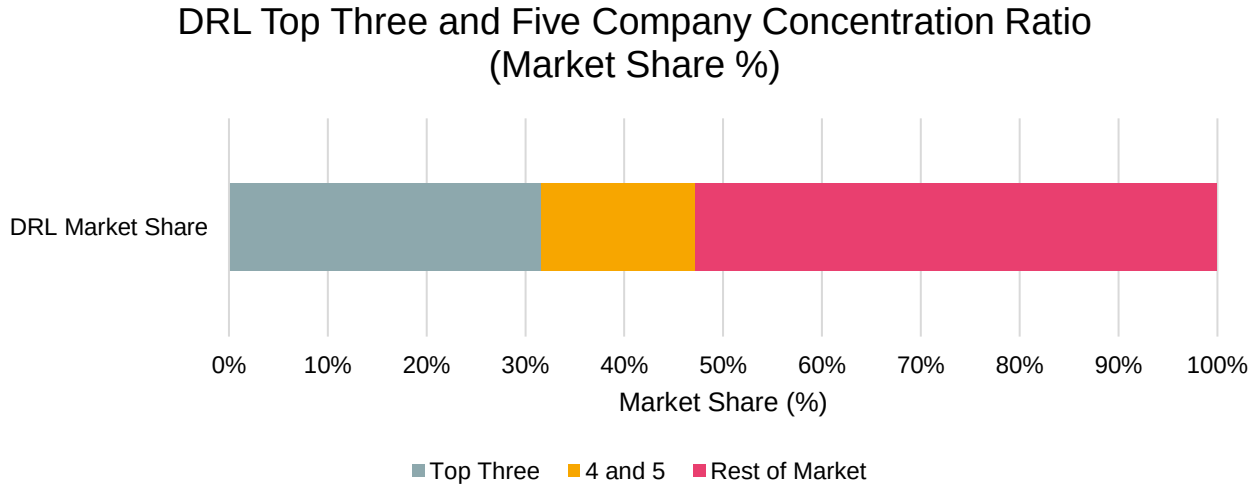


Dynamic Response Products

Dynamic Regulation has a low HHI, but top 5 owners concentration ratio could raise some concerns

- **Across the Dynamic Regulation products the top three owners commanded 31% of Low and 32% of High markets. This results in an unconcentrated market, with an HHI of 750 for DR-Low, and an HHI of 861 for DR-High.**
- The HHI calculations for Dynamic Regulation suggest a competitive market place. However, when we look further into the market make up and perform a top three and five concentration ratio test we find that c.50% of the market is made up from five asset owners, and around 30% top three concentration ratio.
- The largest single market shareholder in DR-Low holds 11% of the market, and 12% in DR-High. This does indicate that any significant expansion of their battery storage portfolios or mergers and acquisitions could result in a more concentrated market. The ESO should monitor this as the market develops.

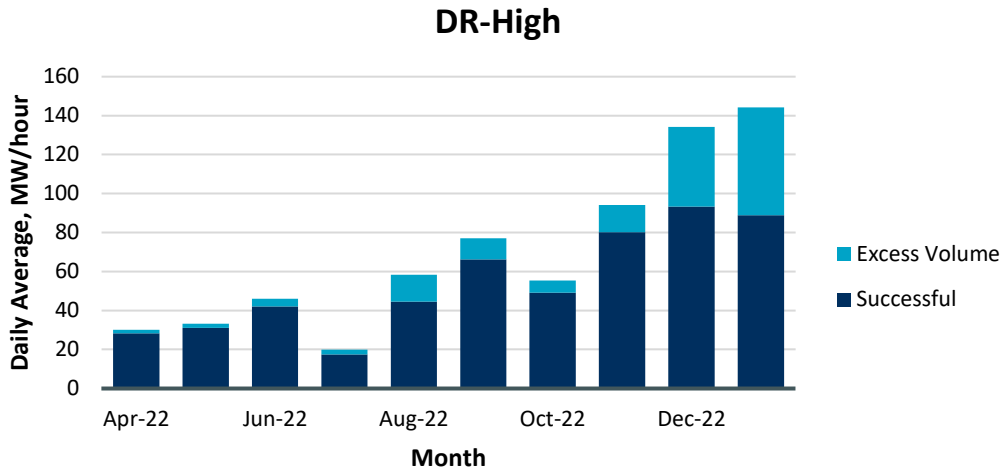


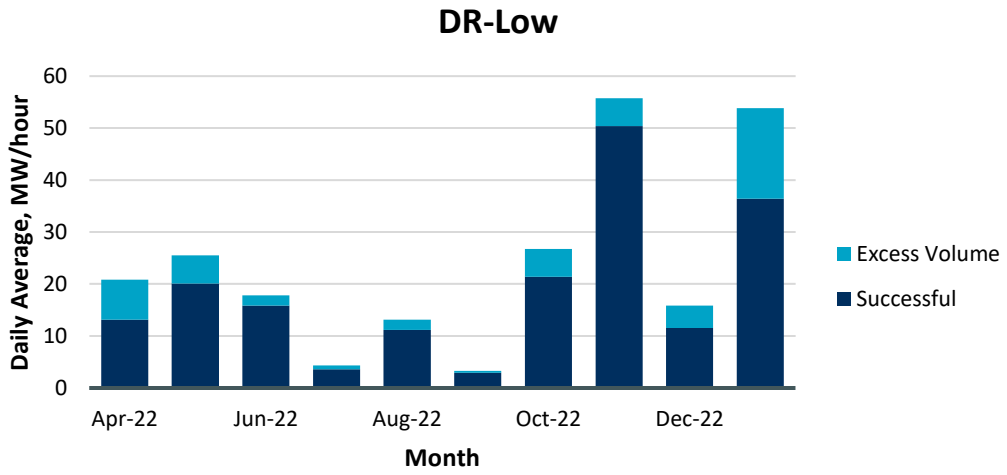


Dynamic Response Products

Dynamic Regulation is attracting market interest with increasing excess volume

- **The excess volume above the requirement in DR-High is increasing and DR-Low has been volatile.**
- DR-Low has been characterised by varying levels of procurement targets and participation on a monthly average basis since April 2022. November 2022 saw a particular increase in participation, as the ESO requirements increase (which would also be dynamic to the units participating) before dropping off in December. Similar to DM-Low, this could be because of increased revenues available, gaining market experience and also the ASDP v3 release.
- Despite the high levels of market concentration, as shown on the previous page, the ratio's of headroom have been relatively high with DR-Low having an average excess volume of 26% over what was procured.
- This will go some way to limit the amount of market power that could be exhibited, but, would likely still allow for costs to increase as the price setting unit would be higher – that would otherwise be out of merit.





Dynamic Response Products

Assessing the Market Design Principles

Dynamic Response Products

Assessing the Market Design Principles - Summary

What is the current situation and how is the market developing?

As the ESO seeks to further their implementation, gradually taking over from existing response services, the dynamic markets continue to mature and develop following phased implementation over the last couple of years. Dynamic Containment, launched in October 2020 is the most liquid and mature market exhibiting good levels of competition which has driven down its price. Despite being newer, Dynamic Moderation and Dynamic Regulation have also an unconcentrated market which is showing good signs of development.

What are the relevant priorities under the market roadmap?

We have found that the dynamic services are generally well aligned with the framework but with ambers in competition and net consumer benefit, which the ESO may wish to review. The services have not attracted any assets other than batteries to participate in the dynamic services. The ESO should ensure that there are no market barriers to other technologies, as the more diverse fuel mixes can increase competition and therefore more market reflective pricing which would in turn improve Net-Consumer Benefit.

Priority principle	Assessment rational
Competition	There is a significant lack of diversity of fuel mix in the dynamic products - solely batteries - that the ESO should review as to whether any of its technical requirements unnecessarily preclude other technologies capable of meeting the system need.
Net Consumer Benefits	Net-consumer benefit would be significantly improved if the ESO focussed on increasing market depth and competition.
Adaptability	The dynamic products are all procured at day-ahead stage and split into six EFA blocks for committed delivery making them highly adaptable. Adaptability could be improved by shorter commitment periods and closer to real-time procurement.

Dynamic Response Products

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Competition	**Other than Dynamic Containment, the dynamic products are very immature markets, and there should be suitable caution and weighting put to that when analysing them. However, the market concentrations exhibited have been acceptable – with the exception of DM, which the ESO should keep under review. There is a significant lack of diversity of fuel mix in the dynamic products, solely batteries. The ESO should review whether any of its technical requirements unnecessarily preclude other suitable technologies that are capable of meeting the system need. Increased market liquidity would improve market depth and improve competitive price formation.** The dynamic response suite of products exhibit varying levels of competition and market concentration. Dynamic Containment demonstrates the highest levels of competition with an HHI of 430 for DC-Low and 455 for DC-High. This is unsurprising when considering that the DC products are the most mature markets, having been implemented in between October 2020 and September 2021. The DM and DR markets are newer than DC, so this should be considered when reviewing the markets, and particularly comparing them to DC. The data points available to reserve are limited, and therefore can pose results that are not actually reflective of the markets, or otherwise are not a fair representation of the markets in their current development. However, the DM and DR products have varying levels of participation – but typically acceptable levels of concentration. DM is not concentrated, however DML HHI market concentration score is 1095 and DMH 978; which suggests that the markets are at risk of imperfect competition. The ESO should keep this under review to ensure that market concentration does not grow. All dynamic products are provided by battery storage which is necessary due to the technical requirements of the system need. This is a growing market, and there is a significant pipeline of battery storage both merchant and through the Capacity Market. Response seemingly lends itself to lower capacity, shorter duration batteries, which have the quickest build out rate. This is a fast growing section of the battery storage market lending itself to a good assumption that the Dynamic markets will grow, and increase in liquidity and competition. The sole technology providing dynamic services being batteries can be restrictive to a liquid market. Although the parameters are well suited to batteries, the ESO could assess whether any of its technical requirements unfairly preclude other suitable technologies from participating in the market. This would have a beneficial impact on the market depth, and also de-risk the ESO from any (albeit unlikely) impact on the GB battery storage market or concentration from single large investors in battery storage assets which are increasing with battery storage market development in GB. However, technical parameters should not be erroneously weakened just to allow for additional liquidity if the system need is justified, and we expect liquidity to be increased significantly in the coming years from battery storage pipeline.	-

Dynamic Response Products

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Net Consumer Benefits	**Day-ahead procured short term markets, that are split into EFA block delivery, allow for a daily market price that is representative of the market conditions for the period of delivery. Although this means that the market is allowed to respond upwards and increase its costs, it will also respond downwards when exogenous costs are lower. As analysed in competition, the lack of technology diversity and competition in DM and DR presents a risk of poor market outcomes.** Day-ahead auctions with delivery set to an EFA block period allows for the product costs to be reflective of the prevailing market conditions for the period of committed delivery. This allows flexibility for a provider, and prevents price lock-in for a longer period where the risk of lost higher revenue or cheap charging (and managing state of energy) is factored in over a greater period of time. Many of the assets participating in the dynamic suite of products do so on an opportunity basis. Battery optimisers take decisions across a number of time horizons, typically within prompt timeframes. This means that based on the market conditions, the optimiser will cycle a battery based on its characteristics to maximise revenues, whilst also managing cell deterioration. With this ability to commit to Dynamic Response market windows during the day, a provider is able to optimise between the different markets throughout the day. Net consumer benefit would be significantly improved if the ESO were able to increase market depth and competition. Although this is based on the depth of the battery storage market that it is accessing, it could improve this depth by assessing whether other technology classes could provide this service. This in turn would help with competitive price formation and improve net-consumer benefit. At present, the ESO applies a single unit cap to prevent fewer larger assets dominating the market. With larger and longer duration assets coming forward in the battery storage market, to maintain good competition and therefore a net-consumer benefit, the ESO should only remove this cap when it is satisfied that a competitive market place with plenty of market depth exists. The progression and implementation of the Enduring Auction Capability (EAC) would ease the stacking of dynamic products, including across the dynamic suite, and could increase participation of assets in the more periphery dynamic products of DM and DR – increasing competition and therefore cost reflective clearing prices.	

Dynamic Response Products

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Adaptability	**The dynamic products are all procured at day-ahead stage and split into six EFA blocks for committed delivery making them highly adaptable. This allows for a flexible procurement approach that can change and adapt on a within-day basis, this prevents the lock in of providers across the day in periods – if necessary. As the dynamic products only pay an availability fee, this ensures that the services costs are representative of the requirement at the time in the day that it is required.** The dynamic products provide different service to the system linked to the largest loss reserve on the electricity system over that period of the day. This could be one of a number of assets, which at present is either a) Sizewell B, b) IFA-1 (a single bi-pole of 1000MW), or c) North Sea Link (1400MW). Due to the dynamics of interconnectors, the flows can change from period to period, either from the ESO trades or price dynamics between interconnected markets. This can make on occasion the largest loss reserve change within day. On a month to month basis, DC procurement has remained relatively stable (when accounting for market growth), with DM and DR being more volatile – largely due to the infancy of the market. The dynamic products, in combination with the Accelerated Loss of Mains Protection Programme (ALOMP) has enabled the ESO to move towards operating a market with less inertia. Currently, SQSS requires the ESO to maintain a system inertia level of 140GVA/s at any given time (this requirement can change based on the background flows of interconnection). However, with ALOMP removing the risk of units de-loading or tripping based on Rate of Change of Frequency (RoCoF) the ESO has been able to operate the system with less inertia and faster responding services to maintain frequency within operational and statutory limits. The ESO is currently undergoing a review to reduce the inertia requirement to 102GVA/s with 120GVA/s as an intermediary step, which would likely increase the need for the dynamic suite of products and increase its utilisation – this would be a major test in the products ability to facilitate that system need.	

Dynamic Response Products

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Investability	**The ESO has provided clear investment signals through the dynamic suite of products and the previous Enhanced Frequency Response (EFR). With battery storage able to access Capacity Market agreements, it is important that the ESO concentrates on maintaining a stable market environment for batteries in its products, rather than seeking to underwrite investment that sits with the UK Government.** Through the dynamic products, and their precursor Enhanced Frequency Response (EFR), the ESO has provided clear investment signals for the need and valuation of battery storage. The dynamic products have provided a valuable, enduring revenue stream for battery storage, with the growing requirement and the need well communicated to the market. In response, the market has invested its capital where required and we are observing an exponential increase in the deployment of battery storage projects. This is enabling the ESO to manage their system at less cost (without the need to warm and dispatch conventional generation ahead of time) and therefore better able to facilitate renewable generation deployment more cost effectively. It is likely that participation in the market is to grow significantly in the coming years, with a bullish pipeline of battery storage projects, both merchant and in the Capacity Market. This will increase the number of unsuccessful participants in the market, and this saturation will be of concern to investors – particularly those already active in the market with higher Capex from being early market movers, where their variable, operating and maintenance (VOM) costs and required profit margin is greater. This will, however, have the benefit of organically increasing competition in the products and therefore ensuring a more cost reflective market price and avoid the identified risk of market power. Despite the ESO providing these clear investment signals, dynamic products on their own do not underwrite or provide viability for investment in battery storage, instead, making up a blend of revenues that make a project viable. Despite concerns of its suitability, the Capacity Market provides a stable revenue stream that is able to provide a level of cover for the fixed costs and long-run costs of a battery storage project, incentivising deployment. There is little need, from a holistic policy perspective, for the ESO to intervene in the market to provide a long-term, stable return to battery storage investors. The single unit cap that the ESO has implemented to encourage market liquidity and avoid concentration could be having a perverse impact on the investment of larger scale storage that would be excluded from this market, or influence splitting and stacking decisions. The ESO should be cautious of the investment signal that these caps may send to the market.	

Dynamic Response Products

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Coherence	**When considering the overall stated aim of the UK Government to meet net zero by 2050, and a net zero power system (subject to security of supply) by 2035, the need for the ESO to be able to manage the electricity system in the absence of conventional generation is paramount. The ESO's target of being able to manage a zero-carbon power system by 2025 hinges heavily on products like the dynamic suite.** Dynamic products are replacing the fossil fuel heavy Mandatory Frequency Response (MFR), Firm Frequency Response (FFR) and increased inertia holding (the latter particularly provided by CCGTs). Even as the competition in the Dynamic auctions increases, through assets coming to market with dynamic participation in mind, these assets will be able to provide flexibility services in the Balancing Mechanism or in the merchant markets that can act to fill in gaps of lower renewable generation to meet demand without the need for fossil fuel generation. This makes the products particularly robust to policy change. At present, although it is theoretically feasible, we see very little splitting of services with the dynamic products. This will seemingly be better facilitated and enabled with the introduction of the ESO's EAC. With this, we will likely see the increase of participation across all dynamic products as there is not the opportunity cost of missing out on a Dynamic Containment (for example) revenue based on entering into another dynamic product. In order to continue to increase participation from assets that are susceptible to output availability based on wind or solar, the ESO may choose in the future to opt for an intraday procurement timeframe instead of day-ahead. This would also enable battery storage to place bids into the dynamic markets based on when they were able to charge at lower costs when there was surplus renewable generation. Similar products are procured on a day-ahead basis the same as dynamic, and this seems suitable with little barrier to participation. However, this may be worth further investigation by the ESO. We expect any wholesale market impacts to be limited and also justifiable based on the way in which the Dynamic products are enabling a net zero power system by reducing the amount of inertia (typically provided by fossil fuel generators). The dynamic response products will remove capacity from the day-ahead wholesale market auction as operators speculate on the price achieved in dynamic response markets. This will likely push providers who are unsuccessful to sell their power in the less liquid continuous (sub D-1) and intraday markets. As the battery storage market grows the impact that it would have on the power wholesale market would likely increase. Those who are successful in the dynamic response markets may, on occasion when it makes financial sense, sell their power through the power wholesale market to lock in value in the earlier ay ahead wholesale market – and then bet on high dynamic response market prices (at 14:00) that would provide better returns than the price secured in the power wholesale markets. This may explain some of the exceptionally high maximum bids in the dynamic containment market auctions. This could have material impact on the power wholesale market – with buy back in less liquid shorter time horizon markets resulting in the perception of false liquidity in the wholesale markets through supply side buy back competing with retailers and consumers.	

Dynamic Response Products

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Locational Signals	**There are no locational signals in the dynamic products, and any move to add them in in the short-term would be counter-intuitive to the market growth if that were to be limited to location. The frequency response service is primarily a national requirement and not locational. The UK's REMA project is considering how it can implement locational signals across all assets that should provide this above the ESO's market framework.** The dynamic products have no locational signals at tender stage or at dispatch. All assets are expected to monitor the frequency of the GB electricity system and respond once the trigger point has been met, to help restore the frequency within its limits as soon as possible regardless of location. There could be scope for the ESO to investigate further the locational need for dynamic services, however, as this is a growing market this would be counter intuitive to limit the market growth based on location when the frequency requirement is a national system need. This will become increasingly challenging, even as the market participation grows as the system requirement too will increase (based on largest loss reserve and the decreasing system inertia). There maybe be a decreasing need for the ESO to apply a locational signal to the dynamic products also. As the UK Government progresses with its Review of Electricity Market Arrangements (REMA), a key proposal is around Locational Marginal Pricing (LMP) – which would incentivise the build out of all forms of generation and demand (including battery storage) to be developed in areas where there is a lower congestion charge (i.e.. lower transmission constraints), making access to the battery storage capacity less hindered.	
Transparency	**The ESO has provided good levels of transparency by providing ahead of time forecasts for procurement targets and timely results with information that allows the replication of procurement decisions. This includes any non-economic auction decisions, primarily a paradoxically rejected block.** The procurement requirements of dynamic products is particularly transparent, with indicative requirements for the DM and DR services published up to 6 weeks ahead of time for each EFA block. The ESO also provides 4-day forecasts of DC requirement. The dynamic products are typically cleared in merit order (i.e.. based on economics), this makes the auction's outcomes (with the published ESO data) easy to replicate with the application of bid-stack analysis. However, there are occasions where units are rejected (or "skipped") based on the paradoxically rejected block. This is typically where a unit would have otherwise been within merit, however, they are skipped for a more expensive unit, as the cheaper unit had a capacity that would have taken the procured capacity beyond that of the auctions target capacity. As of 31 January 2023, this is an aspect of the auctions that could become apparent, however, has not. This is clearly identified in the ESO's auction results data.	

Firm Frequency Response

Firm Frequency Response

The ESO announced its intention to phase out Dynamic Firm Frequency Response (FFR) by April 2024, but continue to procure Static FFR in the interim

- **Firm Frequency Response (FFR) is a frequency response product that is split into dynamic and non-dynamic (or Static), and for dynamic sub categories primary, secondary and high response. An FFR unit must deliver a minimum of 1MW response.**

- **Dynamic frequency response** is continuously provided to manage second-by-second changes to system frequency. It is due to be replaced by Dynamic Regulation and Dynamic Moderation when the market is mature and can be relied upon, but continues to be procured in the interim.

- **Non-dynamic (static) frequency response** is a service triggered at a defined frequency deviation. Static FFR has no ramping envelope – allowing the contracted units to increase to full delivery in whatever manner is suitable for the unit, so long as full delivery is met within 30 seconds following a frequency deviation of 0.3Hz.

- The ESO has announced its intention to phase out Dynamic Firm Frequency Response (FFR) by April 2024, but continue to procure Static FFR for the foreseeable future under its own framework, removing it from the FFR Standard Contract Terms. Therefore, we have assessed only Static FFR, as the enduring product. Static FFR is due to be replaced with Static Recovery – which is still in development.

Static FFR Developments

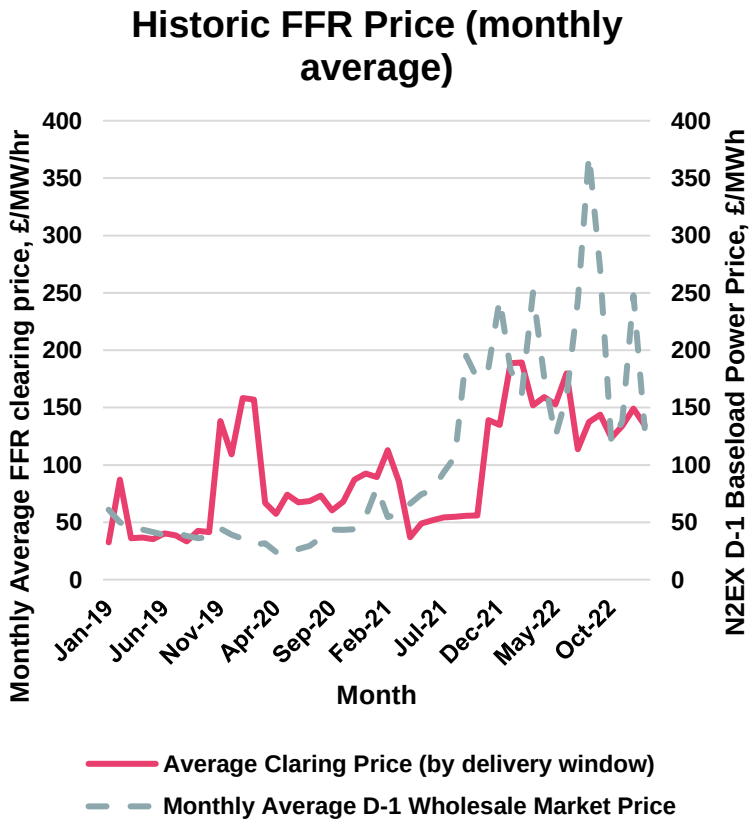
Following approval by Ofgem, the ESO has made a number of changes to the procurement framework of Static FFR to make it CEP compliant

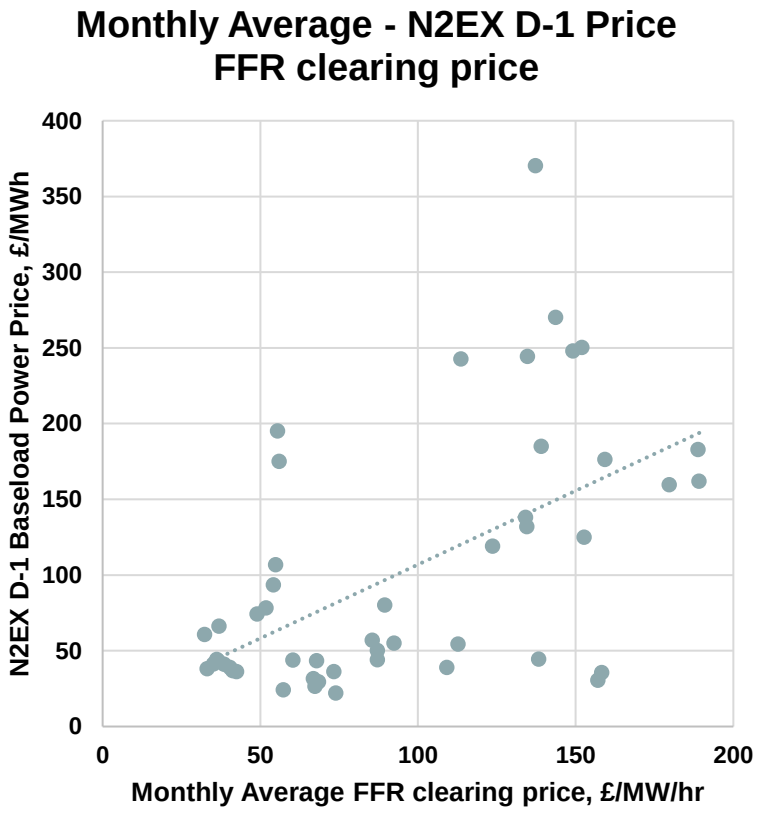
- **Following an Ofgem decision on the amendment making Static FFR its own Terms and Conditions Framework, the ESO intends to commence commercial procurement of Static FFR from the 31 March 2023 (first delivery on 1 April 2023).**
  - Changes to Static FFR to make it compliant include:
    - Daily procurement;
    - Pay as clear payment mechanism;
    - Independent bids for each EFA block;
    - Automatic formation of contracts following results publication;
    - Pre-qualifying and testing managed on the Single Markets Platform.
- The changes made to Static FFR's procurement framework means that there is little value analysing the historic market outcomes and dynamics as a proxy to understand the way in which the ESO's policy development is meeting the framework.
- The move to day-ahead procurement will enable participants to optimise or split more easily across the dynamic suite of products, Static FFR and reserve products. It will also simplify bidding through a pay-as-clear pricing mechanism, allowing a unit to put a marginal price into the auction, rather than trying to price at the marginal unit, enabling greater participation of non-conventional suppliers, particularly DER and intermittent providers.
- **In the following pages, we analyse the monthly FFR tender pricing in comparison to the N2EX D-1 wholesale market – to help explain how the providers price their bids in the FFR market. We also review the recent Static FFR mock auction results. These are not perfect proxy's for analysis of the Static FFR market, however, does provide some insight of who may participate.**
- For example, the mock auction will allow for potential participants to test their own participation processes and the ESO to test theirs. This means this will likely not be reflective of actual competitive bidding prices. The review of this market focusses on a market design principles and policy assessment.

Firm Frequency Response

Historic monthly FFR pricing shows positive correlation with the N2EX D-1 auction price

- The historic FFR price (monthly auctions) has been less volatile than the D-1 N2EX wholesale market price, but they are positively correlated.
- Although it is useful to understand the correlation between the two markets, in reality, there are more variables influencing bidding behaviour and commercial strategy that influences the market price.

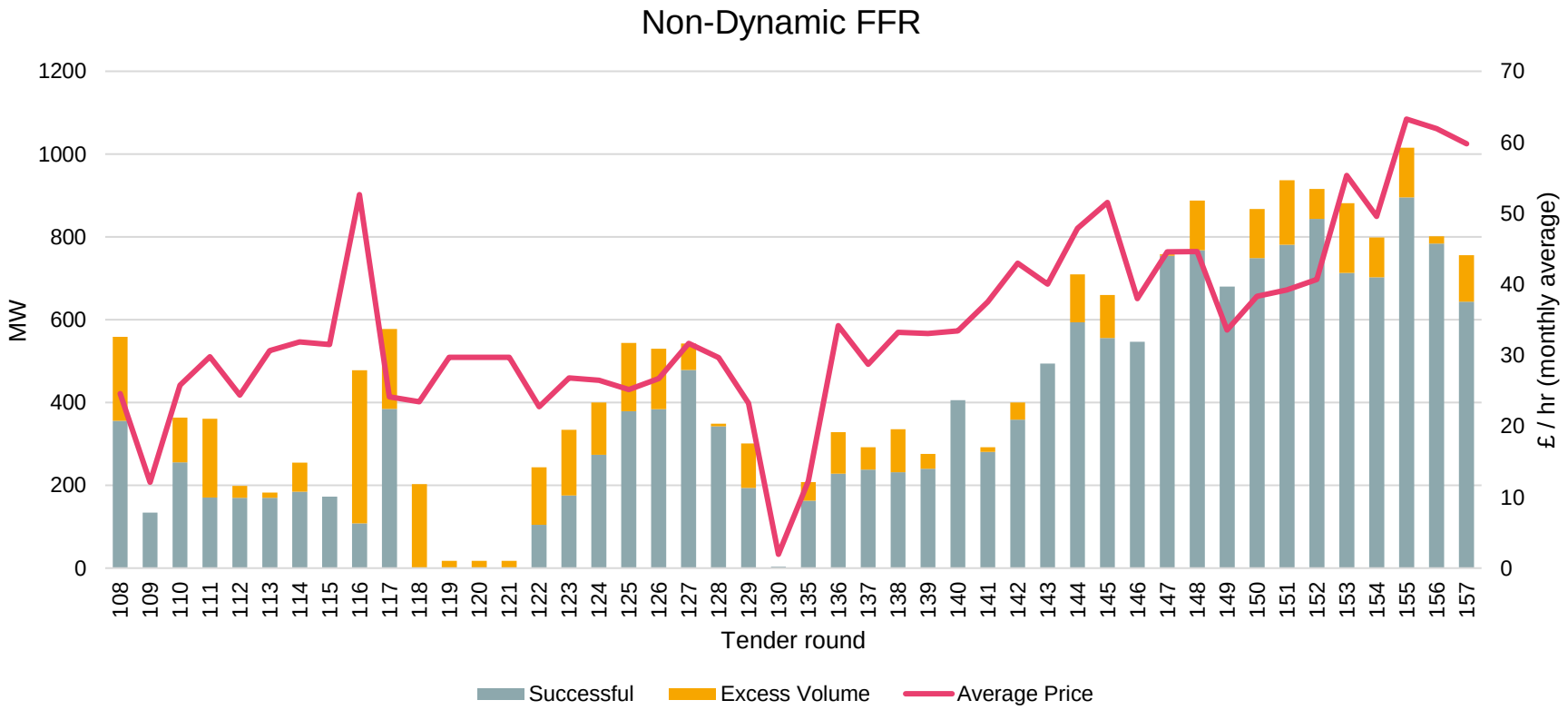




Firm Frequency Response

Historic monthly Non-Dynamic (static) FFR volumes and prices should be analysed with caution

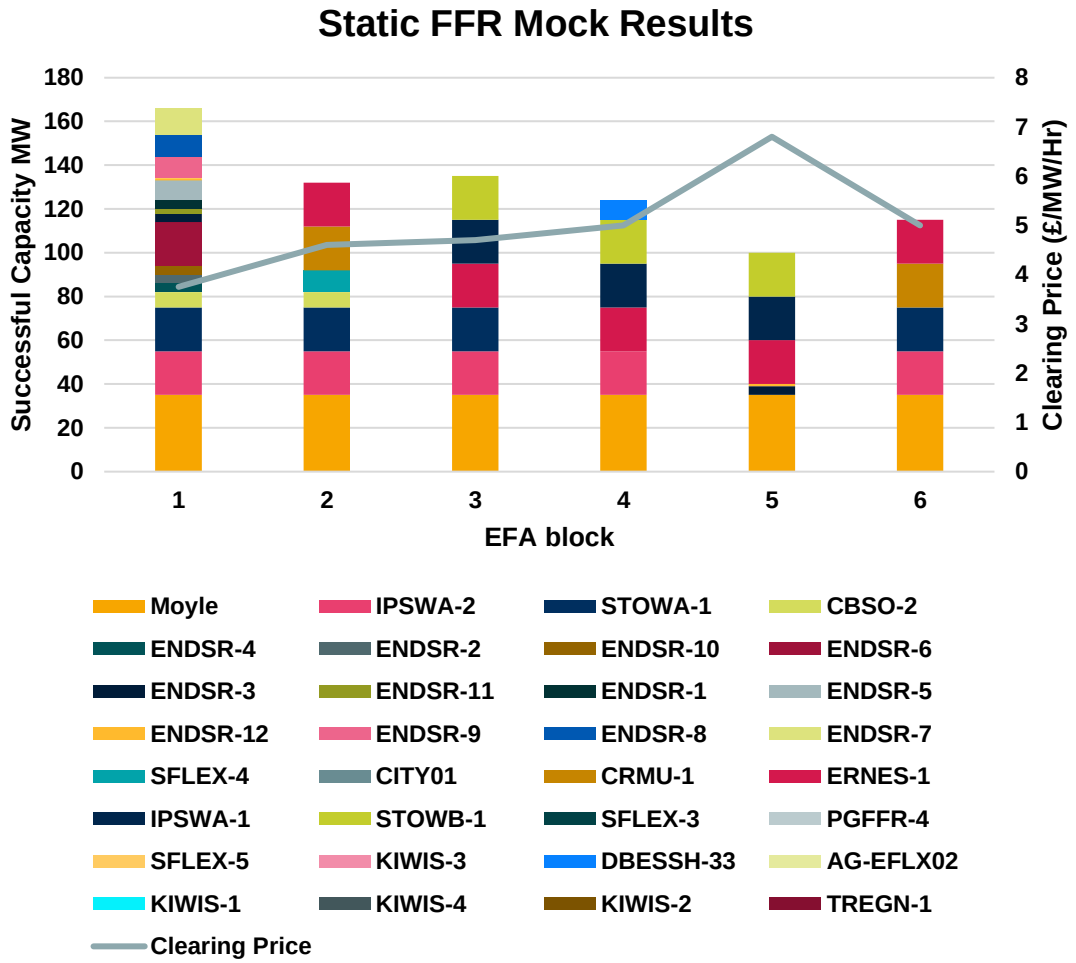
- **Historic Non-Dynamic FFR has seen an increase in the amount of volume accepted from Tender Round 108 (January 2019) through to 157 (February 2023).**
- As with the FFR pricing in the previous slide, average monthly Non-Ddynamic (static) FFR prices are less volatile than the D-1 N2EX wholesale market price, but they are positively correlated.
- As mentioned earlier, the changes made from Non-Dynamic to Static FFR's procurement framework means that the results here should be analysed with a degree of uncertainty.



Firm Frequency Response

The ESO held its first mock auction of the Static FFR auction w/c 27 Feb 2023 providing indicative insights into potential participants

- **The ESO held its first mock auction for Static FFR in week commencing 27 February, compliant with the CEP. The auction attracted a number of participants, including the Moyle interconnector.**
- The market clearing price (availability £/MW/hr) ranged from £3.75/MW/hr in EFA 1, to £6.80/MW/hr in EFA 5 (the evening peak EFA block).
- The Moyle interconnector won mock contracts in all six of the EFA blocks across the day, placing the cheapest bids, and coming at the bottom of the stack.
- Although it is unlikely that this mock auction will be reflective of actual market outcomes, it is indicative of the new participants that will come to market through the changes made to the procurement framework.



Firm Frequency Response

Assessing the Market Design Principles

Firm Frequency Response

Assessing the Market Design Principles - Summary

What is the current situation and how is the market developing?

With Dynamic FFR due to be phased out over the coming financial year, we have only reviewed Static FFR. The Static FFR changes have meant that using previous monthly Static FFR tenders as a proxy for future daily Static FFR tenders is not a robust approach. We therefore took a market design and policy principles approach to its review in the first instance, with some analysis of FFR monthly pricing and a review of the recent mock Static FFR auction to supplement our analysis.

What are the relevant priorities under the market roadmap?

The daily Static FFR procurement is well aligned with the framework: being highly adaptable with delivery windows within day; pricing set on a pay as clear basis; and, a day-ahead auction. These developments would change participation in Static FFR, as new technologies (particularly DER) are attracted to the ability to optimise at day-ahead stage, and having shorter commitment windows. This will also enable optimisation across the ESO's day-ahead auctions and the wholesale market which would likely increase participation across the markets and possibly reduce total ESO expenditure if all markets have good liquidity.

With Static FFR expected to be phased out in due course, the ESO would do well to ensure good transparency is provided of the future of the service.

Priority principle	Assessment rational
Competition	The changes that have been made to the Static FFR procurement framework, and indicative mock results, means that the market may enable the participation of new, non-conventional assets such as interconnectors.
Net Consumer Benefit	Moving to day-ahead procurement has opened the possibility for a service provider to co-optimise across all response markets.
Adaptability	The day-ahead procurement and EFA block commitment window enables the ESO to vary its requirement on a daily basis and throughout the day

Static Firm Frequency Response

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Competition	**Static FFR has historically been procured through the monthly FFR auctions. With a standalone Static FFR market yet to run commercially it is difficult to assess the competitiveness and participation. Through the changes that have been made to the Static FFR procurement framework, and what the mock results have indicated, it appears that the changes may enable the participation of new, non-conventional assets such as interconnectors. Many of these assets would likely bid low prices into the market, often essentially entering a price taking bid.** In consideration of the technical requirements, it is likely that units will seek to optimise across FFR, dynamic products and Quick/Slow reserve. This decision would be based on whatever service the asset is successful in at its market strike price. With the introduction of the EAC, this co-optimisation across services should increase market depth and liquidity across all services and bringing down total cost. The ESO has historically accessed secondary static response on interconnectors (EWIC, Moyle and IFA) through bilateral contracts. The changes made to the Static FFR procurement framework would likely remove the need for these to be accessed through untransparent bilateral arrangements, and instead encourage them to participate in open, competitive auctions. It is very important in regards to alignment with the framework and the ESO's wider market development ambitions that FFR develops with this in mind, and seek to phase out these bilateral contracts in favour of an open and competitive marketplace. Further, the ESO expects that it has enabled Demand Side Response (DSR) to participate in the Static FFR auction through frequency relays. It has achieved this by removing technical barriers to entry, but also the day-ahead procurement will likely satisfy the typical appetite for embedded resources to participate in ancillary services for shorter periods and being committed from shorter time horizons (i.e. day-ahead). The minimum capacity threshold of 1MW, and to be able to be aggregated, is in line with other ancillary services, and should not be a barrier to entry for smaller units and for units to split their capacity incrementally into to service (to dispatch other portions of volume in other revenue streams). However, it could be difficult for DSR pools to access enough capacity at a GSP group level to meet the de-minimis. The CM has seen relative success in bringing DSR to market through allowing national aggregation of DSR. EFA block windows for delivery could reduce participation from non-conventional assets that could provide the service. The principle of a units risk is dictated by certainty of delivery, and this risk is very different for non-conventional assets. If a unit is committed for a longer period of time, it is beholden to increasing uncertainty of availability. For example, if a wind unit were to bid into an ancillary service, it is required to maintain its commitment for an EFA block it may have a 60% confidence of being able to provide that service for 4 hours. This 4-hour EFA block may be characterised by 1-hour of very low chance of meeting the requirement, but 3-hours of high chance of meeting the requirement. By making commitment windows more granular (down to half hourly settlement periods), it reduces the risk of non-delivery for the committed period and therefore avoids additional risk premia added to the market price. At present, it is unclear how many of these providers, particularly those reliant on wind or solar availability, would participate in the ancillary services – but the ESO should keep this under review and avoid unnecessary barriers to entry.	

Static Firm Frequency Response

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Net Consumer Benefits	By moving to day-ahead procurement, the ESO is opening up the possibility for a service provider to co-optimise across all response markets. This will enable the ESO to make total expenditure savings across its response and reserve services.	
Adaptability	Due to the nature of Static FFR, the only fee paid is an availability fee in a MW/hour basis, and a commitment window is based on EFA blocks. The day-ahead procurement and EFA block commitment window enables the ESO to vary its requirement on a daily basis for each EFA block. However, the ESO will aim to procure 250MW of Static FFR in each EFA block. This will be dependent on: the single largest loss, the background inertia of the electricity system, and the procurement level of Dynamic Response products. This adaptability will prove to be important as FFR is phased out as the dynamic response products are introduced and takeover the requirement.	
Investability	Static FFR has been communicated to the market as expecting to be phased out (as with Dynamic FFR by the end of financial year 2023/24) eventually. There will be very little that will make the FFR revenue stream investable. There is, however, an understanding that Static FFR will be replaced with dynamic response products and Static Recovery. The latter may be designed very similar to Static FFR, and we will be able to assess the investability of the enduring product in due course. However, in terms of allowing an asset owner to achieve a revenue stream, the ESO has provided an additional opportunity to be successful in achieving an ancillary service contract. Further, for assets and optimisers that are transitioning from the FFR to dynamic auctions, this provides an opportunity for providers to familiarise themselves with being successful in the dynamic and reserve products, with the confidence of being able to utilise their experience in FFR auction success (albeit with new changes) to increase their chances of success. Static FFR's procured volume is based on the single largest loss, inertia background, stability pathfinders and Dynamic Response procurement. This could result in the procured capacity varying relatively frequently, however, the ESO's aim is to procure 250MW.	

Static Firm Frequency Response

Assessing the Market Design Principles

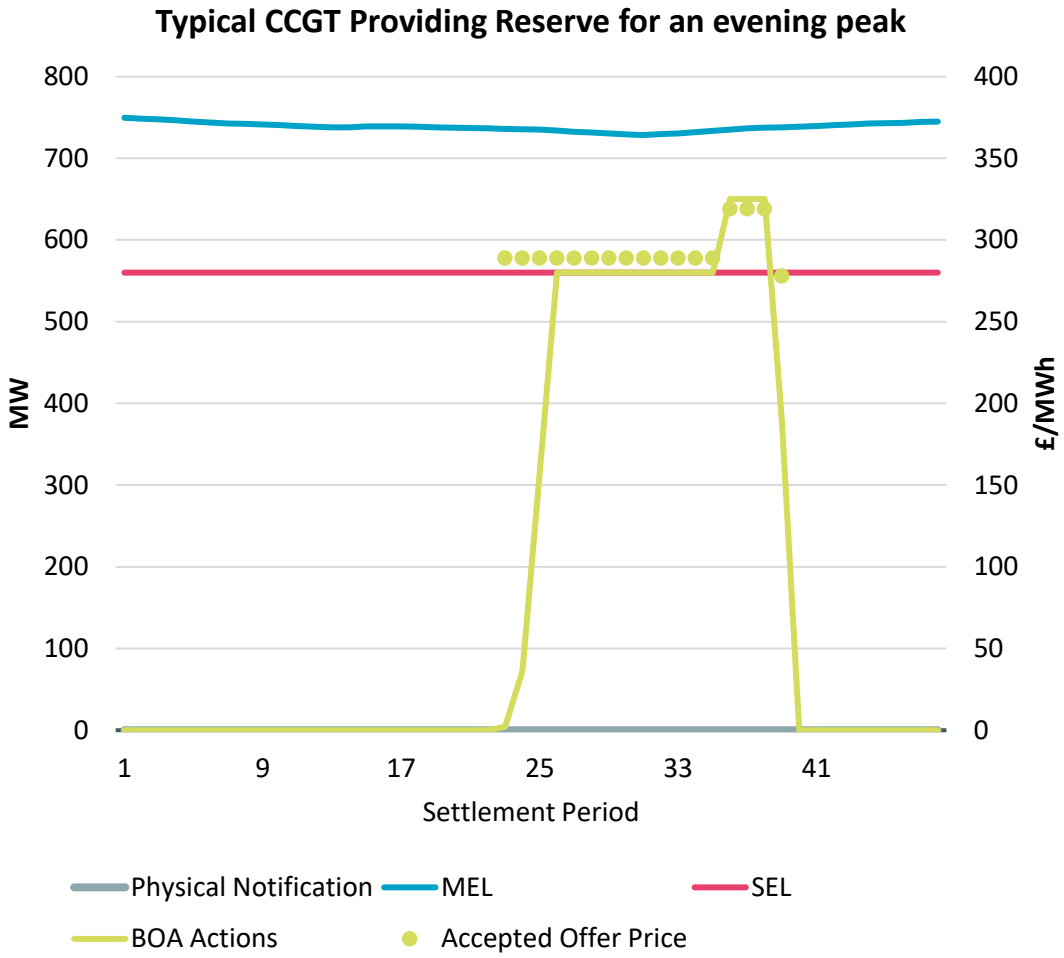
Principle	Assessment	RAG Rating
Coherence	**Following the approved changes to Static FFR - particularly to make it day-ahead procurement, pay-as-clear pricing mechanism, and EFA block commitment windows – makes the product consistent with other response balancing services. As an interim measure while the dynamic products develop, this will require all Static FFR providers to transition to the procurement and delivery methodology of the dynamic products. An issue with having Static FFR participating alongside the dynamic products is the risk of competition between the products, and Static FFR removing volume from DM and DR which would impact on the learnings and development of the market.** An ambition is to shift all balancing service procurement to half hourly settlement periods. This would ensure that the flexibility of the markets for the ESO remains as high as is possible; with the ESO being able to change procurement levels up to 48 times a day. This would also encourage those who would not otherwise have participated - due to the uncertainty of their ability to deliver across longer commitment windows - to tender. The current day-ahead auctions run at 11:00 and it is not expected to immediately be included in the EAC. However, auction results will be published no later than 17:00, but are expected to be published around 12:30. This is an important nuance, as any failure to notify a unit of their success or failure in the FFR auction would preclude them from any further bidding in the day. For this, we deem this to be amber, and the ESO should consider providing firmer commitments to 12:30 at the latest for auction results. This also would result in a wholesale market impact, as it would preclude capacity from participating in the day-ahead wholesale market, possibly pushing it into the intraday market for dispatch. The ESOs sequencing of the 11:00 auction is driven by time available in the day to run an auction, in an already crowded daily auction timetable, and the need to run it prior to the ESO's products that target capacity is reliant on the outcome of the Static FFR auction. Despite these risks, the 11:00 auction seems suitable as it comes shortly after the D-1 wholesale market and just as the GB-EU auction settles but there is an increased risk of price convergence with the wholesale market. This could also add complexities for interconnectors participating in the market and lead to some price convergence with the D-1 wholesale market. We have demonstrated that monthly FFR auction results have been linked and can be explained by power wholesale market prices (as well as volumes bidding into the market – as higher procurement levels attract higher levels or participation, but also captures more marginal units). We expect there to be a small impact on the power wholesale market from the enduring Static FFR market, and the monthly dynamic auction – but we there is a risk that we would observe price convergence between the markets – as we have already seen links.	
Locational Signals	No explicit locational signals are provided by the ESO for Static FFR. Frequency response is a national requirement, and as such, does not require a locational signal. However, aggregation is allowed up to GSP Group level that enables the ESO to understand where the response is being activated more easily, and manage the system and its network constraints as such.	
Transparency	The ESO provides market information on FFR for two months ahead (M-2). This information includes analysis of contracts awarded in FFR, and the requirements for the following month across all EFA blocks and across dynamic Primary, Secondary and High. Following the auctions, the ESO will publish the results, including the bid-stack and buy-order, enabling replication of the decisions being made.	

Reserve

Reserve Overview

Reserve requirements will vary

- **Reserve, in the form of headroom and footroom, is procured in order to access additional capacity of generation and demand. The amount of reserve required is affected by:**
  - Seasonal changes in demand and renewable output.
  - Temperature changes the amount of regulating reserve available.
  - Wind forecast and availability increases the reserve requirement as the impact of forecasting error increases.
  - Time of day for peaks and day of week, and also, a lower reserve requirement as forecasts increase in reliability closer to delivery.



Reserve

Reserve is becoming ever more important with increased wind and solar penetration

- **Reserve supports security of supply for the ESO for both pre- and post- fault. It secures against forecasting error (supply and demand), which has only increased in importance with the penetration of wind and solar generation, as well as acting as replacement energy for the loss of the single largest loss on the system.**

- The ESO currently meets its need for reserve through two methods: Short Term Operating Reserve (STOR); and, actions taken in the Balancing Mechanism (BM). Until the introduction of the Clean Energy Package (CEP), Reserve was procured through STOR, BM and an additional product called Fast Reserve (FR).

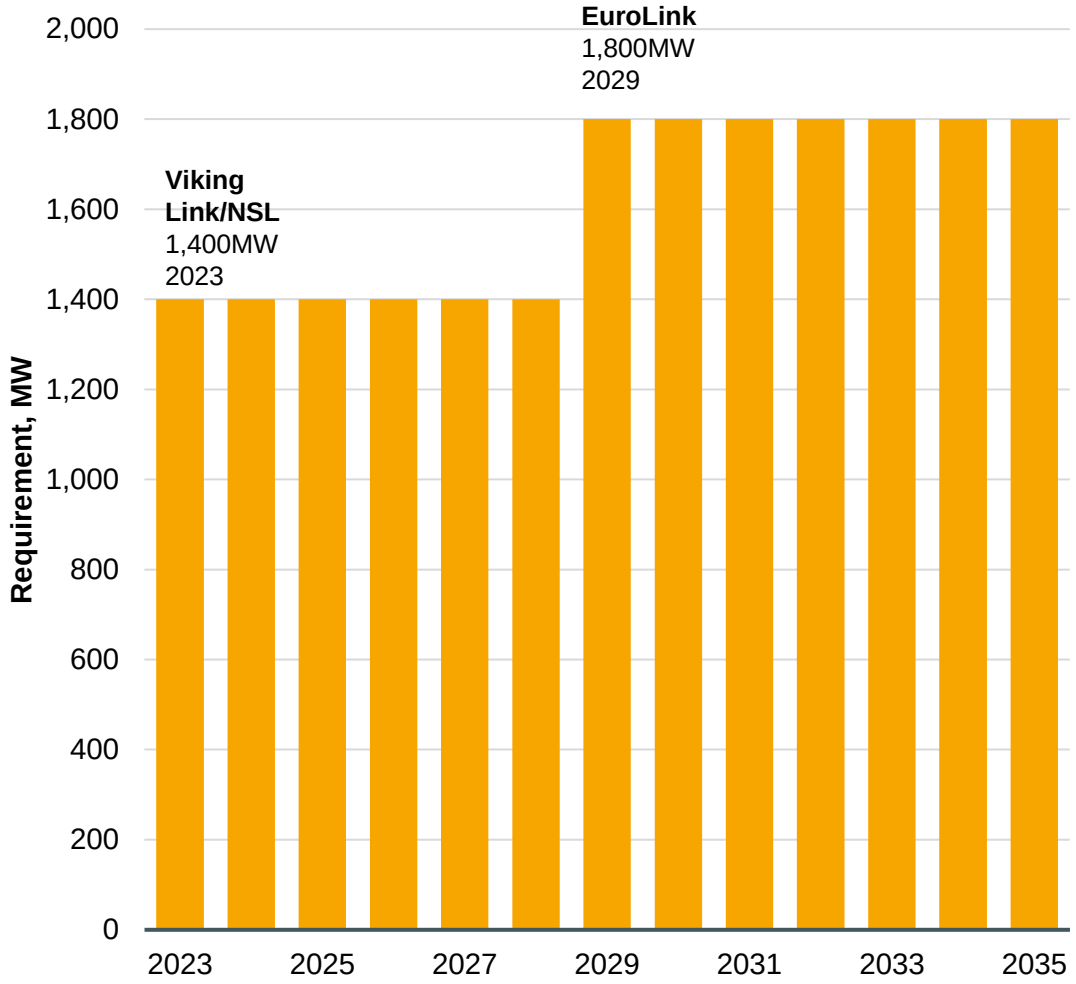
- All three of these products were inconsistent with the CEP, with the ESO opting to cease firm procurement of FR in 2020. This was due to the technical nature of the product being deemed unsuitable for procuring at day-ahead stage. Optional FR which is procured post-gate closure and intraday was maintained.

- With wind and solar penetration expected to increase exponentially as a key component to meeting net zero, and with the largest loss on the system to develop over the coming years, it is critical that the reserve products are able to work cohesively with exogenous market frameworks to ensure that investment in these markets remains suitable to meet the system requirement.

- Whereas post-fault reserve services are linked to the single largest loss, pre-fault reserve is linked to:
  - Demand and renewable forecast uncertainty;
  - Changes of demand behaviour; and
  - Fluctuation of interconnector flows

Reserve

The single largest loss is evolving with new assets coming online



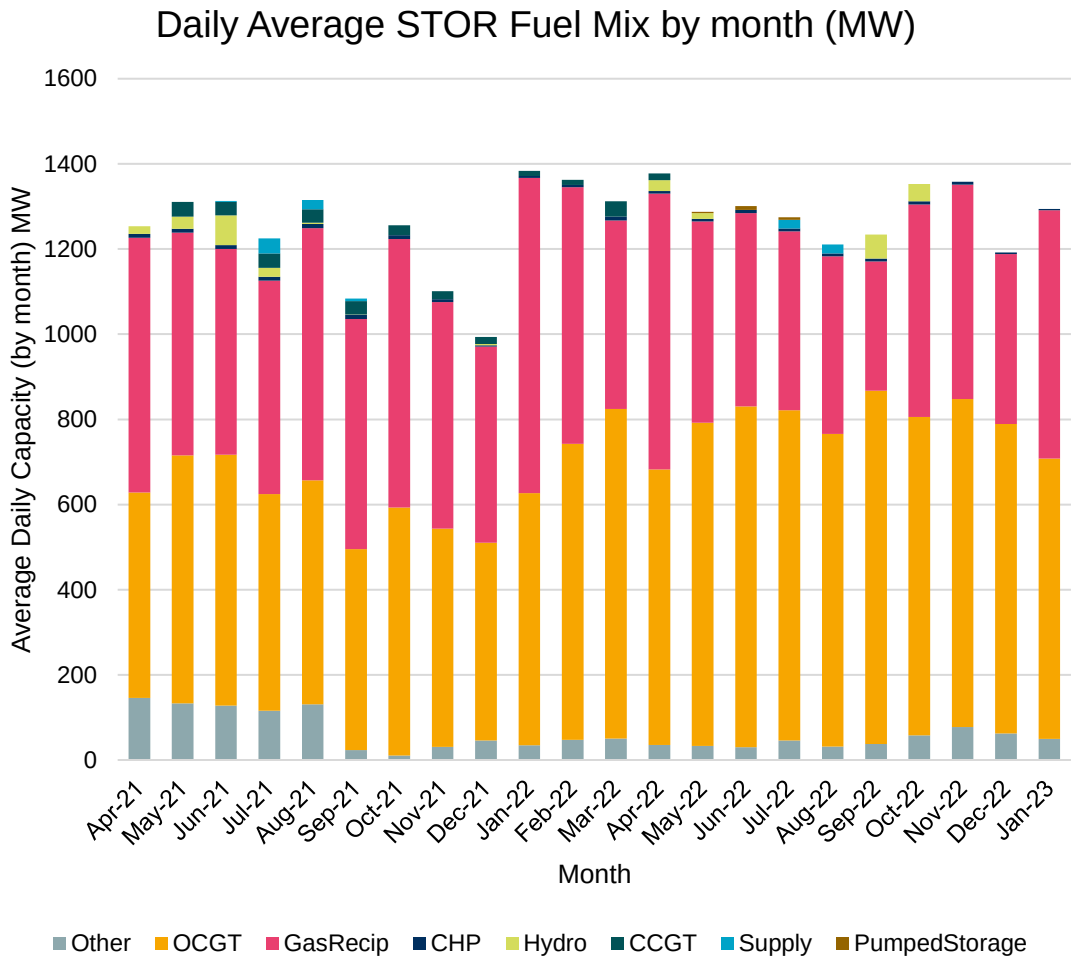
- The ESO's post-fault reserve services (like response) is linked to the largest credible loss on the system. Currently, that is typically either:
  - Sizewell B (1260MW);
  - A single bipole of IFA-1 (1000MW); or
  - North Sea Link (1400MW).
- In the coming years, however, several individual large infeed loss risks are due to come to market that will evolve the requirement of the ESO's reserve holding. These units include:
  - Hinkley Point C (1600MW) – due 2027;
  - Viking Link (1400MW) – due later this year;
  - EuroLink (1,800MW) due to be operational in 2029; and
  - Potentially, proposals of Xlinks, a 3GW interconnector.

Short-Term Operating Reserve (STOR)

Reserve

STOR provision is dominated by OCGT and Gas Recips

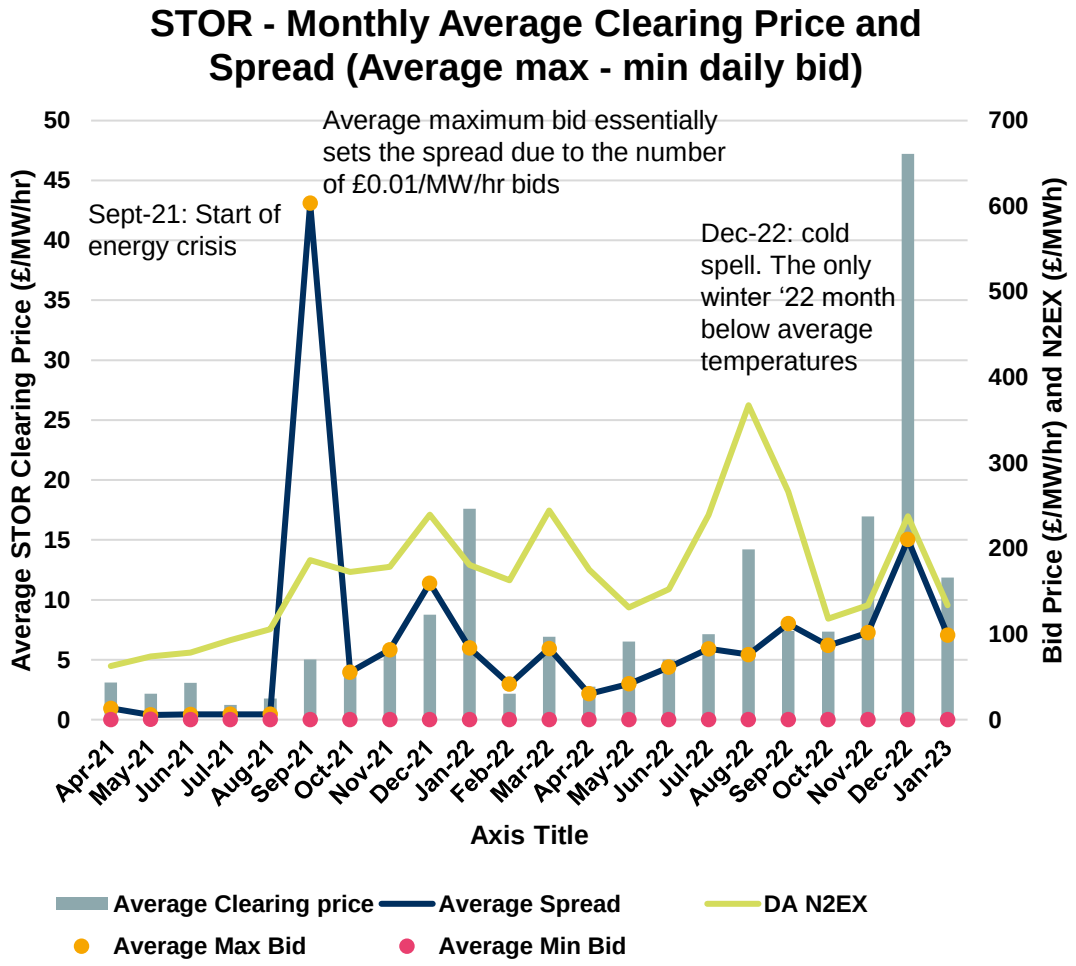
- **Short-term Operating Reserve (STOR) provides additional active power to the ESO when there is a post-fault (such as the loss of large generator) event on the electricity system.**
- It is accessible to service providers who can increase generation or reduce demand by at least 3MW across the committed windows (typically across the morning and evening peak).
- Service providers must be able to maintain the minimum delivery capacity for at least 2 hours and respond to an instruction within 20 minutes. Due to these requirements and that there are markets that better value new assets, the service is dominated by carbon intensive technology classes.
- Payments are made based on an availability fee that is determined in a day-ahead auction clearing price and a utilisation fee which is priced real-time to allow the STOR dispatch price to better reflect market scarcity.



Reserve

Short-term Operating Reserve prices can be relatively volatile

- **The average STOR availability clearing price from April 2021 to the end of January 2023 was £8.59/MW/hr.**
- This price has fluctuated on a day to day basis between a low of £0.01/MW/hr in May 2021 (monthly average £2.15/MW), to £175/MW in December 2022 (monthly average £47.20/MW/hr – the highest cost month).
- This volatility represents a standard deviation of 19.8 across 670 observation points – which is moderately significant, but less so than alternative electricity markets such as the wholesale market across the same period which have experienced significant volatility (baseload N2EX c. 90 across the same period).
- In the STOR auctions, £0.01/MW/hr have become standard bidding behaviour. This bid spread (shown on this graph as a daily maximum – daily minimum bid averaged over the month) has been significant since September 2021. This was the start of the energy crisis, where bidders had a higher marginal cost of production to cover, and were pricing in scarcity value. The average spread in bids was wide at £93.00/MW/hr.
- The spike in September 2021 average maximum bid represents a response to exogenous market drivers as providers factor in the opportunity cost of not participating in the wholesale market. September 2021 marked the start of the global energy crisis, with high electricity prices driven by high commodity costs and risk premia in trading. Since then, there has been some occasional loose corelation of the STOR clearing price with the N2EX day-ahead price, albeit to a smaller degree.



Reserve

The top 5 providers dominate the market with STOR being considered an Oligopoly

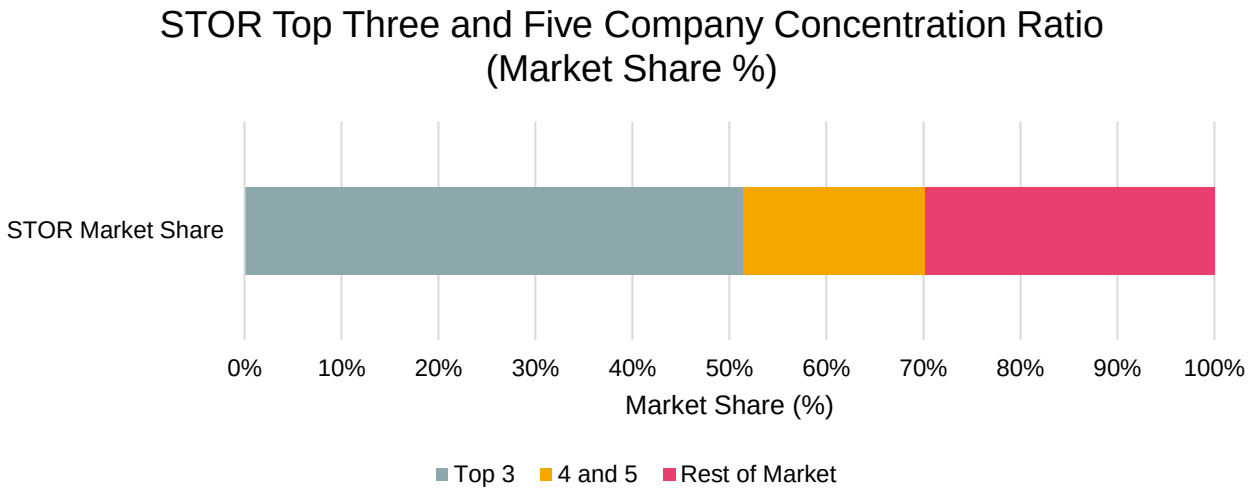
- **STOR average HHI is 1171, making it an unconcentrated market on average but possibly exhibiting signs of imperfect competition. However, it is considered an oligopoly.**

- This graph shows the top three and five concentration ration test. The top three owners hold 51% of the overall market share, with the largest provider accounting 21%. STOR has a top five concentration ratio of 70% which would be deemed as an oligopoly and uncompetitive.

- Market concentration in the STOR auctions since April 2021 on average has a Herfindahl-Hirschman Index (HHI) of 1171. This is below the threshold of 1500 for a moderately concentrated market, however, any market greater that 1000 could exhibit signs of imperfect competition and should be monitored. There are likely individual auctions where 1500HHI is exceeded.

- Over 50% of the market is held by the top three providers and around 70% held by the top 5 making it an oligopoly. This market structure suggests that any mergers or acquisitions would likely lead to significant increase market concentration.

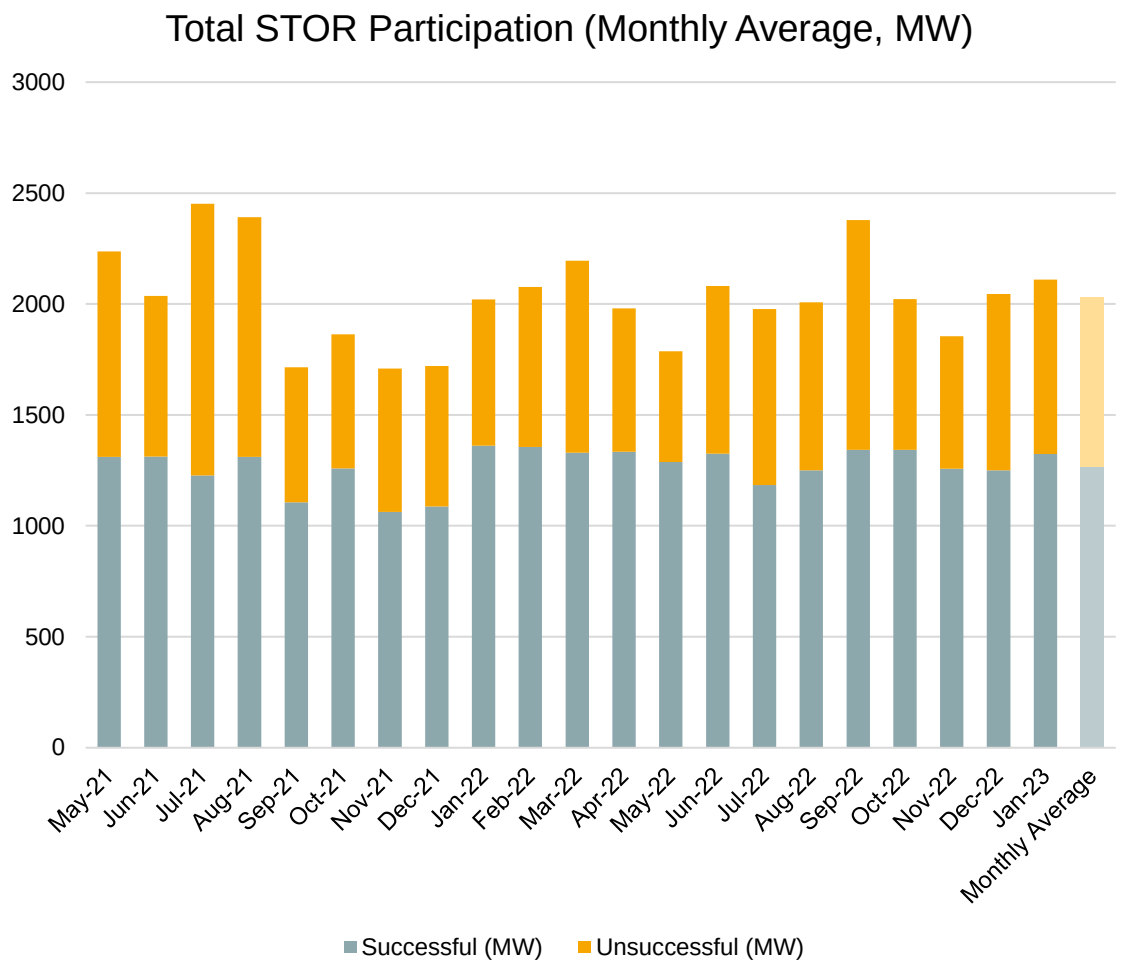
- Despite the average excess capacity in the STOR auctions being 60% (meaning that the market could cope with the unlikely exit of the top three market providers), there were four months where the headroom was less than that of the top three companies market share; the minimum head room being in May 2022, when normal STOR participating units are likely commencing outages.



Reserve

There is sufficient Headroom in STOR participation

- **The STOR requirements are based on the single credible largest loss on the system and the risk of underperformance of STOR assets. The average monthly requirement has been around 1300MW.**
- Despite the average concentration of the market being moderately significant, the auctions remain relatively deep. The average unsuccessful bidders (those who are uncompetitive in the auction rather than exiting the auctions) is 765MW.
- Across the period observed, this would allow for an average of 60% of the successful market participants to exit the market and the STOR requirement to be maintained (although at higher cost).



Short-Term Operating Reserve

Assessing the Market Design Principles

Short-term Operating Reserve

Assessing the Market Design Principles - Summary

What is the current situation and how is the market developing?

There are expectations for STOR to be phased out given that this is viewed as inconsistent with a net zero energy system. However, it has proven to be a well designed product, supporting security of supply at low cost. It has also demonstrated its flexibility to policy and regulatory change following adaptation following the implementation of the Clean Energy Package.

What are the relevant priorities under the market roadmap?

Making the STOR product procured at a day-ahead basis for commitment windows within day makes the product highly adaptable and, theoretically, incentivises all possible providers to consider participation with few barriers to entry (other than technical requirements).

We found through our analysis that STOR is not a centralised market, although a significant portion of the market is held by the top three asset owners. Generally the STOR market performs well against all principles, although it is seemingly not-coherent with policy direction; we are aware that any changes to address this would likely be deprioritised as the long-term reserve solution will be through quick and slow reserve.

As this product is phased out, the ESO should prioritise competition and net-consumer benefit to ensure that a fair price is paid and no market power is exhibited as the risk of assets exiting the market increases.

Priority principle	Assessment rational
Competition	The market is moderately concentrated which could provide an opportunity for market power to be exercised and inflate costs outside of a rational market when the requirement increases. The market also has a limited fuel mix.
Net Consumer Benefits	The cost of the ESO not holding a STOR product is significant, as one of the last interventions it can make to maintain security of supply in the event of pre- and post-fault incidents. Net-consumer benefit could be improved by improving market depth and seeking to reduce market concentration from the three largest providers.
Adaptability	STOR auctions run on a daily basis with two windows: one over the morning and the other over the evening peak. This allows for a flexible and adaptable market procurement approach.

Short-term Operating Reserve

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Competition	**The STOR market is relatively deep, with good average headroom in the auctions (capacity not achieving availability contracts) at 60% of the tendered capacity. Whilst the market is relatively competitive (with an HHI of <1500), we found that over 50% of the market is owned by the top three providers which could mean that any mergers or acquisitions would raise competition concerns. The market also has a limited fuel mix, which ultimately could lead to an increased market cost; particularly as it is more exposed to global commodity prices. We deem that competition is the highest priority principle for STOR to keep overall cost down. However, with STOR expected to be phased out, any reforms to STOR may be unnecessary at this stage.** From January 2022 to present, there was an average availability fee of £8.59/MW/hr, the smallest clearing price at £0.01/MW/hr, and the highest at £175/MW/hr. STOR is a relatively volatile market, with a standard deviation of 19.8, but less so than other energy markets across the same period. The STOR market is not concentrated, however, as the HHI is over 1000 there is a concern of the competition in the market – suggesting that in individual actions the 1500 HHI threshold is exceeded and imperfect competition existing. This raises the potential risk of market power being exercised to increase costs (for example, with the optimisation of portfolio which increases total expenditure). Despite these concerns, the market has been relatively deep, with a high amount of capacity bidding into the market in comparison to the tendered capacity. There has also been a significant amount of price-taking bids (down to £0.01/MW/hr) which has laid rise to the average bid spread of £93.00/MW/hr. The low availability bids indicate the desire for certain units to hold a STOR availability contract. This is likely largely due to the units having very low opportunity cost as they would otherwise not be dispatched. From April 2021 to present OCGTs and reciprocating peakers have accounted for 94% of the tendered STOR, with hydro, pumped storage, supply and CCGTs accounting for the other 6%. Not only do many of asset technology classes have stringent environmental regulations including running hour limits applied to them, the cost to run is high – meaning that they are typically only within merit for a handful of hours a year. The payment of a well priced availability fee provides a modest yet stable return (alongside other payments such as the CM) fits with the general operating models of the assets that bid into STOR. However, the high proportion of fossil-fuel derived generating units could pose an increased risk of exposing the STOR market to increasing commodity costs. Although the ESO could improve the STOR product by increasing competition in the market for both companies and technology classes, which we believe dictates an ‘amber’ status, it is understood that STOR is to be phased out in the coming years to ensure that the system can be operated at zero carbon. Therefore, it may be prudent to focus reforms to STOR to be deprioritised and effort concentrated on the reserve reforms.	

Short-term Operating Reserve

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Net Consumer Benefits	**The short term market allows for a daily market price that is representative of the prevailing market dynamics (any risk premia, commodity costs, and opportunity cost) for that day. Although this means that the market is allowed to respond upwards and increase STOR costs, this keeps the STOR requirement fulfilled, and is also allowed to respond downwards when other market costs are low. This prevents 'cost lock-in' for the ESO and therefore the end consumer. The cost of the ESO not holding a STOR product is significant, as it is one of the last interventions it can make to support security of supply in the event of post-fault incidents.** The daily auction allows for the STOR market to be representative of the costs incurred by the provider, and to add in the appropriate margin based on the revenue opportunity elsewhere and the prevailing market conditions. This reduces inaccurate or irrational bidding to protect against unknown opportunities and the inclusion of risk premiums. In theory, so long as a market is suitably liquid and is not concentrated, availability payments keep utilisation fees down, as it does not put so much pressure on uncertain utilisation fees to cover annual fixed costs. Assets bidding into STOR have particularly low load factors, driven by high marginal costs (efficiency, carbon and fuel) and environmental regulations (for example, limiting running hours). Assets that provide STOR are typically dedicated STOR assets (i.e., low load factor Non-BM units, or gas turbines installed behind larger trading units to provide auxiliary power and ancillary services). The availability payment on the STOR product ensures that those capable of providing the service remain available on the system. Alternative approaches would be a reformed product (discussed under Quick and Slow Reserve, and Balancing Reserve section), or, dispatch in the BM that would likely be more costly as similar units would be dispatched with no availability payment – pushing them to recover their fixed costs over the a limited number of runs. The utilisation of this product is used by many in the market as an indicator of scarcity and system stress, and therefore STOR is utilised in less than 900 settlement periods between January 2022 and February 23. Net-consumer benefit could be improved by improving market depth and seeking to reduce market concentration from the three largest providers. If it is the ESO's ambition to remove STOR and replace with Quick and Slow Reserve this should be an important consideration, and reducing the de minimis from 3MW to 1MW for these new products is a positive step. Although this product is mainly ageing and highly fossil fuel intensive units, it may be more cost effective to incentivise that these units remain available for such short running hours and 'back-up' than incentivising their replacement for security of supply.	

Short-term Operating Reserve

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Adaptability	**STOR auctions run on a daily basis procuring for typically two delivery windows; one over the morning and the other over the evening peak (optional STOR operates outside of these windows). This allows for a flexible and adaptable market procurement approach. When considering the adaptability of the STOR framework, this was proven through the implementation of the Clean Energy Package and the subsequent reforms to make the market pay as clear and by moving to day-ahead procurement.** With the market design of the STOR product, the ESO can change the parameters of the STOR auctions on a daily basis and procure differing amounts of STOR across the day for the different commitment windows. Despite this, on a monthly average it has stayed relatively stable at 1267MW with a maximum monthly average procurement of 1362MW, and a minimum of 1063MW. This is important as if the ESO were to increase its variation of the target capacity, this would send poor signals to the market and market providers which could ultimately increase market cost as risk premia is factored in. The target capacity is relatively easy to predict for participants as it is based on prevailing system dynamics and the predicted largest unit on the system, as is outlined in the Balancing Code No.1 (part of the Grid Code). The availability fee of STOR has a monthly average of £8.59/MW/hr. The utilisation fee is not included in the tender, instead allowing real-time intraday pricing. This allows STOR committed units to price their units accordingly to the prevailing market conditions. This makes the seldom utilised STOR product difficult to analyse the balance of availability to utilisation fee as the latter could peak to whatever the scarcity on the system is reflecting. Beyond that, Reserve Scarcity Pricing allows the cash-out price, and the STOR utilisation fee to become a multiple of whatever the Loss of Load Probability (LOLP) is (if >0, STOR is dispatched and wholesale market prices are greater than STOR utilisation fees). These pricing dynamics between availability and utilisation fees reflect the seldom, yet important, nature of the STOR product for security of supply.	

Short-term Operating Reserve

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Investability	**There is little to no need for STOR to focus on primary investment (i.e. bringing new units onto the system) with the product expected to be phased out as well as the CM available to maintain units on the system. Rather the ESO should ensure that STOR, or alternative products, remain regular and dependable revenue stream for investors and developers who will consider STOR in their revenue streams when building or maintaining a viable business case. There is no expectation that specific investment from STOR is needed to meet the long-term requirement.** The units that are being put forward to provide STOR are typically existing units and are either opting in to participate in STOR due to the opportunity of achieving higher returns than in other revenue streams (i.e.. the wholesale market), or, because it is how the operator is choosing to optimise the units (for example, to avoid margining costs of an asset in the merchant markets). A long-term contract is not required to provide STOR or incentivise investment as there are other mechanisms, such as the Capacity Market, that can support the investment case in these products. The assets are also valued in merchant markets, albeit rather limited due to the missing money market failure due to decreasing access to residual demand (demand not met by intermittent renewables and nuclear). STOR will help to build a business case for an asset through a blended approach to revenue streams, diversification of revenue opportunity, and a beneficial availability market. Assets bidding into STOR are doing so as part of daily optimisation, looking for the most lucrative contract to obtain based on where the revenue opportunity is. The STOR markets ability to respond to high merchant market price enables the requirement to be maintained through both availability fee and real-time utilisation bidding. Many STOR units have high short-run marginal costs due to a lower High Heating Value (HHV) efficiency and higher carbon intensity, therefore, their exposure to global commodity costs can be considerable – short-term, short-duration auctions help the optimiser to cover a units position and costs at a more regular cadence. A STOR asset is typically existing, but its Variable Operations and Maintenance (VOM) can be significant, roughly it to be the same as CCGT's and CHP's at £5/MWh – this can be largely covered with the availability fee and the ability to access a CM agreement. There is a need for the ESO to provide certainty over the future of STOR to be signalled as far out as possible to allow existing assets to prepare for the new reserve markets, or to prepare for asset retirement.	

Short-term Operating Reserve

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Coherence	**The ESO continues to maintain consistency in its approach to procuring STOR, with average monthly procured quantities stable and tracking to the largest losses on the system. This makes it fairly easy for market participants to forecast tendered target capacities. Currently, STOR is not consistent with indicated Government ambition in REMA, and decarbonisation targets. More immediately, STOR may not be consistent with the ESO's ambition to operated a zero-carbon electricity system by 2025. The ESO has indicated its ambition to replace STOR – without this indication we would deem this principle to be amber.** At present, STOR is not consistent with decarbonisation targets. There are few technology classes that are capable of providing the STOR service that are not carbon intensive, are not valued better elsewhere for the services they can provide (for example, pumped storage), or have support mechanisms that interfere with participating in ancillary services. Similar criticisms have been made of the Capacity Market, with the UK Government taking proactive steps in the 2021 Call for Evidence and the subsequent 2023 consultation to better align it with net zero. STOR will also seemingly not be consistent with the ESO's ambition to be able to operate the electricity system net zero by 2025. The UK Governments signalled ambition of locational pricing in the Review of Electricity Market Arrangements (REMA) may replace the need for certain energy balancing actions, it is likely that a need to correct sudden changes in supply and demand (pre-fault) and large generation losses (post-fault) will persist. Therefore, STOR seems to remain consistent with this policy package. The stackability of STOR is limited to non-energy services and the Capacity Market so as to prevent the double delivery. However, if a bid is accepted that is curtailed, under the Enduring Auction Capability (EAC), it would be easier for the provider to offer non-accepted capacity to other revenue streams, such as other reserve or even self dispatch through the wholesale market. This would likely bring down the cost of delivery in STOR, as undispatched or valued capacity able to more easily access a revenue stream and the loss of earnings not being factored into the minimum acceptable volume. The ESO is assessing revenue stacking and splitting with STOR and its suitability and for the foreseeable it will only be allowed with response products. The wholesale market impact of STOR is limited by the way in which a lot of STOR assets are specifically bid into the market, and have little appetite to participate in merchant markets. STOR assets, as currently participating, tend to be low efficiency units, with environmental running limits. These would be rarely within merit in the wholesale market, and therefore we deem the impact on the wholesale market to be limited.	

Short-term Operating Reserve

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Locational Signals	**STOR does not have locational requirements at tender stage, however, location is taken into account in dispatch. It may be more appropriate in the future to provide locational signals at tender stage, however, that may send unnecessary market signals for when the whole of the STOR requirement is utilised to balance supply and demand (for example, a post-fault issue).** STOR does not distinguish at tender stage between locational need as this is largely fluid intraday. For example, this could be based on thermal constraints in the transmission network. This is primarily a service that needs to be able to provide energy quickly and for a longer duration in the event of a fault on the system – taking over from response services and therefore a national need. Locational signals are sent implicitly through BM acceptances not made for energy reasons (system flagged) when dispatching STOR units, for example if a STOR unit is missed in the BM merit order despite being seemingly the next unit in the stack replacing a more cost effective offer. The ESO may be able to reduce the amount of required STOR (and therefore reduce Totex) holding if pre-tender locational signals are sent where the service can be relied upon for its accessibility regardless of constraint concerns or confidence in a units output usable based on constraints. However, many of the assets in STOR have fewer locational constraints than other technology classes, such as intermittent renewables that are based on the wrong side of boundary constraints. There is seemingly a lack of need for a pre-tender locational signal, and as such we deem STOR to be adequately aligned with the locational signals principle.	
Transparency	**STOR transparency could be improved by ahead of time forecasting of requirement, similar to what is provided for the Dynamic Response products. However, this is complicated through individual unit behaviour, and the reliance on units honouring their Initial Physical Notification (IPN).** STOR seasons and committed windows are published to industry on an annual basis based on the requirement over the coming financial year. However, STOR requirement being published ahead of time could be improved. Currently it is fairly static and is only published in the Market Information Report. This is largely due to the requirement being influenced by the forecast single credible largest loss which is only known to the ESO once a) units seemingly likely to be generating on the day through REMIT data has been ascertained, and b) demand and generation forecasts are more accurate. With 05:00GMT day-ahead procurement, the ESO sets STOR auction parameters on incomplete information (prior to Initial PN's and interconnector schedules). Providers are able to forecast the STOR requirement with some degree of confidence based on what the assumed largest single generator on the system will be (through REMIT data), and the supply and demand forecasts. The ESO could improve transparency of STOR by providing forecasts of STOR requirement ahead of time, eve with confidence intervals. Following STOR procurement, the ESO published full bid-stack data and auction results. To better understand auction decisions, it would be beneficial to market providers on developing their future positioning in the market by providing decision codes against each provider.	

Quick and Slow Reserve

Overview

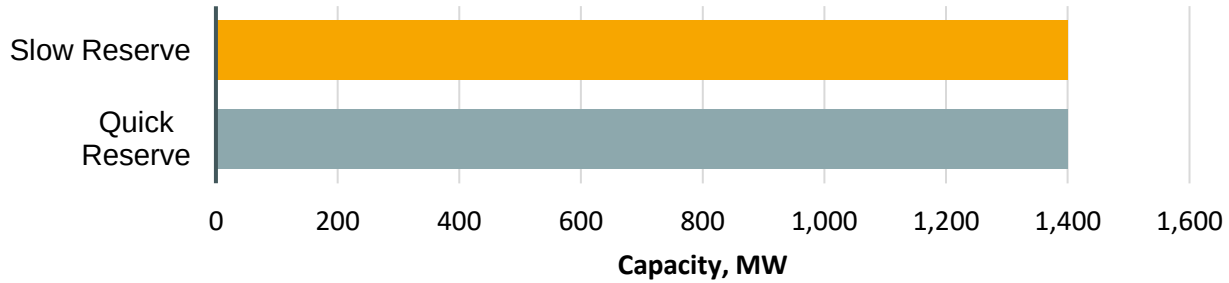
Quick Reserve

Slow Reserve

Reserve

There are two main products under Reserve Reform: Quick and Slow Reserve

- **The ESO has commenced a programme of work that will implement a suite of positive and negative reserve products. These new products will replace: Short Term Operating Reserve (STOR), Fast Reserve (FR) and Optional Downward Flexibility Management (OFDM).**
- The two main products in this new suite of products under Reserve Reform are:
  - Quick Reserve:
    - Min Capacity 1MW
    - Full activation within 1 min
    - Sustain 5 – 15 mins
  - Slow Reserve:
    - Full activation within 15 mins
    - Sustain 30 – 120 mins
- The tables to the right show the commitment windows for Slow reserve (one overnight 8 hour window and eight 2-hour window) and Quick reserve which is twelve 2-hour windows.
- Both of these products will be assigned by ESO as optional and/or firm requirement (as demonstrated in the table to the right). If optional, no availability fee is paid, but a utilisation fee will be. Firm will provide a utilisation and an availability fee.



Source: NGESO Operability Strategy Report, Dec 2022

Quick Reserve Windows

Window	1	2	3	4	5	6	7	8	9	10	11	12
Start	23:00	00:59	03:00	05:00	07:00	09:00	11:00	13:00	15:00	17:00	19:00	21:00
End	00:59	02:59	04:59	06:59	08:59	10:59	12:59	14:59	16:59	18:59	20:59	22:59

Slow Reserve Windows

Window	1	2	3	4	5	6	7	8	9
Start	23:00	07:00	09:00	11:00	13:00	15:00	17:00	19:00	21:00
End	06:59	08:59	10:59	12:59	14:59	16:59	18:59	20:59	22:59

Quick Reserve

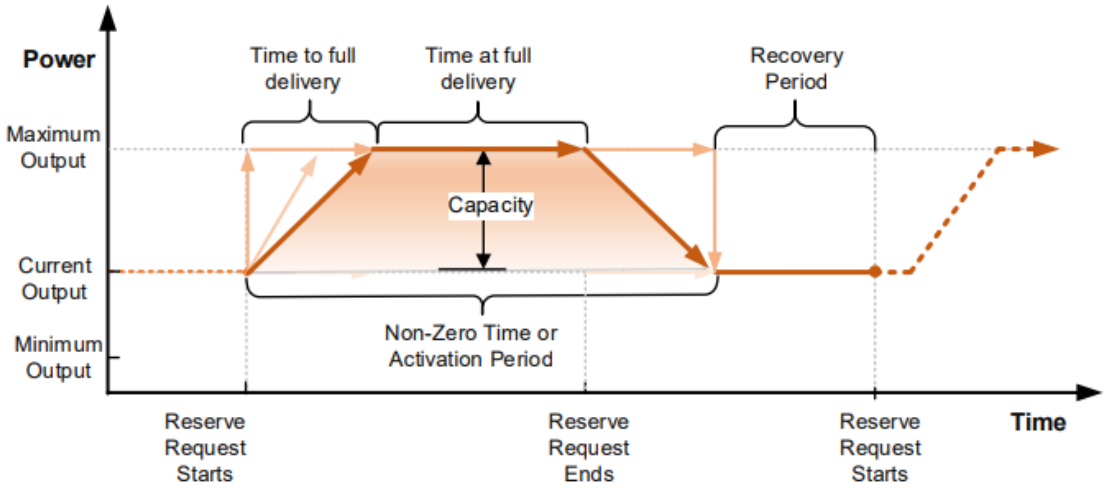
There are minimum technical requirements to delivering Quick Reserve

- **Quick reserve is a fast acting frequency management service needed for when there is supply/demand imbalance. It is a symmetrical service, separated into Negative Quick Reserve (NQR) and Positive Quick Reserve (PQR).**

- The aims of Quick reserve are to:
  - Restore the system frequency within statutory limits within 60 seconds;
  - Restore the system frequency within operational limits within 15 minutes; and,
  - Respond to supply/demand imbalances that take pre-fault frequency close to operational limits.

- The technical requirements are:
  - Minimum capacity: 1MW
  - Time to Full Delivery: Full activation within 1 minute
  - Max. Activation Period: min. 15 mins
  - Min. Activation period: Up to 5 mins
  - Aggregation Rules: Within GSP Group
  - Dispatch mechanism: BM: BOAs, Non-BM: ASDP
  - Operational/Performance metering: 1Hz/1Hz
  - Baselining: 60-minute nomination baseline

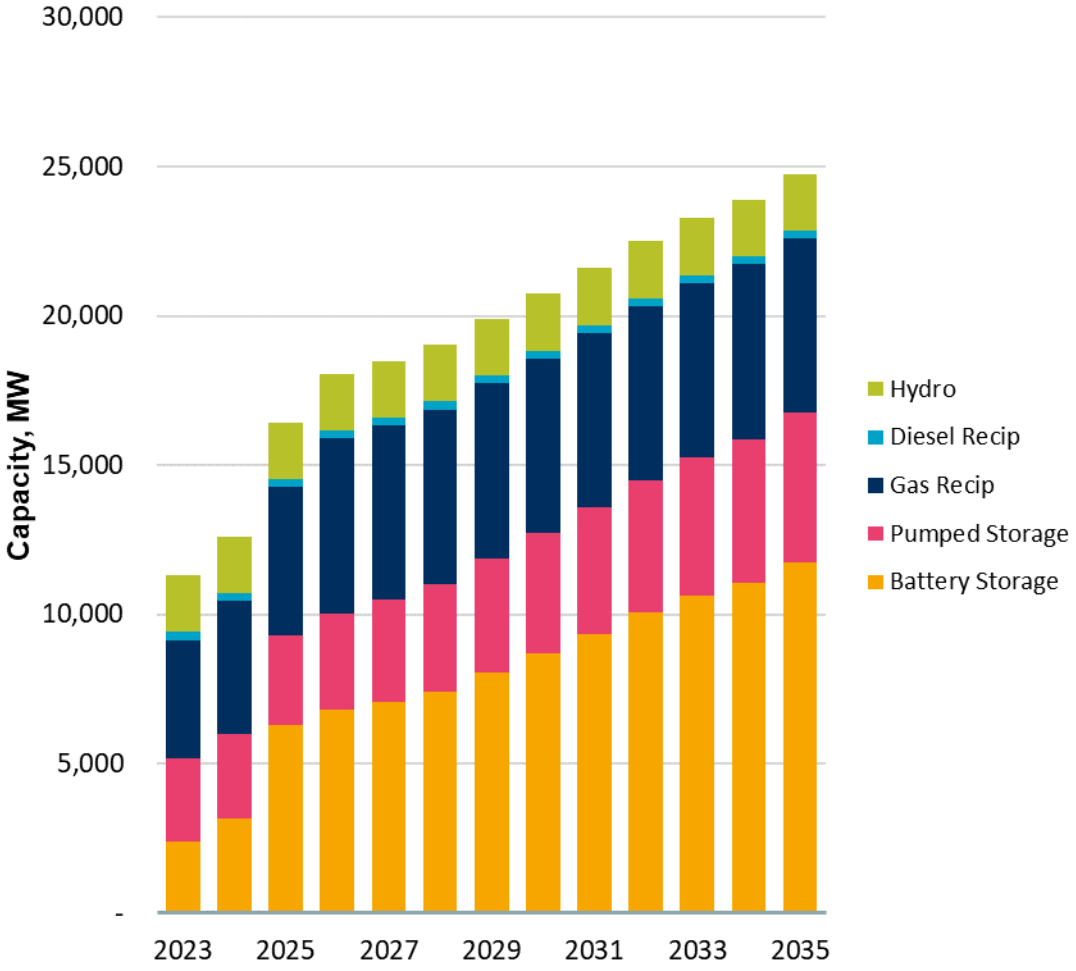
- The ESO will hold Quick reserve procurement in a co-optimised auction across DC, DR, DM, Slow and Quick reserve.



Quick Reserve

We expect that the total installed capacity able to provide Quick Reserve will exceed the published requirement

- **As part of the ESO's Ancillary Services Capability mapping project, LCP Delta was separately engaged by the ESO to understand what assets may be able to provide this service. We expect that the total installed capacity able to provide quick reserve will exceed the published requirement.**
- This capacity consists of:
  - Controllable Hydro (which has been active in the STOR DA markets in summer)
  - Pumped Storage
  - Gas/Diesel Reciprocating units – typical start-up times c. 2 mins to full load but upgrades are available which can reduce this to below one min. This keeps start up costs low and therefore increased round trip efficiency.
  - Battery Storage – short duration (c. 1h) assets will operate principally in energy and frequency markets as this is where their unique dynamics are best valued.



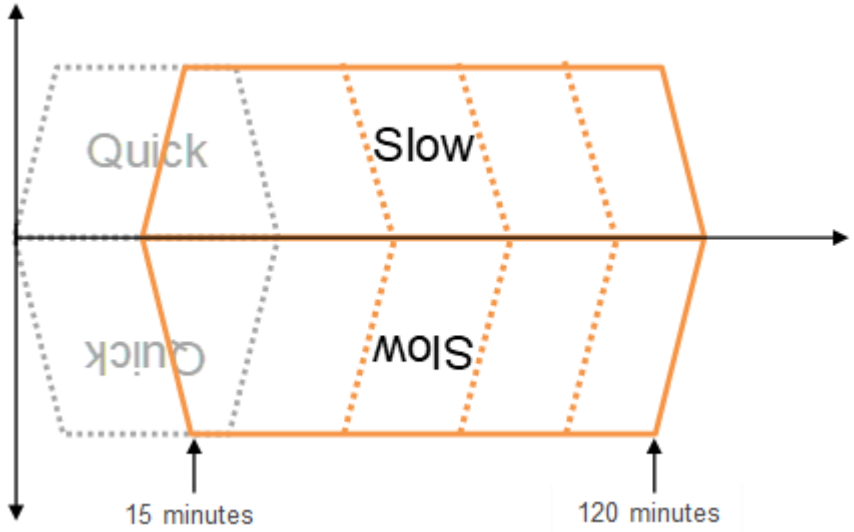
NB: Battery deployment likely a conservative estimate in light of CM T-4 auctions held in 2023 and will likely exceed this

Slow Reserve

There are minimum technical requirements to delivering Slow Reserve

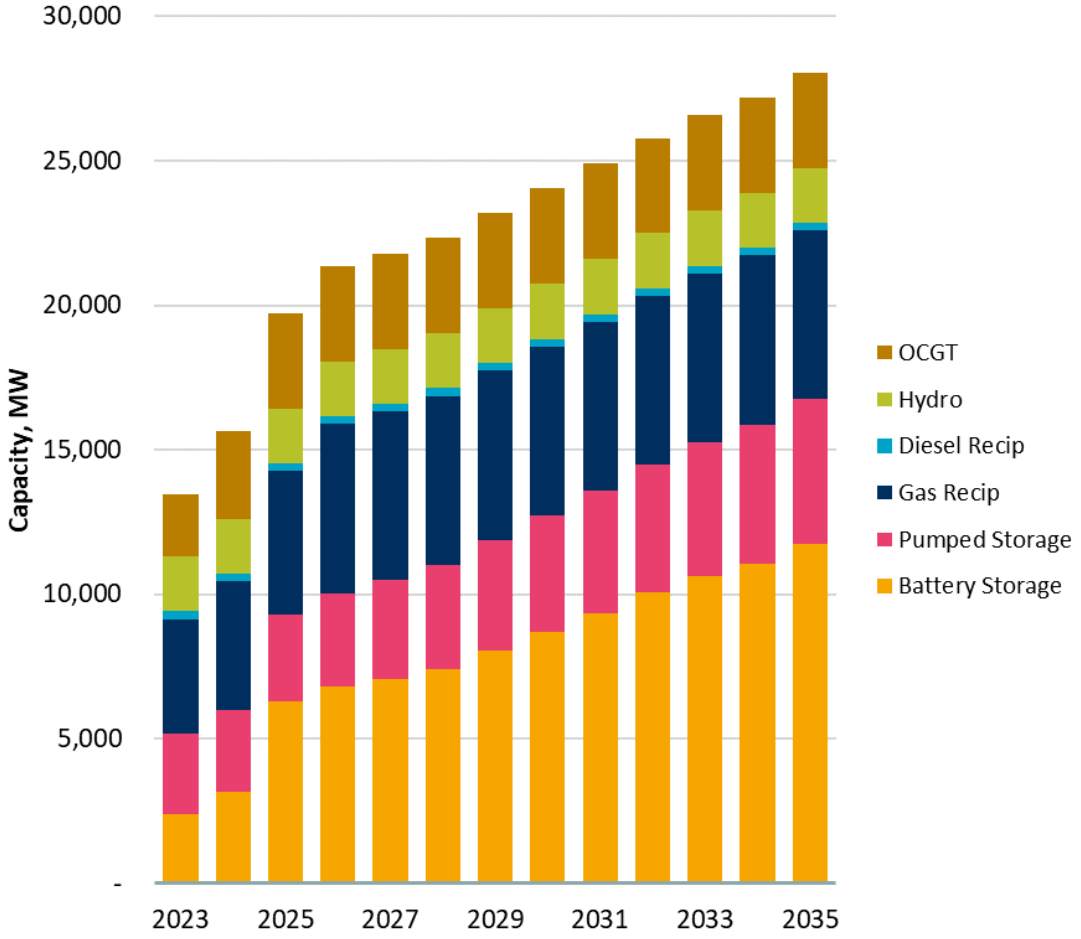
- **Slow reserve is a post-fault reserve service for frequency management when there is an imbalance between supply/demand. It is a symmetrical service separated into Negative Slow Reserve (NSR) and Positive Slow Reserve (PSR)**

- Technical requirements:
  - Full activation time: within 15 mins of instruction
  - Max. Activation Time: min. 120 mins
  - Min. Activation Time: max. of 30 mins
  - Max. recover time: 30 mins
  - Aggregation Rules: Within GSP Group
  - Dispatch mechanism: BM: BOAs, Non-BM: ASDP
  - Operational/Performance metering: 1Hz/1Hz
  - Baselining: 60-minute nomination baseline



Slow Reserve

There is a significant capacity that will be available to meet the Slow Reserve requirement



- Slow Reserve is driven by the System Operator Guidelines (SOGL) to restore the frequency to within +/-0.2Hz deviation following a contingency and there is significant pipeline capacity available to meet requirement.
  - The slower time to full load requirement allows additional technology classes to participate in this service. For example, OCGTs which have a start-up time in the region of 15min but typically have larger installed capacity than reciprocating engines can participate. We are also aware of some Original Equipment Manufacturers (OEMs) which can make sub 10 minute start-ups possible.
  - The Quick Reserve service is similar to Fast Reserve which has historically seen a large number of short duration instructions.
- The ESO will hold Slow Reserve procurement in a co-optimised auction across DC, DR, DM, Slow and Quick reserve. Originally, the ESO was to take a two auction combined approach to procurement. An initial early morning auction to provide the ESO with confidence of a base requirement for Slow reserve being met, supplemented with an afternoon auction aimed at DER units as this is when confidence in delivery is greater. This shows adaptability in the ESO market design to meet the needs of the participants.

Quick and Slow Reserve

Assessing the Market Design Principles

Quick and Slow Reserve

Assessing the Market Design Principles - Summary

What is the current situation and how is the market developing?

Quick and Slow Reserve are the ESOs long-term enduring solution to the reserve system need. Over time, these two products will replace STOR and Optional Fast Reserve.

What are the relevant priorities under the market roadmap?

We have found that the design principles of Quick and Slow Reserve are well aligned to the framework, however, it will be easier to assess once active. The Quick and Slow Reserve products are well designed to enable high levels of participation while achieving the base requirement far enough ahead of real time for ESO control room planning.

We believe that new products must be highly adaptable to allow for adjustments to be made once implemented. The ESO should focus on ensuring that as much competition is possible in the market in order to keep prices low and ensure net-consumer benefit is high.

Priority principle	Assessment rational
Competition	We have identified a significant and growing capacity capable of providing both Quick and Slow reserve
Net Consumer Benefits	The cost of not reforming could bring about very real risk to security of supply in the future. As zero cost generation increase in system penetration it is important that the ESO has tools ready to manage the system.
Adaptability	The ESO also has the option of not procuring windows, and also opting to not procure firm reserve over windows where the requirement is low. This means that an availability fee is not provided and only a utilisation fee is paid out in the event of dispatch

Quick and Slow Reserve

Assessing the Market Principles

Principle	Assessment	RAG Rating
Competition	**We have identified a significant and growing capacity capable of providing both Quick and Slow Reserve. It is important that the ESO considers this when developing the markets to ensure they remain open to technologies.** For Quick and Slow Reserve, the delivery windows will initially be 2 hours in duration. Only with Quick Reserve has there been an explicit commitment by the ESO to move towards settlement period commitment windows. Typically, a longer commitment window will preclude assets that rely on either prevailing system conditions to know availability (such as opportunity to charge and make commitment to a service profitable) and to assets such as wind and solar that, if they were to compete in the future, would benefit from shorter commitment windows where weather forecasts can de-risk commitment (for example, a forecast being 90% accurate for 30 minutes, but only 50% accurate for 2 hours). Further, a 2-hour commitment window precludes any storage asset with a duration of less than 2 hours – which is a significant proportion of the battery storage market. As competition increases in the dynamic product, it seems counter intuitive to limit market participation through increasing duration requirement. It is also worth noting that longer duration will likely seek to weight their optimisation strategy towards arbitrage over ancillary services as greater returns from an intraday spread may be accessible for the peak periods. The ESO should consider moving to shorter commitment windows in the future. The ESO is also implementing a 500MW single unit cap on the markets. The reasons for this are two fold, i) Preventing units exercising market power by concentrating the market when it is being developed, and ii) it allows confidence that an asset will be available to the ESO to be flexed up to it's MEL or down to SEL. Whilst a cap is important for the purposes of avoiding a concentrated market and introducing false liquidity, this should be a temporary measure that should be removed after a mature market has been developed. The 500MW cap for means of flexibility is unlikely to capture many assets, with only large CCGTs, nuclear and pumped storage coming above that cap. The ESO has made good steps in evolving the development of the Quick and Slow Reserve products to ensure maximum participation. For example, they have recently reviewed the recovery time – which is a important design consideration for reciprocating engines, pumped hydro, DSR and gas turbines but less so for battery storage – to ensure that it is suitable for these assets. When reviewing day-ahead STOR assets, the ESO has found that c.80% of existing STOR assets would be able to participate in Slow Reserve with a maximum recovery of 30 mins. Similarly, following engagement with industry, the ESO has increased the recovery period for Quick reserve from 1 min to 30 mins. A co-optimised auction across all new response and reserve products provides simplicity to participating in the auctions. This will encourage wider participation from assets, providing competitive price formation, which will provide a net-consumer benefit.	

Quick and Slow Reserve

Assessing the Market Principles

Principle	Assessment	RAG Rating
Net Consumer Benefits	**The move towards Reserve reform is a required step that the ESO needs to make to ensure that the electricity system remains suitable for decreasing inertia levels and increasing single credible largest loss.** The existing Reserve suite of products were inconsistent with new regulations and would not lend themselves to operating such low inertia system without increasing carbon intensity. As these have not yet been implemented, it is difficult to place a cost prediction on the Reserve reform markets, however, the cost of not reforming could bring about very real risk to security of supply in the future. Cost of generation in GB is lowest in zero-marginal generation, namely wind and solar, and as these increase in system penetration it is important that the ESO has its tools mature and ready to manage the system. The Enduring Auction Capability (EAC) programme will implement an auction platform owned by the ESO that will, among other things, ease stacking across products. Form day one of the auction, it would be possible to stack a Quick or Slow Reserve positive contract with a negative contract, and possibly with a non-energy contract so long as it did not impact on the assets ability to provide the reserve service. The EAC will enable the asset operators to more easily optimise their assets, maximising their potential revenue but also ensuring that the asset is properly utilised. This should provide a cost benefit bringing down the cost of production for multiple ancillary services and increasing total revenues for the asset owner. The 2-hour windows provide more flexibility than EFA blocks to the asset operators, improving competition in comparison to existing and other ancillary services. This also limits the risk to the ESO of the complexities of auctioning on a half hourly basis. The co-optimised auction for the Dynamic Response and Quick and Slow Reserve products should result in lower prices as the day-ahead trading session is less congested and the simplicity of bidding into the market is improved.	
Adaptability	Quick and Slow Reserve will both be procured day-ahead across a number of 2-hour windows (and an 8-hour window overnight). The ESO is able to set the requirement for each of those availability windows ahead of procurement. The procurement is somewhat predictable and stable, as it is set out in the Grid Code based on the single largest loss, background inertia of the system and the stability pathfinders active. Further, the ESO also has the option of not procuring windows, and also opting to not procure firm reserve over windows where the requirement is low. This means that an availability fee is not provided and only a utilisation fee is paid out in the event of dispatch. Confirmed for Quick reserve, an eventual move to half-hourly settlement periods from 2-hour availability windows would further improve this flexibility, which although not deserving of an amber has meant that we assess this principle as light green. For firm Slow and Quick Reserve, an availability fee is paid based on the auction clearing price (from phase 2 onwards) set on a pay-as-clear basis. This is stacked with a utilisation fee if a unit is dispatched based on a price bid into either the BM or PAS. The real-time pricing structure of the utilisation fee enables the unit to recover its costs more accurately – costs that an asset provider would not have perfect foresight on at day-ahead stage. Conversely, the availability fee prevents the utilisation fee from needing to be uneconomically expensive for that period, particularly if a seldom dispatched unit seeks to recover its fixed costs over its limited annual runs, such as in STOR. If a unit was not paid a utilisation and availability fee, this would likely result in higher market cost as a service provider would need to factor in the cost of an asset being dispatched; even in windows where it seems unlikely.	

Quick and Slow Reserve

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Investability	**It is difficult to assess the investability of a market that has not yet been launched. As with our view of all the other ancillary services procured at day-ahead stage, investability is gained through long term, stable revenue streams that make a business viable. These markets do not offer these investment signals, but rather wider UK Government energy policy, such as the Capacity Market that can cover fixed costs, are able to.** Quick and Slow Reserve can help with investability through providing an accessible revenue stream that provides an opportunity for asset owners to increase certainty of daily returns through a variety of revenue streams. Essentially, the ESO must focus on making Quick and Slow Reserve accessible to all technology types that can or could provide the service, and maintain regular procurement (or good foresight and transparency of when it will not and why). From the outset, ESO will be launching regular procurement through a co-optimised, day-ahead auction with dynamic response products. This is a positive step for investability in the reserve markets. Although it is limited at launch of the products, these co-optimised auctions (or the EAC) will ease stacking and splitting. For firm Quick and Slow Reserve, a pay as clear dictated clearing price will be set for the availability fee and pay-as-bid (real-time pricing) utilisation fee. In a following phase of implementation we expect half hourly settlement period windows to be implemented, which will increase participation and an asset owners ability to optimise its asset more efficiently – ensuring its technical dynamics are being deployed where the ESO most values them. We deem the move to half hourly settlement periods important for the investability of the Quick and Slow Reserve products. The ESO markets have provided the clear market signals for the investment in batteries which have, until recently (with the 2022 Capacity Market agreements favour shifting to 2-hour+ batteries), been short duration. It is important that the ESO remains able to tap into these shorter duration batteries as they will remain valuable to the electricity system. With increasing levels of competition in the dynamic suite of products (and market saturation already demonstrated in DC), it will send a favourable signal to the investment community of the value of the assets by enabling sub 2-hour storage technologies to participate in these Reserve markets (if they meet technical requirements). In most cases, battery storage is best suited to provide frequency response and will be valued best in these balancing services. This means that there could be less reserve provided by batteries than would be expected, unless the battery asset is particularly well suited to reserve (such as being longer duration) or they optimise through reserve due to missing out on a Dynamic Response contract. Reserve will be met most cheaply through the units that are out of merit in the power wholesale market, and were not expected to run. These units have the lowest opportunity cost – such as gas peakers – and therefore will be the most cost-effective reserve provider. Although the 500MW cap is high, it could still send perverse investment signals to the market, incentivising or encouraging investment in assets below that cap to avoid precluding its assets from revenue streams. The ESO should be mindful of the weight that the signals it sends to investors and developers has.	

Quick and Slow Reserve

Assessing the Market Principles

Principle	Assessment	RAG Rating
Coherence	**For firm Quick and Slow Reserve, the day-ahead procurement and stacking of a utilisation fee with an availability fee is consistent with the ESOs ongoing approach of keeping Reserve costs down by paying only when needed and to avoid unnecessarily high availability fees. However, this is inconsistent across the other response markets that offer only availability fees. This is though justified as load factors of Reserve units are often significantly lower than those across the other response areas.** The ESO is proposing to maintain delivery days to 23:00-22:59 (referred to as an "EFA day"). This is consistent with other balancing services, and also maintains consistency with continental Europe's ancillary service frameworks, were GB were to enter into pan-European market agreements in the future. This also helps to align with interconnector scheduling, and would not preclude interconnectors from participating in Slow and Quick Reserve if able (similar to Moyle in the Static FFR mock auctions). In consideration of UK Government decarbonisation policy and the ESOs target to operate the electricity system zero-carbon by 2025, these new Reserve markets will further support the roll out of increasing levels of non-synchronous, zero-carbon generation. Although the Reserve Reform markets do not include locational elements, there is nothing in the market design that would be impacted by, or would impact, the move to additional locational signals in the overarching electricity market design. It is important that the ESO considers carefully the 2-hour windows for Quick and Slow Reserve, and how much of an impact this inconsistency with wider markets may have on service providers. Although theoretically they would still align with EFA blocks and settlement periods, it could result in assets becoming dormant for periods of the day, as they may be unable to self dispatch or find an alternative revenue stream or market activity (like charging) between commitments. The length of windows may be a barrier, or at least a disincentive to unconventional ancillary service providers such as interconnectors and wind or solar as the commitment period may be too long and risk too high. This could result in increased whole system costs. We feel that the new approach of a single co-optimised market across DC, DR, DM, Quick and Slow Reserve (simultaneous) presents far less risk of exogenous market impact. The co-optimised auction, theoretically, decreases market fragmentation risk (where different prices emerge in different auctions) and poor transparency impacting on bidding behaviour. It does, however, create a risk of price convergence where these service prices correlate and could result in an increase in market costs. [cont…]	

Quick and Slow Reserve

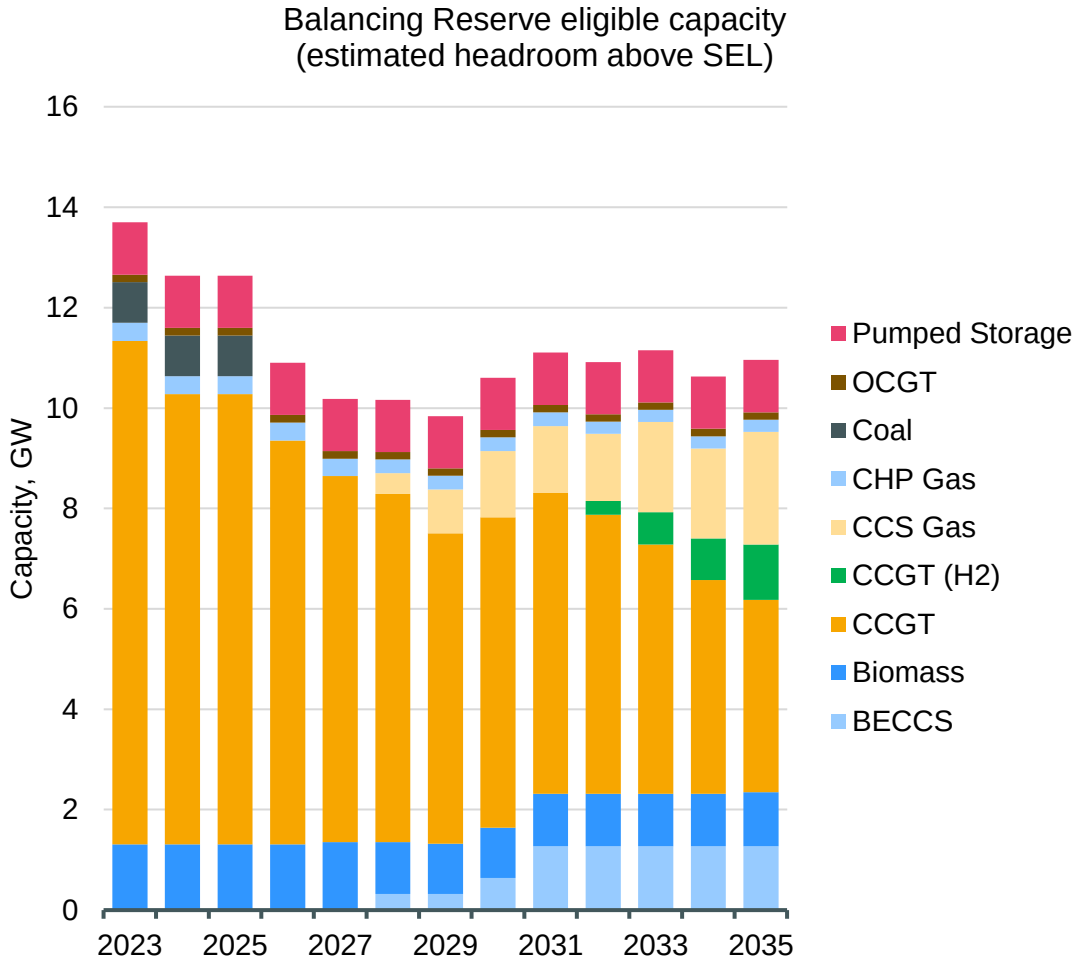
Assessing the Market Principles

Principle	Assessment	RAG Rating
Coherence continued	A 500MW cap signals that the ESO is preparing for large generators to participate, and our capability analysis concurs. This could result in a large removal of generation offered into the day-ahead auction, which would likely look to trade in the intraday market if it fails to succeed in the Reserve auctions, or look to NIV chase on cash-out. We expect a minimal impact from Slow Reserve on the wholesale market (similar to STOR). For a large amount of commitment windows, we expect that most assets that would provide Slow Reserve would be out of merit in the wholesale market, or would be specific Reserve assets. The co-optimised auction will increase the potential for assets to be dispatched in balancing services and have less dispatch in the power wholesale markets – this could be more prevalent in Quick Reserve as the assets will likely be newer and more efficient (and have a higher chance of being within merit in the wholesale market). The capacity in the GB power market is expected to increase considerably in the coming years (based on LCP Delta Storetrack database and CM registers) which reduced the impact of the balancing services markets attracting volume away from the merchant markets.	
Locational Signals	**Locational signals for Quick and Slow Reserve are not sent at procurement stage, and there is no suggestion of considering location in the tender (i.e. not dispatching a unit due to location).** Under the proposals for Quick and Slow Reserve, the requirement is one dimensional in the sense that it is an injection of active power required to recover the system frequency back to operational levels. This is indiscriminate of where that active power comes from. It is similar to the concept of imbalance and cash out, and to financially incentivise units not dictated by a Physical Notification (PN), regardless of location, to act in a way that is beneficial to the balance of the electricity system. The ESO will be able to take actions in Quick and Slow Reserve through the BM or Ancillary Services Dispatch Platform (ASDP) to dispatch relevant units based on locational considerations in real time. A decision that would appear made out of merit (i.e.. an ESO control room action taken without an economic reason) would be given in line with normal procedure.	
Transparency	The ESO has committed itself to publishing its firm Quick and Slow Reserve requirement for each Service Window in a Service Day on its website ahead of the first auction opening, as well as an indication of the Quick and Slow requirement forecast across a longer outlook. Window lengths, start and end times, as well as procurement requirements are expected to change based on background system dynamics and seasonality. The ESO must keep this information under review, and take advice from industry as to how it best facilitates their commercial decisions.	

Balancing Reserve

Balancing Reserve

Earlier in 2023, Ofgem refused a request by the ESO to implement a market based solution to securing regulating reserve.

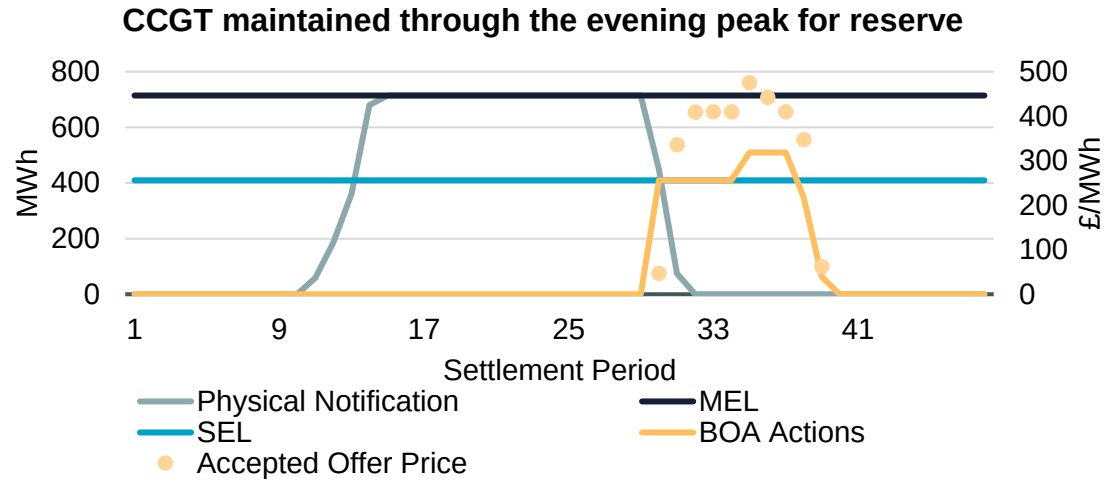


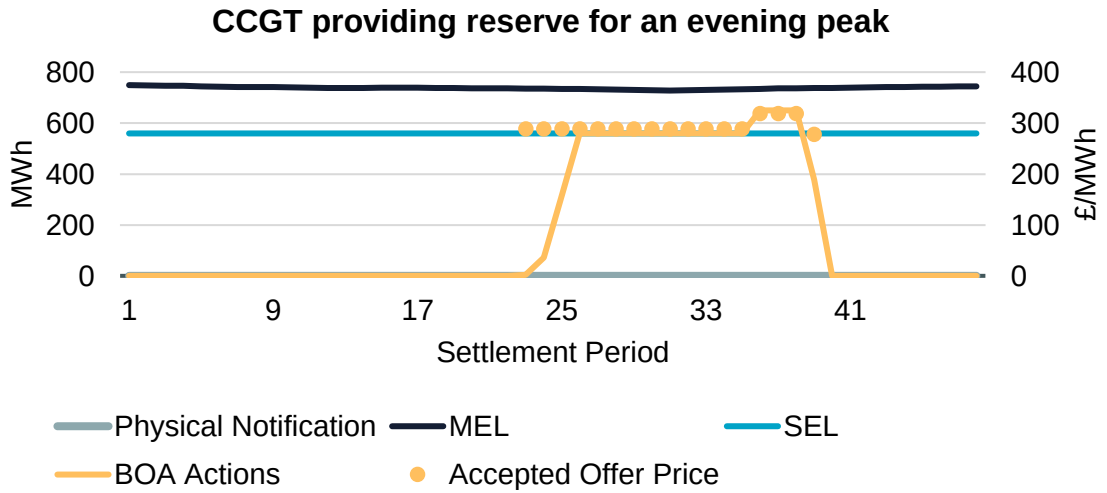
- **Earlier in 2023, LCP Delta performed a Cost Benefit Analysis (CBA) assessing the introduction of the Balancing Reserve (BR) product. This assessment demonstrated a positive impact on net-consumer benefits (£873m over 3 years) from introducing a service through which the ESO could secure the requirement for regulating reserve ahead of time.**
- This proposal was rejected by Ofgem in March 2023, due related to concerns around barriers of entry for small flexible providers and an insufficient deterrent to prevent non-delivery. We understand that the ESO will address the concerns raised by Ofgem and further develop a solution to securing regulating reserve.
- The ESO expects a revised version of BR to be a suitable enduring solution to the provision of regulating reserve (as outlined in its 2023 Market Roadmap). This would remove the necessity to procure regulating reserve through the BM which has been a contributor to high balancing costs.
- LCP Delta analysis found:
  - The available capacity should far exceed the maximum requirement for positive reserve of c. 2.5GW, ensuring a suitably competitive market for BR.
  - CCGT would be the largest provider of reserve, with CCS Gas likely to make a significant contribution once projects start to come online in the late 2020s.
- The full Cost Benefit Analysis of Balancing Reserve performed by LCP Delta on behalf of the ESO can be found here.

Balancing Reserve

Currently, ESO maintains its regulating reserve requirement though BM actions. This comes with a high cost and highlights the need for a market-based solution.

- **To maintain regulating reserve, the ESO currently takes action through the BM. These graphs give examples of the different generating profiles and how the ESO takes action to secure regulating reserve requirement through the BM.**
- Regulating reserve is typically provided by CCGTs being bid down from MEL to SEL, or turned-on up to SEL. Most other technologies are unsuitable for the ESO to provide this system service.
- These turn-ons for reserve often come at a high cost due to the premium added to BM offer prices, as well as plant dynamics – such as Minimum Non-Zero Time (MNZT) and Minimum Zero Time (MZT) – which mean plant have to be run for longer than needed in order to meet the additional reserve requirement over the demand peak. ESO analysis found that in 2021/22, the cost of BM actions to secure regulating reserve totalled around £1.3bn (net).
- The chart on the top shows a CCGT extended by an ESO BM action for 4.5 hours after submitting a de-synchronisation Physical Notification at a time where it could not be brough back on for the demand peak (due to MZT).
- The chart on the bottom shows a CCGT turned on by an ESO BM action for a 6 hour MNZT, but likely only needed for the c.2 hour demand peak.
- A balancing service like Balancing Reserve would mean that the ESO only need to pay the plant to provide headroom for the periods where it's actually required.





LCPDelta

Assessment of Developing Markets and BM

Approach to assessing other Markets

A policy analysis on emerging markets

- In this chapter, we assess the markets that are in development through policy analysis and an assessment of the emerging market parameters through the lens of the framework.
- We have considered how the principles have been applied to the markets and reforms in development by the ESO in the following markets:
  - Thermal
  - Restoration
  - Stability
  - Voltage
- A policy based assessment will consider information available on Pathfinder projects, tender results and Market Design Project developments where appropriate.

In this section, we have also reviewed the Balancing Mechanism (BM) using the same methodology of a qualitative market design and policy assessment.

- LCP Delta and Frontier Economics performed a review of the BM in 2022 following high prices that were being exhibited. The ESO, Ofgem and the UK Government are all pursuing solutions to the balancing market framework. The BM is also a particularly difficult marketplace to apply the framework, and as such, a more principles based review was deemed suitable.
- The BM is the market used to manage system operation in real time. There are two types of actions that the ESO takes within this market: (1) Energy actions to balance the system, (2) System actions to maintain safe and secure system operation.
- This assessment will provide a high-level initial analysis into the “energy” aspect of BM as currently operated, before a more nuanced deeper dive as and when reforms are developed by the ESO and then to assess whether these reforms follow the framework.
- The system actions aspect of this review follows, as the ESO seeks to develop market solutions outside of the BM.

Balancing Mechanism

Assessing the Market Design Principles

Balancing Mechanism

Assessing the Market Design Principles - Summary

What is the current situation and how is the market developing?

The Balancing Mechanism (BM) is the ESO's primary tool to balance supply and demand, manage constraints, ensure system stability and maintain real-time security of supply in each half hour trading period.

The BM is an unusual marketplace. The ESO uses the BM to procure multiple services; implicitly stacking energy products with system services (i.e., for thermal congestion as well as energy balancing). It therefore does not procure a single homogenous product from the market (which is inconsistent with economic theory of an efficient marketplace); suppliers do not even know what product they are providing to the ESO or pricing for ahead of time.

What are the relevant priorities under the market roadmap?

As a heterogenous product, it is not designed to give forward signals to market participants to price their supply ahead of time. Therefore, to ensure the market place runs as effectively as possible within these limitations, the ESO should focus on maximising competition by enabling greater levels of participation and transparency. Increased competition will provide more reflective price formation of the cost of a service. We note that the ESO has made good steps in this regard with the Wider Access programme of work, however, there are shortcomings that could be improved to encourage greater uptake. These seem particularly to relate to commercial considerations of potential participants.

Typically the BM is transparent on an operational basis. However, in consideration of the BM's shortcomings as a market that is procuring a homogenous good with limited competition, the ESO should prioritise providing suitable levels of transparency to enable greater participation and competition.

Priority principle	Assessment rational
Competition	Despite the ESO attempts to encourage market participation, large gas fired generation continues to be the dominant provider in the BM.
Net Consumer Benefits	Costs to balance the GB power system rose to £1.5 billion between November 2021 and February 2022
Transparency	The BM is typically transparent on an operational basis. However, the ESO should prioritise providing suitable levels of transparency to enable greater participation and competition.

Balancing Mechanism

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Competition	**There are many assets that can participate in the BM; all transmission connected units, Virtual Lead Parties (VLP), Bilateral Embedded Generation Agreement (BEGA) and Bilateral Embedded Licence Exemptible Large Power Station Agreement (BELLA) are active. There is theoretically a deep market for the ESO to procure BM actions, which the ESO can at times struggle to access.** The theoretical depth of the BM does not consider: i) pricing behaviour - particularly units that price themselves out of merit order to avoid dispatch (for example nuclear); and ii) the nature of needing to take action on smaller subsets of the supply stack due to more cost effective dynamic parameters (such as, Minimum Zero Time or Minimum Non-Zero Time), and system needs (i.e. fewer units that can provide stability, or are in a location with a system need). Pricing can be particularly price responsive during tight periods, or at times of system stress, as the market responds to scarcity; with a lower supply margin over recent years, marginal participants are increasingly able to exercise market power. Large gas fired generation continues to be the dominant provider in the BM. The ESO are taking steps to try to encourage greater participation but to limited effect. There are various requirements before units are able to access the BM in order for the ESO to have confidence (and to test) that a unit would deliver an instruction when called upon and has suitably robust communications processes. Up until recently, a unit could only access the BM by installing costly ESO infrastructure – known as Electronic Data Logging (EDL) and Electronic Data Transfer (EDT) systems. This is still required for Transmission connected units (particularly Critical National Infrastructure (CNI)) which also typically requires the National Grid owned OpTel systems. However, with the Wider Access programme of works, VLPs are now able to aggregate several smaller units by GSP Group level that only requires a Web API communication system; overcoming a key barrier to BM participation. The VLP route to market was developed in collaboration with GB power market participants (known as the ESOs ‘co-creation’ approach), however, this is proving to be a less commercially desirable route to market for many non-conventional BM providers than had been expected. Industry responses to the UK Governments proposals to make all Capacity Market Units BMUs had identified several barriers to entry to the BM, including (1) the commercial concerns of VLP arrangements, (2) the lengthy lead times in becoming a VLP and secondary BMUs, and (3) it being unsuitable for an asset to become a BMU based on its business model. Regarding (1), the VLP route to market can be undesirable for some due to commercial arrangements between secondary BMUs and a VLP – usually a profit sharing arrangement - and that it removes the ability to NIV chase as a revenue stream (if Final PN flag is set to “T”) which has contributed to limiting uptake. The BELLA and BEGA route to market still requires costly infrastructure to satisfy the ESO requirements, but avoids the need to enter into commercial arrangements with a VLP. Regarding (2), long lead times to VLPs and Secondary BMUs being onboarded onto the ESO and Elexon systems, we encourage the ESO to work with industry and review this process to ensure a pragmatic and expedient solution. The ESO’s current approach to BM dispatch also makes it very difficult for smaller units to be competitive. This is due to the view from industry that the ESO has difficulty with its current systems making lots of smaller actions in favour of one large action. This is being addressed through the Balancing Programme.	

Balancing Mechanism

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Net Consumer Benefits	**LCP (July 2022), on behalf of the ESO, completed a review of the BM following the very high cost days witnessed in Winter 2021/22. Costs to balance the GB power system rose to £1.5 billion between November 2021 and February 2022, up from the 3-year average of £500 million between 2017-2020 across the same period. The review highlighted the impact of scarcity pricing and the illiquid nature of the BM market.** We acknowledge the positive steps that the ESO has taken in response to these high prices and market failures found in this BM Review. Despite it being found by Ofgem to be inconsistent with principles of open competition and excluded participation, LCP Delta found that the Balancing Reserve product would have resulted in a significant cost saving for consumers by removing regulating reserve procurement from the BM (typically interconnector flow reduction and corresponding actions on domestic generation). Scarcity prices provide incremental revenue in periods of system tightness to assets. This should provide a signal to invest in new capacity, particularly flexible assets. If sufficient investment in flexible capacity occurs, this may reduce dependence on large inflexible capacity on the high cost days, reducing overall costs.	
Transparency	**Operational transparency in the BM is typically adequate, with data is available through Balancing Mechanism Reporting Service (BMRS) and the ESO Monthly Balancing Services Summary (MBSS), as well as in other reporting in the ESO data portal.** The ESO is often required to take actions that appear contrary to what would be deemed within merit due to the complexities of managing an electricity system that requires units that need to meet certain characteristics (for example, location, inertia or reactive power). Until relatively recently, the reasoning for these actions being taken was not communicated. Under the ESOs Dispatch Transparency data set the ESO now provides a reason for all decisions taken out of merit in the BM where there is no identified reason for that action being taken. Whilst this is a positive step, many market participants have voiced their requirement for greater understanding and transparency of why assets are taken out of merit order (for example, February Balancing Programme Quarterly update). There is an enduring industry perception of *Control Room Bias* towards larger BMUs (particularly gas units) despite the ESO taking steps to open the market as outlined. The ESO could also improve the overall functioning of the BM by seeking ways to improve its understanding of the position of non-BM (and not providing balancing services) units and publishing that to industry. This would improve BM participants understanding of the system need, and improve competition and pricing. In general, increased transparency is positive however, with markets such as the BM, there is the risk of a paradox of too much transparency resulting in poor market outcome. This could have an anti-competitive impact, for example, advising them of specifics about their portfolio that gives them a competitive advantage in the market, this is deemed very low risk. [cont...]	

Balancing Mechanism

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Transparency	Until recently, Schedule 7A and BSAD trades were not identified in BMRS. The ESO now provides an identifier of what BM Party has been traded on in the BM stack as a Schedule 7A/BSAD. This is a good development, however, greater transparency could be provided by assigning greater detail of reasoning as to why these bilateral trades have been made to allow assets with these characteristics to provide competitive prices, and therefore, put downward pressure on balancing costs in the BM or a competitive procurement process (i.e.. a balancing service). Transparency will impact on competition and investability. The ESO should focus on providing suitable levels of transparency to ensure that competition and greater market participation is facilitated, and investability nurtured. Providing greater levels of transparency allows for greater levels of understanding why the BM is not coherent with the wider GB electricity markets and would likely provide greater comfort and confidence in utilising the BM as a revenue steam for an asset.	
Coherence	**The European Clean Energy Package requires all ESO balancing products pricing to be set on a Pay-As-Clear basis. The BM, along with some other enduring ESO mechanisms, requires an ongoing derogation from GB's Regulatory Authority (Ofgem) and is therefore not coherent with current policy and regulation. We do however believe that the BM's derogation is appropriate, and a Pay-As-Clear market for such a segmented market – which is away from sound economics of a market procuring a homogenous good – seems inappropriate as a unit should be able to be remunerated for the services it provides to the system, and the value of this should not be applied to the whole market. This derogation is a signal of inconsistency with policy and regulation and should be reviewed in that scope.** The GB power market has become shallower in recent years following the withdrawal and closure of coal power stations (albeit maintained recently through the coal contingency contracts). This has led to increasing utilisation of the BM as a key revenue stream for some, particularly ageing, units. We have observed that more marginal units may act in a manner that exercises their market power to access the greater revenue available in the BM than would otherwise be available in the wholesale market. This behaviour of reoptimisation towards BM revenues may have wholesale market impacts, as a unit may look to buy-back its position sold in forward markets or withhold a position that will change wholesale market dynamics. The design across the BM and the CM seems less suitable, particularly when we consider the sequencing of actions being taken in the BM when a CM Notice is active. The ESO control room does not account for CM unit delivery if a CM Stress event is actioned, and ahead of time will take actions in the BM – dispatching CMUs – at a cost despite the units being required to be available through CM obligations anyway. The overarching electricity market design also creates difficulties in the BM. For example, the Contracts for Difference regime creates an incentive for supported units to maximise output. This significantly increases the cost of making these assets flexible, as the cost of decreasing electrical output is linked to the commercial CfD contract. This too reduces the cost effective flexibility available to the ESO in the BM. This is understandable, however ESO and UK Government policy should be re-evaluated to ensure coherence. [cont...]	

Balancing Mechanism

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Coherency	Over the energy crisis, significant levels of market backwardation have seemingly impacted on market participants ability to hold a forward hedge due to increasing mark-to-market credit limit exposure. This is where a unit has hedged its position with a counterparty, and it is required to maintain a level of credit that is calculated off the current cost of the counterparty needing to buy back (or "unwind") its position, mitigating risk of counterparty default. This has contributed to increasing levels of spot time horizon liquidity and decreasing levels of forward market liquidity. This mark-to-market risk combined with the need for an owner to hedge its portfolio to cover against increased cost of trip risk (i.e. either costing in the additional risk, or withholding some volume in the market until the risk of trip is acceptable) has seemingly led to greater utilisation of the BM as a route to market where good profitability has been experienced due to this shallower market. This has acted to remove supply from the wholesale market. Schedule 7A and BSAD trades provide additional complexities to the BM's mechanics. Bilaterally secured trades are largely contrary to the objectives of the ESO's procurement strategy of open competition and is seemingly taken out of merit to a residual balancing tool. A coherent BM would provide greater confidence of the viability of an electricity generation/storage asset and therefore improve the investability of the assets. A coherent market allows for greater confidence of achieving revenue from the different revenue streams and route to markets. Failing this, suitable levels of transparency should be provided to allow for an understanding of why a market is not coherent with wider market design.	
Investability	**LCP analysis shows that the future volume of BM actions is likely to increase as wind penetration grows and the number of energy imbalances subsequently increase. The BM will provide some signals to bring forward investment in flexible assets if prices spike, but this is unlikely to be a critical factor and this is not the purpose of BM as this is a short-term back stop market. The BM is not designed to provide long-term signals to investment.** The BM is a short-term market for energy balancing that enables the ESO to manage the system – it is not designed to provide long-term signals for investors and other UK Government support mechanisms (such as the Capacity Market), and ESO Pathfinders are available to offer this. The value of BM will change per settlement period based on system requirements, and whilst more frequent high price periods may in theory attract investment; the revenues achieved will be highly variable and not provide the predictability investors value. The BM can be used to access scarcity in the market and higher returns, but this is just one of the routes to market to access that volatility (including the wholesale market, and ancillary services). Investment will be promoted by the ESO through ensuring that transparency and market coherence is enhanced and thereby improving participants understanding of the market and where revenues are achieved. This increases the confidence of GB power market investors with the viability of a business. When providing a RAG status, this could be flagged as Red as it does not provide long term investment signals. However, this is not the purpose of the BM so we have reviewed this as Amber.	

Balancing Mechanism

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Adaptability	The BM is not designed, and there is little requirement, to provide long-term signals to advise on market behaviour. The BM provides no long-term agreements, being highly adaptable to the ESOs needs for real-time balancing and management of the electricity system. There are no set procurement targets, and a unit is paid on a pay-as-bid basis – with the dispatch length as long in duration as is required.	
Locational Signals	Being the ESO's key real-time residual balancing tool, the BM does not provide explicit locational signals. Instead, taking generation or storage as an example, a units BM bidding behaviour will be influenced by: 1) the cost it will incur (or typically save) to be turned off, which is regulated by the Transmission Constraints Licence Condition (TCLC), and, 2) the cost it will incur to increase its generation or to export energy with a margin that is based on what the operator expects will be the marginal unit in the bid-stack. Based on these bidding behaviours the ESO will call on BMUs - often a unit is skipped out of merit for locational reasons by the ESO, and where this happens, the ESO is expected to provide clear reasoning. The BM therefore does not provide an explicit locational signal nor feed into a units real-time decisions making, but decisions by ESO may be taken for locational reasons. A units locational signals are provided outside this market framework; instead embedded into the locational element of network charging. The BM can, theoretically, provide implicit locational signals through a providers ability to analyse the historic locational dispatch of assets in the BM and when / where units are called. This, paired with the planning of network reinforcement projects, would feed its way into the decision making of investment decisions in locational assets. However, historic market performance will never be robust as a metric for future market performance. Clearer signals for actions that are addressing locational constraints on the electricity system are provided through the constraint, voltage, stability and thermal pathfinders – and the future of locational constraints should be considered through these markets. The BM should remain as a mechanism to address the unique system conditions that the ESO Control Room is presented with at that moment in time, without being concerned with forward looking signals.	

Thermal constraints

Assessing the Market Design Principles

Thermal constraints

Assessing the Market Design Principles - Summary

What is the current situation and how is the market developing?

Network constraints are currently managed through BM and trades at significant cost. The ESO is developing market solutions including Constraint Management Intertrip Scheme (CMIS); Local Constraint Markets (LCM) and a MW Dispatch Service. This assessment focuses on the two tenders for the B6 Constraint Management Pathfinder under CMIS and whether these tenders have followed the principles under the Market Roadmap. We will additionally consider MW Dispatch Service and the Local Constraint Market (LCM) that are due to go live this year within this assessment.

What are the relevant priorities under the market roadmap?

There have been two tenders for the B6 Constraint Management Pathfinder under the CMIS which have proven to be relatively illiquid and the ESO should identify any further barriers to entry, or why many that expressed interest did not tender under the competition principle. Prices in the two bidding outcomes have been variable which presents challenges for investors to understand the true value of the service. CMIS is only awarded to transmission connected assets.

The ESO is correctly looking to procure thermal constraint services from distribution network connected service providers through LCM and the MW Dispatch Services. Neither of these markets are live yet, so will be a relatively light touch assessment that refers to the market design. The RAG status will predominantly focus on CMIS given the Pathfinder results and market development, with further details of MW Dispatch Service and LCM in the analysis,

Priority principle	Assessment rational
Competition	There have been two tenders for the B6 Pathfinder with little apparent competition despite expressions of interest. The ESO should explore whether capability rules were appropriately applied. The MW dispatch service has specific requirements that could limit access and this should continue to be considered whether the requirements are appropriate by the ESO. LCM provides a route to market for non-BM Units which is positive.
Investability	There is significant spread in the service cost of the contracts awarded and considerable variation within the B6 tenders. Whilst the value / price of service remains unclear, this may cause investment challenges
Locational Signals	Products are for a local solution. The ESO continues to consider providing other market signals to alleviate constraints.

Thermal constraints

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Competition	There have been two tenders for the B6 Constraint Management Pathfinder under the Constraint Management Intertrip Scheme (CMIS). The first tender (2023/24) awarded contracts to all assets that tendered (10 assets) from 50 assets that had expressed an interest. The second tender (2024/25) was more competitive with 11 assets successful with three assets not awarded a contract. This demonstrates a relatively illiquid market. It is unclear whether the relative lack of competition in this market is due to limited assets available for contracts to be awarded, or whether there are barriers to entry; for example 40 assets in the 2023/24 tender expressed an interest but did not subsequently tender. The ESO should explore whether capability rules have restricted competition, or whether there were other reasons these assets did not submit tenders. We recommend the ESO considers what learnings can be taken if this is carried forward to other boundaries. Only 1 battery storage asset has been awarded a contract, with the other contracts awarded to wind farms. Consideration should be given as to the assets tendering for this service. The ESO has published the approach used to calculate the cost and the results of the tender are transparent and inline with this approach. With regards to the LCM, this is open to units that are not able to access Balancing Markets and the ESO is proposing to remove the minimum unit size of 1MW and be open to any technology type. This should ensure barriers to entry are removed and competition is enhanced. The MW dispatch service has specific requirements that will necessarily limit access, for example: Control Equipment - 'visibility and commercial control' infrastructure installed at the generation site by the DNO; and, Respond to instructions (via the Control Equipment) and reduce output to zero MW within a 2min Response Time. Without a current tender, it is difficult to know whether these requirements will limit competition. The ESO should ensure that the infrastructure required is not overly costly or burdensome to install. This will reduce participation, as has been observed in the BM, and required the introduction of the wider access API to reduce the barrier to entry. The 1MW limit may also limit participation levels and ESO should continue to review if that is relevant and necessary.	
Investability	Comparison between tenders is difficult as the arming fee has changed from £/MWh to £/Settlement Period within CMIS. Within tenders, there is a significant spread in the service cost of the contracts awarded. Based on our assessment, in the 2024/25 tender the service costs varied between £3.15/MWh - £30.03/MWh. Meanwhile, in the 2023/24 tender, the service cost range was considerably larger with a range from £54/SP - £3,800/SP. This variability within tenders will make it challenging to value this service for investors and predict revenue streams. There is significant variation in revenues for different assets, and the ESO should ensure that is appropriate. Neither the MW Dispatch Service or the LCM provide an availability fee, nor long term investment signals which will limit investment in this service (Amber).	
Locational Signals	CMIS is a product to support constraints and is tendered for those specific locations (therefore does not require additional signals). The ESO meanwhile continues to highlight locational challenges such as market signals that would reduce the need for constraint payments across the system. CMIS is only awarded to transmission connected assets. The ESO is correctly looking to thermal constraint services from distribution network connected service providers through Local Constraint Market (LCM) and the MW Dispatch Services. (Green)	

Thermal constraints

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Adaptability	CMIS contract lengths are set at 1 year which gives an opportunity to retender. The ESO makes reference to possible extensions, but it is unclear on what basis these would be extended and what competition would be available at that point. The ESO have developed an innovative volume cap model in which each month all successful units will re-bid their 'utilisation cost below the price cap set' and compete to be selected and therefore paid an arming and tripping fee. The ESO can arm maximum 800MW when the service is needed; the yearly tender sets the provider's price caps and then on a monthly basis a provider can change its offer and set the price below the price cap in order to get armed and therefore paid the arming fee. It is unlikely a provider will get paid the tripping fee in the event it is a 1-in-25 year probability. The CMIS provides longer term signals to transmission connected assets via longer term contracts, whereas the LCM and MW Dispatch Service which both operate closer to real-time, allow the ESO to fine-tune position before BM timeframes. There are no longer term contracts within these services.	
Net Consumer Benefits	Customers are benefitting from the introduction of CMIS as thermal constraints are better managed; less wind curtailment has reduced Carbon emissions (as usually gas assets would be offered up) and realised cost savings. It is unclear what the total cost / budget of this programme is that would be necessary in order to extract the size of the customer benefit compared with the published annual cost savings. A lack of an explicit annual budget raises concern. Costs appear to have reduced significantly between the two tenders and after just two tenders, its challenging to know the true value of this product for customers, investors or asset owners at this stage. We will not provide an assessment on the net consumer benefit whilst the LCM and MW Dispatch service are in development.	
Coherence	There is reasonable coherence with the development of the Pathfinder projects and the discussion about wider reforms required for stronger locational market signals. There may be a minor impact on wholesale prices and BM activity as the LCM will seek to address potential constraints outside of the BM. BM units are excluded from the LCM, and the LCM service is not to be provided simultaneously with any other Balancing Services or 3rd party service. This would be assessed as Amber, but at this stage, the LCIM Pathfinder provides a stronger coherency signal and we maintain our light green rating.	
Transparency	Results have been published on the tenders for CMIS which provides key information to potential investors / participants with clear system requirements from the ESO, for example, 1.6GW of capacity required. A capacity cap ensures value for money and avoid over procurement for customers yet allows the ESO some judgement in picking winners for this service as its not a straight auction. The total number of awarded generators will be decided by the ESO if 1.6GW is reached. This could cause challenges for participants as there is a capacity cap and its not based on meeting a price for the service. Similar challenges are presented that there is a limit on the 36 channels in the B6 Commercial Intertrip Scheme. We do not provide an assessment for MW Dispatch Service or LCM as no tenders have been run or results published that would impact transparency.	

Voltage

Assessing the Market Design Principles

Assessing the Market Design Principles - Summary

What is the current situation and how is the market developing?

The ESO are carrying out long-term reforms under the 'Reactive Reform - Market Design' programme to enable more participants across different technologies and connection types to provide reactive power in the right locations.

This assessment will also consider some of the interim arrangements made, for example the Merseyside and Pennines Pathfinders. We will use the Pathfinders to develop our RAG assessment which will otherwise predominantly focus on the Reactive Reform Market Design and whether published material setting out market design align to market design framework.

What are the relevant priorities under the market roadmap?

Under the investment principle, it is positive to see that the mined to position under the Reactive Market Design Reform is to create three markets that should promote investment: 1) Longer term markets which offer multi-year contracts to support investment in assets; (2) annual mid-term contracts - year-ahead to finesse procurement; and, (3) short-term markets operating at the day-ahead stage to enable participation from assets unable to make long term commitments. Allowing all possible assets to access this product is an important step in promoting competition to a greater number of providers and locations. In addition, as Reactive Power needs are locationally constrained (an asset can only support a local market in reactive power), location is considered high importance in the design.

Regarding the two Pathfinders, we find that competition was adequate in both auctions (stronger in Merseyside) but that investment signals may have been affected by changes in process within Merseyside following changes to contractual terms.

Priority Principle	Assessment rational
Competition	Recommendations in the Reactive Reform Market Design focus on including all possible assets to promote competition and avoid market power. Interim arrangements to 2026 have not (yet) provided detail to assess if sufficiently competitive and at what cost.
Investability	Long and short-term markets are to be established which provides multi-year contracts for those requiring additional investment and certainty within the Reactive Market Design. However, investment signals may have been affected by changing contractual terms.
Locational Signals	Nodal markets are to be established that provides market information and signals to service providers.

Voltage

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Competition	Recommendations within Reactive Reform Market Design is that all commercial providers should be eligible to participate which should bring competition to such a market. As these reforms are in development, we are not in a stage yet to assess whether the market is sufficiently competitive. In the interim, whilst Reactive Reform is being developed, the ESO has implemented commercial service agreements to access reactive power capacity from existing units between 2023-2026. Over 100 solutions were submitted (transmission and distributed connected) and commercial terms are being offered (as of March 2023). There is limited information on how these tenders have been assessed and on what terms and whether these interim arrangement meet the "Competition" principle. Regarding the two Voltage Pathfinders – Merseyside and Pennines. Competition was enhanced as the Pathfinders sought to find alternative commercial solutions rather than network owner solutions for the first time and welcomed participation at both transmission and distribution levels. Merseyside had tenders submitted by 14 companies, covering 76 solutions. This was significantly lower in the Pennines at 31 solutions. It may be that this lower level of competition explains why the NGET counterfactual was the most economic solution and therefore no market solution was procured. This would require further insight and analysis. Were this to be assessed, for the reasons of the lack of competition in the Pennines tender, we would assess this as Light Green.	
Investability	The proposals being recommended under the Reactive Market Design Reform are to create three markets in order to promote investment: 1) Longer-term annual markets which offer multi-year contracts to support investment in assets; (2) mid-term annual contracts at year ahead stage to finesse procurement as required, and, (3) short-term markets operating at the day-ahead stage to enable participation from assets that are unable to make long term commitments. These markets are positive for investors who are able to bid at appropriate contract lengths for their asset and financing requirements. Regarding the Pathfinders, we would assess investability as Light Green. This is would have been Amber given the fact that modifications were necessary to the contract to pass through additional costs to compared with what was originally tendered in the Merseyside tender. However, the clarifications made means this issue has been addressed. These contracts are multi-year (which supports long-term investment signals) with predictable revenues; availability payments only. We therefore assess investability as light green when taking both aspects into account.	
Locational Signals	Reactive power services are required to be locational. Assets in one region are less effective at meeting the needs in a different region. In development of Reactive Reforms, the ESO recognises that this can give assets market power and is a driver for the reforms under consideration. According to the ESO, in the program design development, to ensure sufficient locational signals the minded to position is that the ESO "are recommending a nodal market" with a methodology created that "enables a consistent, transparent and repeatable way to produce market signals." Regarding the Pathfinders, we would also regard this as Green given the clear indication within the tender documents of the priority areas even within the tender location.	

Voltage

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Adaptability	The recommended approach to Reactive Reforms includes both short, medium and long-term markets (with in-year adjustments) to ensure that the ESO is able to adjust the volumes procured whilst providing strong investment signals when requiring multi-year contracts. Regarding the Pathfinders, we find these less adaptable as contracts are for several years (9 years in Merseyside, and 10 years in the Pennines) and have only awarded contracts to one or two service providers in each area. The procurement method does not include a utilisation payment within usual tender rules (amended after the event for Merseyside following discussions with the successful bidder). This would be assessed as Amber for adaptability but this is not significant for a Pathfinder project. However, we keep the overall rating as green given that Pathfinders are an interim solution to the market development.	
Net Consumer Benefits	Under current market scenarios, the ESO is potentially a price taker where competition is insufficient and regional solutions are required. The revised approach in Reactive Reforms to open up nodal markets without barriers to types of assets should ensure increased consumer benefits. At this stage of development, there is limited information on annual costs of procurement or potential savings. Regarding Pathfinders. To deliver value for the consumer the ESO compared commercial providers of reactive power to counterfactual solutions by NGET. Opening up the market to commercial participants has meant lower costs than the baseline provision that will be to the benefit of consumers. (Green)	
Coherence	From the ESO Markets Roadmap, March 2022, the ESO stated that “The Obligatory Reactive Power Service (ORPS) methodology as written in Section 4 of the CUSC hasn’t been reviewed in many years. Following the conclusion of the Future of Reactive Power project we will need to consider whether changes should be made to ORPS to ensure the service works coherently with any new market arrangements.” This should be carried out in order to ensure coherence with other services. The development of the service is in line with changes to policy / legislation given the expected changes in generating technology affecting the ESO ability to control voltage. Regarding Pathfinders, we find this well aligned with design of other pathfinder projects and consistent with policy direction. This is not a priority principle. (Green)	
Transparency	The recommended market design outline sets out clearly the eligibility, frequency of procurement, lead time, product duration, payment structure and clearing principles. Currently (March 2023), no tenders have been run, therefore, it is difficult to provide analysis on the ESO power to pick winners or information on published results. Both the Merseyside and Pennines High Voltage Pathfinder tender provides full analysis ranked by cost effective reactive volume to meet the tender requirements. It is possible to recreate the tender results with the published results. The lessons learned document makes it clear that improvements were needed after the Merseyside tender, for example what was included in the contract and when to provide (and stop providing) information. As these lessons were highlighted and seem to have been addressed in the subsequent tender, we would assess this light green.	

Stability

Assessing the Market Design Principles

Stability

Assessing the Market Design Principles

What is the current situation and how is the market developing?

To keep the power system stable, the ESO needs to maintain sufficient amounts of inertia, Short Circuit Level (SCL) and dynamic voltage support. As power system transitions, the need for more stability products from non-traditional sources will be required. The ESO are preparing reforms through the Stability Market Design project to assess eligibility rules, contracts and procurement approach. To date, ESO has completed three long-term pathfinders. We will provide our assessment on the program development and the three pathfinders to date.

What are the relevant priorities under the market roadmap?

Introducing competition into these markets is key, the first Pathfinder attracted bidders for stability from rotating stabilisers, synchronous condensers, re-purposed thermal generators and pumped storage. For the second and third pathfinder, the ESO was expecting a wider range of technologies to take part. According to the results of the two tenders, these additional technology providers have not materialised outside of battery storage. The ESO should assess potential technology providers and ensure that these are not restricted from tendering.

As the market develops, the procurement method should be adaptable to changes in service requirements and the technology mix. Stability services are required by the ESO in the near term markets, however, to provide investors with some certainty, the procurement method should provide longer term investment signals which market participants and investors can rely on.

Priority principle	Assessment rational
Adaptability	The core recommendation of the Stability Market Design innovation project is to develop a combination of a dedicated short-term market (day-ahead) with a long-term market
Competition	Limited range of technologies have come through the pathfinder despite a stated objective by the ESO following the first Pathfinder to increase the diversity of assets and promote innovation.
Investability	The ESO is proposing to procure stability services with a dedicated market across several timescales with an initial focus on procuring inertia services.

Stability

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Adaptability	The core recommendation of the Stability Market Design innovation project is to develop a combination of a dedicated short-term market (day-ahead) with a long-term market (building on the well-functioning pathfinder approach) for stability services, while retaining the Balancing Mechanism (BM) option as a backstop. This will ensure that the ESO is able to adjust the volumes procured for this service. Contracts will include a utilisation and availability payment which is in line with the framework metrics.	
Competition	The first Pathfinder attracted bidders for stability from rotating stabilisers, synchronous condensers, re-purposed thermal generators and pumped storage. For the second and third pathfinder, the ESO was expecting a wider range of technologies to take part (Markets Roadmap, March 2022). According to the results of the two tenders, these additional technology providers have not materialised outside of battery storage. It is unclear from the public information whether there were expressions of interest from other technologies, and if so, why these did not tender. The ESO should assess the potential suitable technology providers and ensure that these are not artificially restricted from tendering. From the published results of the tenders, there appears sufficient competition given the number of unsuccessful bids and expressions of interest which avoids market power for providers.	
Investability	Inertia and other stability markets are currently procured through the BM. The BM is not a dedicated market for stability and (as outlined in the BM section) therefore does not provide a market signal to invest in stability technologies or attract new innovation. The ESO is developing three markets to attract sufficient investment. The short-term market is designed to procure inertia from zero-MW capable existing units at day-ahead stage – units will receive payments to be available and receive a utilisation payment if instructed to deliver inertia within the contracted service day. A mid-term market is proposed which concludes one-year (T-1) ahead and provides a one year contract. This reduces exposure to the ESO and provides some investment signals to potential investors. However, as demonstrated through CM design, for enhanced investment signals longer term contract duration and further ahead procurement is preferred for investment signals (for example a T-4 with a multi-year agreement). The ten-year contracts awarded in the pathfinders will prefer a stable and long-term revenue stream incentivising investment.	

Stability

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Locational Signals	Inertia is a national and local requirement. Pathfinder contracts have been delivered at local levels and therefore provided solutions at specific locations. The development of long term solutions will be required to address both national and locational concerns and at this stage, there is limited information available on whether locational signals will be incorporated into the development of a stability market.	
Net Consumer Benefits	Pathfinder 1 has cost £328m, whilst Pathfinder 2 has cost £323m. Successful bidders within the pathfinder tenders have been awarded ten-year contracts. It is unclear why these services have been offered a significantly longer contract, especially given focus from the ESO to consider alternative technologies within the Stability Market Design reform programme – but as we note in the Investability section, it will incentivise investment. The second Pathfinder has provided these lengthy contracts to synchronous condensers and Grid Forming Battery Storage. We recommend that a stronger rationale for longer term contracts should be made public, especially in relation to the Pathfinder programme.	
Coherence	The development of a short-term market could reduce cost inefficiencies associated with redispatch, increase transparency of stability costs and provide real-time market prices for stability.	
Transparency	The ESO provides published results of the Phase 1-3 tenders that provides considerable detail. However, in line with the metrics for this principle, it is not possible to reconstruct the procurement decisions and there is apparent subjective judgement from the ESO given the portfolio approach.	

Restoration

Assessing the Market Design Principles

Restoration

Assessing the Market Design Principles - Summary

What is the current situation and how is the market developing?

Historically, in the unlikely event of a power outage, the ESO has relied on transmission connected thermal generation to restart the electricity system. The Distributed ReStart project explored how distributed energy resources (DER) can help restore power through a competitive tender process; these learnings have now been incorporated into BAU with two regional tenders, with additional regional tenders to follow. This assessment focusses how learnings from Distributed ReStart has been incorporated into business as usual Electricity System Restoration (ESR) Services.

What are the relevant priorities under the market roadmap?

The ESO (Market Roadmap March 2022) forecast an overall rise in costs in Restoration costs compared to the existing framework. However, given the Status Quo is untenable in a future low carbon energy system given the reliance on thermal assets, it is necessary to identify how DER can help restore power. Risks of higher costs have been mitigated to some extent with a more competitive tender process and pay-as-bid mechanisms, with increasing number of potential assets. In the most recent tender gas based technologies are still applying in the SE and Northern Tender but there is healthy numbers of other DER technologies to compete with.

With the revised Electricity System Restoration Standard to be implemented from 2026, the priorities are that new entrants are attracted to this service to improve competition and that this is coherent with the increasing levels of distributed generation on the system. Given its role, it is imperative that it provides Net Consumer Benefits given that this is in effect an insurance product that will (hopefully) not be used.

Priority principle	Assessment rational
Competition	Gas based technologies are still applying in the SE and Northern Tender but there is healthy numbers of other DER technologies to compete with
Coherence	Bringing in learnings from the Distributed ReStart project has been necessary in response to the energy transition and increasing intermittent and local sources of generation.
Net Consumer Benefits	Annual costs are due to increase in the baseline scenario, so a cost-effective solution is required, especially given the nature of power outage services as a public good insurance product in the event of a need for a system restart. It is anticipated to save at least £115M through increased competition by 2050

Restoration

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Competition	Action has been taken to competitively procure restoration services from a wider pool of providers following learnings from the Distributed ReStart Project with two regional tenders, in addition to a one-off wind only tender, already taken place, and with additional regional tenders to follow. Historically, restoration was procured through bilateral contacts that were agreed two years ahead of service, and these were mostly with traditional generators such as coal and some gas generators. Reforms, bringing in learnings from Distributed ReStart, has opened up the market and meant there is less reliance on traditional providers and traditional technology assets. Now, assets such as wind, battery, biomass, and solar are competing with more traditional forms such as gas generators, Hydro, and Pumped Storage to the benefit of introducing new competition within the service and opening of innovative solutions. For the first time, the ESO will be procuring against four separate requirements: (1) Primary Restoration Service Providers (Full Service), (2) Top-up Services, (3) Anchor Generator (Distributed ReStart), (4) Top-up Services (Distributed ReStart) Gas based technologies are still applying in the SE and Northern Tender but there is healthy numbers of other DER technologies to provide a more competitive market place.	
Coherence	Bringing in learnings from the Distributed ReStart project has been necessary in response to the energy transition and increasing intermittent and local sources of generation. Where historically the system relied on traditional thermal sources of generation, the new approach has explored how distributed energy resources (DER) such as solar, wind and hydro, can be used to restore power to the transmission network in the unlikely event of a power outage. DER is still expected to only play a relatively small role in 2050 with transmission connected assets still expected to contribute the majority of service delivery.	
Net Consumer Benefits	The ESO (Market Roadmap March 2022) forecast an overall rise in costs in Restoration costs compared to the existing framework. However, given the Status Quo is untenable in a future low carbon energy system given the reliance on thermal assets, it is necessary to identify how DER can help restore power. Risks of higher costs have been mitigated to some extent with a more competitive tender process and pay-as-bid mechanisms, with increasing number of potential assets. Restoration services are a public good insurance product to meet the new obligations of the Electricity System Restoration Standard (ESRS) to ensure industry can deliver effective and rapid restoration in the event of a need for a system restart.	

Restoration

Assessing the Market Design Principles

Principle	Assessment	RAG Rating
Transparency	The procurement of DER is a competitive tender process with sufficient information available ahead of the tender which is important given these are new assets competing for these tender processes who would not normally have been considered for Restoration Services. Results from tenders are not published due to sensitivities around Critical National Infrastructure which is appropriate.	
Adaptability	There are two key elements to payments: Availability Payments and Capital Contributions. These payments in 20/21 made up 94% of total payment, the other costs include payments such as feasibility and testing. Utilisation / Availability payments give the ESO greater scope to vary the amount it pays service provision as its requirement changes; relative to an availability / capital payment which is paid regardless of the ESOs requirement. The ESO launched a one-off initiative for large scale onshore/offshore wind generators who can provide transmission-led full restoration services. Restoration contracts through competitive tenders are mostly 5-years in duration.	
Investability	Due consideration on the *Route to Market* has been applied by the ESO through its report 'Distributed ReStart – A high level outline of commercial and regulatory arrangements – October 2020'. The analysis contained within the report ensures appropriate commercial arrangements were appropriately assessed in line with the requirements under the market roadmap that could be included in BAU processes. This analysis has recommended pursuing Approach 2 – where the party responsible for procurement contracts for all of the required elements of a DRZ with whichever parties create the best value proposition, and can hold one or multiple contracts per DRZ. Learnings from Distributed ReStart have been brought into BAU processes in Southeast and Northern tenders.	
Locational Signals	The procurement is a local / regional procurement and designed to reflect the system in that region. For that reason, the programme has begun with South East and Northern regions as they were deemed most at risk of not meeting the new ESRS.	

LCPDelta

Wholesale Market Assessment

Wholesale Market Assessment – Introduction

Energy and system services have different levels of interaction and impact on the wholesale market

- **As part of the coherency principle, we have assessed the ESO's balancing services against its interaction with the wholesale market. We have considered the assessment based on three categories of balancing services: a) Energy, b) Balancing Mechanism, c) System.**

A) Energy – e.g. Response and Reserve services

- A provider offers to make its energy available to the ESO to meet system balancing needs, withdrawing that energy from the wholesale market either before selling (ex-ante) or buying-back after selling (ex-post) balancing service tenders.
- This makes balancing services "substitute markets" for wholesale market activity. They provide an alternative revenue stream to the wholesale market.
  - There is a direct interaction with the wholesale market as services are competing for the same supply (i.e. the same MWh cannot be sold twice), with opportunity cost of wholesale revenues feeding into balancing services prices.
- They are typically procured at the day-ahead stage due to legislation and the needs of new providers such as DER and intermittent renewables which participate closer to real-time than conventional participants.
- We provide a deep assessment of the following markets as these energy services will have a direct interaction with the wholesale market:
  - Response; and
  - Reserve

B) Balancing Mechanism (BM)

- In the BM, the ESO can take actions on individual assets to manage supply and demand, constraints and other system services. Imperfections with the BM and procuring system services are covered in the BM section of this report. We consider some of the ESO's plans for future BM market design in the system services section.
- We focus on the BM and wholesale market interactions under the energy balancing services section of this report, as this is where key impacts exist.
- Unlike other energy balancing products, units are not expected to withdraw or buy/sell-back volume in the wholesale market.

C) System – e.g. stability, restoration and voltage services

- System markets are "complementary markets" to the wholesale market and are not in direct competition. Service providers are generally still able to sell volume into the wholesale market or stack with other services.
- We do not expect a notable wholesale market impact as they do not withdraw capacity from the wholesale market.
- We therefore do not carry out an in depth assessment of the wholesale market interactions of these products, but we do provide a separate overview assessment within this report.

Wholesale Market Assessment – key findings

We found three overarching interactions between the wholesale market and balancing services

- **1) Supply competition: Energy balancing services compete directly with the wholesale market for the same supply (energy volume)**
  - Through this competition for the same supply, those power market participants that can provide both balancing services and energy in the wholesale market can choose which market to dispatch their assets in. This is largely driven by opportunity cost – the optimiser will seek to capture the market revenue with the highest yield.
  - We demonstrate that this optimisation behaviour has led to withdrawals from the response and reserve markets to capture high wholesale market revenue.
  - Therefore, this competition for energy volume will either: i) remove volume from the wholesale power market, or ii) risk the failure of the ESO to secure the system requirement (i.e.. response/reserve)
    - The more granular procurement of energy balancing services (day-ahead auction and shorter commitment window) increases an optimiser's ability to switch revenue streams. This increases the risk of these two impacts.
  - This is also the case in the BM, where we have observed units utilising the BM using as a route-to-market to capture within-day scarcity.
- **2) Trading complexity: Day-Ahead trading session congestion is increasing the risk of inefficient dispatch**
  - We demonstrate that market and regulatory drivers have pushed an increasing amount of liquidity to shorter-time horizons, particularly the day-ahead stage.
  - The number of energy auctions at day-ahead stage is increasing, making the trading session more congested and complex. This increases the risk of inefficient dispatch as optimisers seek to dispatch in the revenue stream providing the highest yield for that period.
- **3) System services generally have limited impact with the wholesale power market, but can influence pricing in energy markets**
  - Unlike energy balancing services, system services do not compete for energy that is traded in the wholesale power market. Rather, system services buy products that are not valued in the wholesale power market (such as stability, and restoration). Due to this, there is limited impact on the wholesale power market from the ESO procuring these services.
  - Some providers of system services provide them as a by-product of energy production/consumption. This enables them to stack system service revenue streams with energy contracts. The system service revenue could support market pricing for these units, and in extreme scenarios displace more efficient units.

Wholesale Market Assessment
Energy Balancing Services

Response

Reserve

Balancing Mechanism

Wholesale Market Assessment - Overview

Wholesale market impact is observed, but the ESO is managing the risk well through good market design

- **We have found that the ESO energy balancing services have an impact on wholesale power markets as they compete for energy volume. The reverse is also true, with power wholesale markets impacting ancillary services by setting the opportunity costs for participants.**

- The key interactions between the ESO energy balancing services and the wholesale market can be categorised as:
  - Competition for the same volume; and
  - Sequencing of auctions risking inefficient unit dispatch.

- The necessary design of balancing services is that they create a competing revenue stream that typically removes volume from the wholesale power market.

- With this in mind, we have found that the ESO's market development is limiting the impact it may have on the wholesale market through the market design. In particular, we note the option to procure the new balancing services products in a co-optimised auction as opposed to sequential auctions diminishes this impact.
  - Co-optimised auctions decrease wholesale market complexity and risks, and reduces the congestion in the day-ahead trading session. This should improve dispatch efficiency.

- Wholesale market and balancing services interactions are driven by assets competing over the same day-ahead time horizon which has increased in recent years.

- Spot time-horizon markets have become more liquid in recent years, at the same time as the ESO has moved to closer to real-time procurement, which increases the interaction.
  - The ESO's move to closer to real-time procurement is driven by legislation and in order to access the greater market depth in spot-market time horizons as intermittent and DER unit participation grows.

- Simultaneously, greater spot wholesale market liquidity has increased, driven by:
  - the increased costs of maintaining a hedge from volatile energy markets (i.e. mark to market exposure and maintaining credit margin making it difficult to support high levels of forward trading);
  - the developing fuel mix towards assets that optimise across shorter time horizons; and
  - Intermittent CfD explicitly designed to the day-ahead reference price.

- We note efforts across UK Government, Ofgem and the ESO to try and address the underlying energy market issues that are causing this shift in trading dynamics.

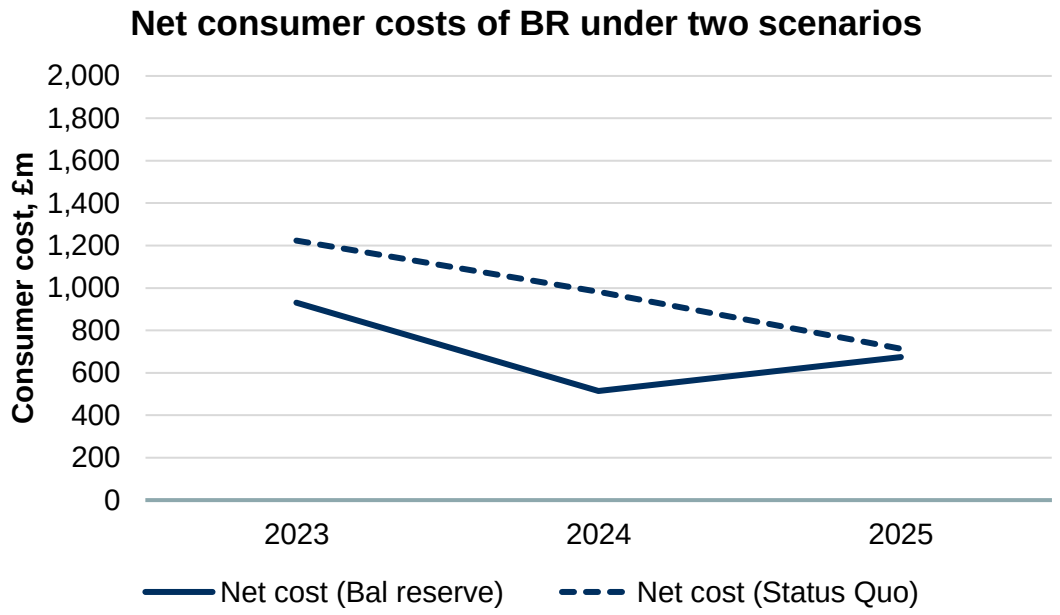
Wholesale Market Assessment – Balancing Reserve CBA findings

LCP Delta found specific interactions with the wholesale market with BR, but that there was a positive impact on net-consumer costs

- **On behalf of the ESO, LCP Delta has separately performed a cost benefit analysis (CBA) of the recent Balancing Reserve (BR) proposals.**

- Through this work, we determined the drivers of interactions between balancing services and the wholesale market:
  - Availability prices are determined by the opportunity cost of committing to BR, plus any additional costs from running.
  - Opportunity cost will be determined by expected wholesale market revenue from generating at self-dispatch – as determined by day-ahead auction prices. Or in the case of storage, the spread between the daily low and daily high price.
  - For reserve services like BR - including STOR – the marginal unit (in wholesale market) typically bids into BR at the lowest price because it is making minimal returns from wholesale dispatch. This means it has a lower opportunity cost than more efficient units (while having lower costs to recover than less efficient units).
  - Units which are accepted for energy balancing services are replaced in the wholesale market by units with a higher short-run marginal cost that will increase the wholesale price.

- This graph shows the net-consumer cost of procuring regulating reserve through BR as opposed to through the BM (Status quo), These results may provide signals as to how other the ESO energy balancing services interact with the wholesale market.



Modelling results of LCP Delta's BR CBA showing cost of procuring regulating reserve through the BM (status quo) and through the since rejected balancing service – balancing Reserve.

Wholesale Market Assessment – (1) Supply competition (Response)

Increased wholesale prices have led to units exiting balancing services. This increases risk of failure to secure system requirement and inefficient dispatch.

- **In the Dynamic Response services section we found a limited amount of the pricing explained by wholesale market price or spread. However, considering Dynamic Containment (DC) between January 2022 to the end of January 2023, fairly significant volumes of volume exited DC to capture higher wholesale market revenue.**

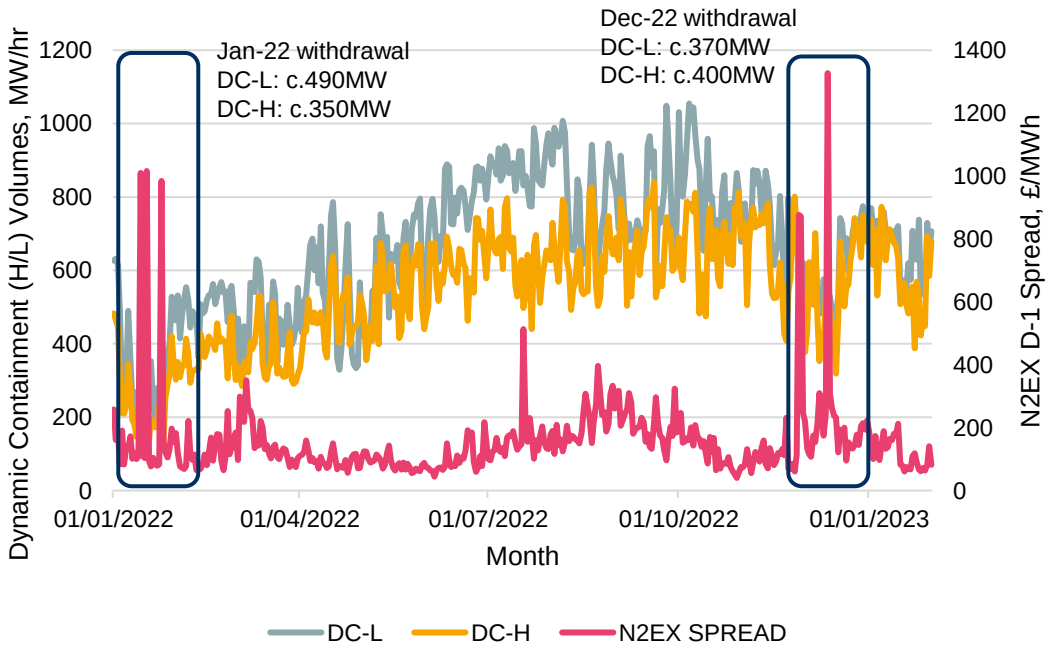
- There have been instances of relatively large proportions of DC volumes exiting the market (relative to the procured volumes) in order to capture high wholesale market revenue. In January 2022 coinciding with high D-1 power market spread, DC-Low procurement fell from 631MW to 142MW; and, 483MW down to 123MW DC-High. In December, we also observed a c.400MW withdrawal from both DC products.

- This demonstrates the ESO's need to allow Dynamic Response products clearing price to respond to high prices if it is to maintain its requirement, which will become more important as the products take a more significant role in the way that ESO manages the system.

- Despite this being significant for DC, these are relatively modest volumes by wholesale market standards, so is unlikely to have a notable impact.

- Although the D-1 wholesale market auction occurs before the Dynamic Response market auction, a unit may exit the balancing service to optimise in the intraday (ID) or continuous market. Whilst unlikely, this may increase the risk of an asset not efficiently dispatching through sub-optimal commercial decisions. Failing self dispatch, this would push the unit to seek BM dispatch which suggests a poor market outcome.

Dynamic Containment Volumes and N2EX D-1 Wholesale Market price spread



N.B: We focus on Dynamic Containment due to it being the most mature market and therefore giving us the most representative analysis. Dynamic Moderation and Regulation will need to be monitored and analysed in more detail when there is enough relevant data points.

N2EX Spread is used instead of baseload or peak price as it represents opportunity cost to storage assets which provide Dynamic response.

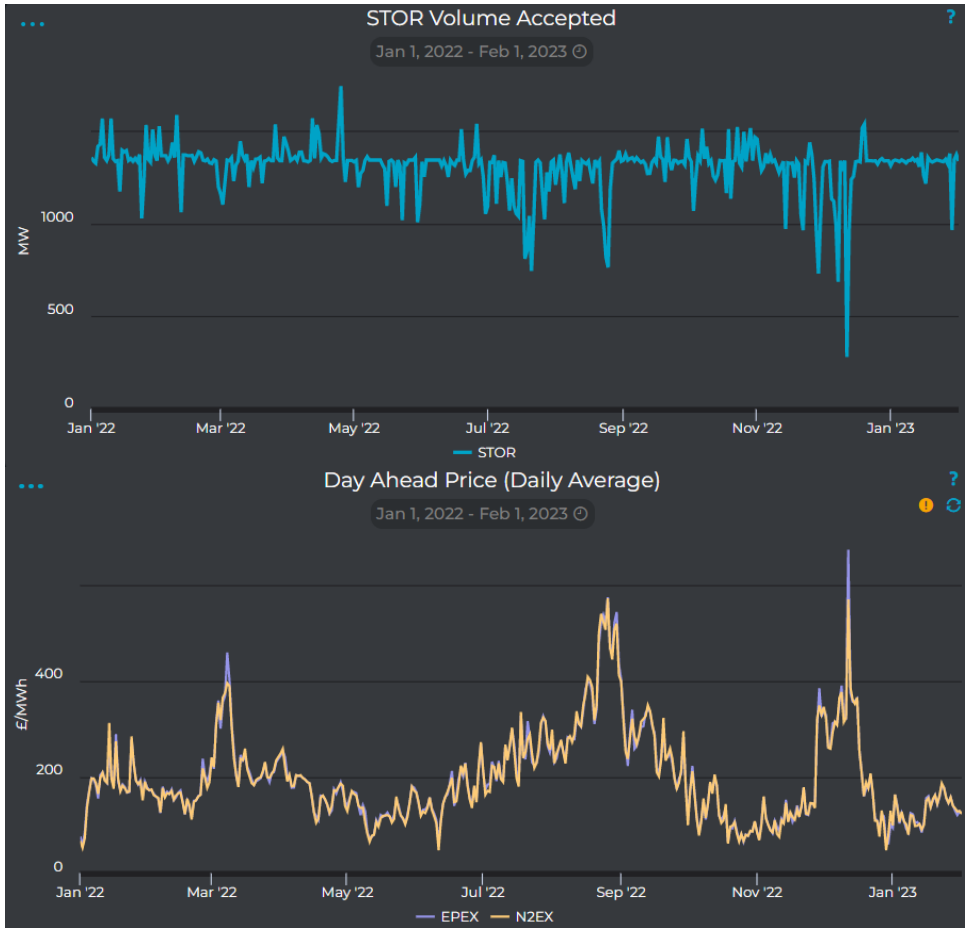
Wholesale Market Assessment - (1) Supply competition (Reserve)

Similar to response, assets exit reserve balancing services to capture high wholesale prices, but the reserve fuel mix has a more notable impact

- **We observe the same market behaviour in STOR as Dynamic Response services; units will withdraw from balancing services to access higher wholesale market returns. STOR assets are usually less efficient thermal units, so the wholesale market impact could be significant as assets are often the marginal (and therefore price setting) unit.**

- As noted throughout the wider framework assessment, although more granular procurement has many benefits, it can also increase the risk of failure of the ESO being able to secure the system requirement. This graph demonstrates STOR market participants exiting the service in order to access high wholesale power market revenue – such as in December 2022.
  - This is not commonly a significant occurrence in STOR as assets will rarely be within merit in the wholesale market.
  - As noted in the previous slide, the ESO should ensure that its markets are able to respond to high wholesale prices to ensure the reserve system requirement is satisfied.

- Unlike Dynamic response services, STOR assets are typically less efficient thermal units. These units will largely be price setters in the wholesale market with higher short-run marginal costs, and will likely price in scarcity to maximise returns for the limited running hours that they are able to operate:
  - STOR, therefore, has a higher likely impact on the wholesale power market than Dynamic Response services by increasing wholesale power price with marginal units. This is a sound functioning of a market though, capturing more expensive units in a competitive market to ensure supply meets demand inline with appetite to buy.



LCP Delta Enact platform. Showing D-1 N2EX wholesale price in relation to STOR volumes

Wholesale Market Assessment – (1) Supply competition

Balancing services compete for volume in the wholesale market

- **The day-ahead energy auctions are competing for the same energy volume as the balancing services, which will likely impact on the price outcomes of the different auctions as the supply profile and additional risk premia are considered.**

- Both the energy balancing services and the wholesale market provide route-to-market for the same product (energy volume). This provides opportunity for asset owners and optimisers to choose between the different revenue streams that will provide the greatest value. This is demonstrated in the previous slides where volume has exited balancing services to access higher returns in the wholesale market.
  - With this opportunity comes also an increased risk of inefficient dispatch of assets. An asset is theoretically providing the greatest value to the electricity system where its price is valued the highest.
  - As procurement frameworks and the day-ahead trading session becomes more complex and congested this risk of inefficient dispatch increases on an individual unit basis. However, the risk to the whole system is likely to decrease as the capacity of balancing service providers is expected to grow (such as battery storage).

- There is a two-way opportunity cost (i.e. opportunity cost factored into balancing service trades, and into wholesale market trades) that exists. This is where the potential revenue that could have been achieved in the wholesale market, if opting to participate in a balancing service auction and vice versa exists. This could result in increasing price convergence as the markets develop and mature.

- LCP Delta found that sequential procurement (i.e. multiple single auctions) increased the opportunity risk of missing out on greater revenues in other revenue streams and may result in poor whole system outcomes. We explore this in more detail on the following page, but it has an impact on traded volumes and participation. For example:
  - Greater value may be placed on the Dynamic response products auction in the afternoon. Assets may dispatch in the morning D-1 power wholesale market which would present a missed opportunity to maximise value; it could also result in sub-optimal dispatch if the system need was greater in a balancing service (and valued higher).
  - Conversely, providers may withhold capacity from the D-1 power wholesale market in attempt to optimise in a later ESO balancing service auction, resulting in decreased supply in the D-1 power wholesale market.
  - Additionally, if the asset or portfolio volume has already been sold in an earlier wholesale market auction, an optimiser or operator may sell the energy again in a subsequent balancing service auction with a higher price. This would require them to buy back the power in the continuous market or intraday auctions. This would impact on the demand dynamics of the least liquid market. Due to the relatively low volumes, and increasing competition in the auctions, we deem this impact to be very limited.

Wholesale Market Assessment – (2) Trading complexity

The day-ahead trading session is becoming crowed, which poses risks

- **The increasingly crowded day-ahead procurement schedule poses risks to all competing markets. The design of the co-optimised procurement framework is important to mitigate these risks.**
- Auctions taking place so closely together pose risks based on how they influence and correlate with one another's price that can result in total expenditure risk, and impact on net consumer benefit.
- Overarching risks from the sequencing of auctions particularly exist in the form of market fragmentation where different prices (and values for energy) emerge in different auctions based on sub-optimal information. Conversely, auctions that occur at similar timeframes may experience price convergence or correlation where a preceding auction directly impacts bidding behaviour in a subsequent auction.
- With such significant time pressures in the day-ahead trading session, information asymmetry (particularly for STOR and FFR) may cause inefficiencies if auction results are not released in time for consequent market auctions, to allow participants to dispatch on up to date information.
- At present, there is a commitment to publish STOR auction results by 17:00 – which would come after all other day-ahead auctions. The ESO does see this as an absolute deadline, with a target of publishing results at 12:30. If possible, this should be revised to a commitment to ensure efficient dispatch of units.
- As many participants optimise and trade on a portfolio basis, they can take advantage of the information they have of their own asset performance in an auction. This will benefit the larger optimisers who may optimise and operate multiple owners portfolios. Timing of information and the transparency of market results and pre-auction parameters are important as it can limit the exercise of market power across the wholesale market and other balancing services.
- The ESO's proposals to proceed with the EAC for new products, and apply a co-optimised procurement approach in favour of sequential auctions is a positive step, and should mitigate these risks due to simplicity and streamlining the trading day.
- By decreasing market complexity and reducing the congested auction schedule, this should result in more efficient dispatch in markets where the most value is held (and theoretically where the highest need for the asset is). Reducing trading session congestion would allow more time for traders and optimisers to process important information that enables optimal trading and dispatch of assets.

Wholesale Market Assessment – Balancing Mechanism specifics

The BM has very similar interactions with the wholesale market as energy balancing services, but there are specific observations

- **In 2022, LCP Delta and Frontier Economics performed analysis on the high balancing costs experienced since the start of the energy crisis. We have further reviewed the Balancing Mechanism (BM) considering its interactions with the wholesale market.**

- The overarching interaction between the BM and the wholesale market is the use of it as a route-to-market to capture within day scarcity. This may either be through the buy-back of a position in the market to make a unit available in the BM where potential returns may be greater, or alternatively a unit not commercially selling its position and looking to the BM as a revenue stream. This in itself removes energy volume from the wholesale market (impacting on the supply profile of the wholesale market) and is a departure from the BM's main aim of being a mechanism for 'residual balancing'.

- This may have a knock-on impact to the wholesale market, where units that would otherwise be expected to be offering their volume into the market are not. This could create false scarcity – although very much deemed to be real by wholesale market players who are seeking liquidity. This would negatively impact on total cost to consumers.

- In the 2022 Balancing market review, we found that there was merit in the ESO continuing its review of :
  - Wind and demand forecasting – to improve market signals or expected scarcity. We found the ESO tends to mis-forecasting wind and demand.
  - STOR procurement methodologies – to ensure that STOR requirement is met under a range of circumstances, including where wholesale market prices increase.

- These interactions between the BM and the wholesale market have been driven by a combination of:
  - **Increased cost of energy** – providers experiencing higher short run marginal cost, and factoring in increased scarcity prevalent in the market.
  - **Increased margining requirements** – energy wholesale market volatility since the start of the energy crisis has reduced companies' ability to maintain a significant forward hedge in the forward markets, pushing them towards shorter time horizons and the BM.
  - **Increased exposure to trip risk** – the higher imbalance costs following the start of the energy crisis (Sept-22) exposing a provider's portfolio to higher penalties in the event of under delivery.

- The UK Government, Ofgem and the ESO has taken steps to try and address these issues. We particularly note the recently rejected the ESO's proposal to implement the Balancing Reserve product – which would have removed the need for the ESO to maintain regulating reserve through the BM.

- Ofgem is also looking to address BM issues. For example, a recent consultation on the Inflexible Offers Licence Condition (IOLC) seeks to prevent the withdrawal or withholding of capacity from the GB power wholesale market (and Physical Notification in the BM) at short notice.

- Finally, an emerging issue in BM is the increasing use of it as a route-to-market to capture scarcity. This is departing from the principle of the BM as a residual balancing tool and its market impact needs further analysis.

System Services

Restoration
Voltage
Stability
Thermal Constraints

Wholesale Market Assessment – (3) System Services

System services have a low impact on energy markets as they don't compete for the same volume, but could support units bidding into the energy markets.

- **The system balancing services have limited impact on the power wholesale market. This is largely driven by the 'stack-ability' of system services with energy markets.**

- When reviewing the system balancing services, we have considered the market developments that the ESO are implementing (i.e.. the Pathfinders and new competitive tenders), rather than the existing procurement method. These market developments are improving the ESO's market framework, limiting poor consumer outcomes that could be experienced through the status quo - correcting system constraints and procuring system services through bilateral agreements and trades, or through the BM.

- In most cases, system services do not limit providers' ability to stack energy market revenues with their system services contract – so long as it meets the ESO's stacking principle of "*not paying for the same MW/MWh twice*". This is because system service providers are largely:
  - Assets that are non-active energy providing technologies (such as fly-wheels, and synchronous condensers); or
  - Assets that provide the system service as a by-product of their normal market activities (such as restoration committed units).

- System services, therefore, do not directly impact on the power wholesale market through competition for the same volume in the way that energy balancing services do.

- **There is, however, some concern that assets that can provide system services have an advantage in energy markets over units that do not provide system services.**

- We note that similar concern exists to reflections of the Capacity Market (CM) that providers of system services are in effect financially supported in their participation in energy markets. This may act to negate any advantage that more efficient units (and therefore lower short-run marginal cost) may have in the wholesale market.

- In extreme circumstances (but largely unlikely) the wholesale market may fail to dispatch more efficient plant in favour of lower efficiency units supported by system service contracts and stacking that with a CM agreement.
  - Note that this may be a desirable result – as long as system services are priced appropriately (at the true system value) and there is access to the system service for all providers, then dispatching the less efficient unit that provides a valuable service may be preferable.

- We feel that this is probably a low-risk, however, and also note that the ability to access energy contracts in combination with system service contracts should result in lower ESO market cost:
  - avoiding action taken through uncompetitive bilateral agreements, the BM; and
  - avoiding the system service provider relying on the ESO contract to make their business viable.

LCPDelta

Annex

LCP Delta and the Project Team

About LCP Delta

Expertise in generation, networks and demand in a single integrated energy transition practice

- Our mission is to enable a better, faster energy transition for all by supporting the energy sector to drive the transition.
- LCP Delta provide data-driven research, consultancy, technology products and training services to companies investing in and navigating the energy transition.
- We are a diverse team based across the UK, France and Netherlands, from a variety of backgrounds including engineers, data analysts, environmentalists and more.
- LCP Delta is a mission driven organisation - all of us want to make a difference to the energy transition and accelerate the path to a low carbon future.
- The energy market is becoming increasingly complex. As consumers become more empowered and as energy systems around the world decarbonise, there is a need to understand both the generation and demand side to effectively navigate the rapid changes occurring.
- LCP Delta was formed through the merger of Delta-EE and LCP's Energy Analytics team to bring together deep generation and consumer-side expertise, to provide our clients with a single partner to help them on their journey and provide them with a 360° view across the energy spectrum.
- www.lcpdelta.com

- We support our clients in four ways:

Subscription research services

- Our portfolio of subscription research services offer in-depth insights across the energy transition landscape. We have been undertaking primary research with organisations active in the energy transition since 2004 – we have an unparalleled international network of contacts we can draw on. Each service focuses on a particular aspect of the energy transition.

Technology & data

- Data integration and analysis is at the heart of the energy transition. However, sourcing and navigating complex, wide-ranging datasets is challenging. At LCP Delta, we combine and curate proprietary and public datasets to provide you with a single source of truth across the energy spectrum, and make this data interactive using our cutting-edge technology.

Market and strategic advisory consulting

- We provide support across the full energy value chain with bespoke research, insight, forecasts and advice tailored to them. Our consultancy offerings draws on expertise and data from across LCP Delta, from strategic market entry analysis through to detailed half-hourly revenue forecasting.

Training

- Our training helps professionals quickly develop their new energy knowledge, accelerating their impact for organisations who want to capture opportunities. We provide meaningful, concise and easy to understand short courses.

Project team

Matthew Deitz
Consultant

Tel: +44 (0)20 7432 6799
Email: Matthew.Deitz@lcp.uk.com

Sam Hollister
Head of Markets

Tel: +44 (0)20 7432 3780
Email: Sam.Hollister@lcp.uk.com

Shivam Malhotra
Consultant

Tel:+44 (0)20 3824 7283
Email: Shivam.Malhotra@lcp.uk.com

Chris Matson
Partner

Tel: +44 (0)20 7432 0674
Email: Chris.Matson@lcp.uk.com

NG ESO – Market Design Framework Metrics library

NG ESO internal guidance provides a longlist of metrics to assess each principle.

These metrics formed the basis of the assessments carried out by LCP Delta

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**

Competition (1/6)

Metric	Definition	Pros	Cons
The number of existing capable providers	An assessment of incumbent providers by technology	• Practical to implement for most markets	• **It is not a sufficient condition for concluding whether a market is competitive or not**
The number of anticipated future providers	Based on a variety of sources including incumbent, capable providers, stakeholder feedback and market assessments	• Existing markets and stakeholder feedback can give an indication of future competitiveness	• **It is not a sufficient condition for concluding whether a market will be competitive or not** • **May be a high degree of uncertainty**
The distortion to competitive price signal from discrimination	ESO can model bid stacks and merit orders and 'bid in' the technology and/or 'remove capacity demanded' in a market to understand the impact to prices	• Gives a quantitative understanding of how market changes may lead to (short-term) price deviations	• **Requires market modelling** • **Static Analysis**
How many technically capable providers are excluded by eligibility rules?	Qualitative analysis of service guidelines and provider capabilities to assess whether any relevant, capable providers are excluded	• Practical to implement for most markets	• **It is not a sufficient condition for concluding whether a market will be competitive or not** • **May be hard to judge for new services**
Residual Supply Index	**Measures whether demand can be met without the supply of the largest seller. It measures the percent of supply capacity remaining in the market after subtracting the supply of the largest firm. The smaller the RSI the greater the market power as it indicates the largest firm is pivotal**	• **Assessment of market power on an hourly basis** • **Often preferred to the HHI in energy contexts**	• **Only works for existing markets** • **Data intensive: require data by hour and participant**

Competition (2/6)

Metric	Definition	Pros	Cons
Market Shares	Analysis of the MW capacity contracted with each supplier relative to total ESO demand.	• Practical to implement for most markets • Can be implemented on capacity of existing capable providers when considering markets that are not yet operational	• **It is not a sufficient condition for concluding whether a market is competitive or not**
Market Share of the Three Largest Providers	The contracted MW of the three largest providers as a percentage of total ESO demand	• As above	• **As above**
Estimated rate of return for long-term contract holders	The annual income a provider receives expressed as a percentage of the original investment	• A high rate of return may signal a greater degree of market power	• **May be impacted on a year-to-year basis by factors other than competition**
System mark-up for selected short-term markets	An analysis of the degree to which price exceeds marginal cost for suppliers	• It only considers the mark-up for the marginal generator	• **Requires an estimate of generators' marginal costs and scarcity pricing means that the price will deviate from MC in certain hours** • **Can only be applied for existing markets**
Herfindahl-Hirschman Index (HHI)	**Index measuring the degree of market concentration. An HHI below 1000 is unlikely to result in abuse of a dominant position. Calculated as the sum of the squared market shares of all market participants**	• **Practical to implement for most markets**	• **Does not consider whether providers would want to participate** • **Static analysis** • **RSI is preferable to HHI in energy settings**

Competition (3/6)

Metric	Definition	Pros	Cons
Lerner Index	Measures the extent to which the market price has "marked-up" underlying production costs. It is calculated as the price minus cost, divided by output price. The closer to 0 the index is, the lower is the mark- up/market power	• An ex-post assessment of whether market power has been exercised • A quantitative metric	• **It requires an estimate of generators' marginal cost** • **Scarcity pricing means that in certain hours prices will deviate from MC. Determining whether a mark-up is anti-competitive or not is thus challenging** • **Can only be applied for existing markets**
Return on Withholding Capacity (RWC)	Measures the potential gain which a producer could experience if it withholds one MWh of capacity. If the RWC is above 1, the supplier has a strong incentive to withhold capacity	• Measures providers' incentive for exercising market power on an hourly basis	• **Can only be applied for existing markets** • **Data intensive**
Net revenue	Cost of goods/services sold from gross revenue	• A measure of market health and the incentives to enter/exit a market	• **Difficulties of estimating SRMC** • **Needs to be interpreted in context**
Volume of trade	An analysis of tendered MW and contracted MW on a tender basis	• As above	• **Cannot be used to draw conclusions about market power**
How much market entry do we expect under the procurement design?	**The forecasted number of new providers in the service in absolute terms or as a percentage of existing providers**	• **Market entry is an indicator of long-term market health**	• **Subjective view** • **Participation not sufficient to ensure competition**

Competition (4/6)

Metric	Definition	Pros	Cons
Elasticity of supply	A measure of the responsiveness of supply to a price change with an elasticity above 1 signaling that supply is relatively elastic	• An inelastic supply suggests there may be a capacity constraint such that some suppliers have market power • A quantitative metric to assess market power	• **Backward looking so it can only be applied to existing markets** • **The implementation for future markets requires market modelling**
Number of market participants adjusted by frequency of participations	Scale the number of market participants by the relative frequency of participation (by bids, capacity, for instance)	• An auction in which there are many providers but only a few regularly participate may not be competitive and this metric captures this • Similar to market shares but may require less data	• **It is not a sufficient condition for determining whether a market is competitive or not**
Barriers to participation raised by stakeholders	A running frequency of the number of (by category) stakeholder concerns. This could be tracked across time	• Provides contextual information on competition from the perspective of providers	• **Does not facilitate a direct comparison of strawmen**
Pivotal Supplier Index	The PSI is a binary version of the RSI whereby it is 1 whenever the RSI is below 1 and 0 otherwise. It is added over a given interval such as a year and the proportion of hours in which it was 1 is assessed	• Produces a more intuitive output than the RSI	• **Only works for existing markets (or else requires a lot of assumptions – power market modelling)** • **Data intensive: require data by period and participant**
Total cost to technically capable participants of becoming eligible to provide the service	**N/A**	• **Quantitatively assesses the degree to which there are barriers to entry** • **May be able to determine whether barriers differ by technology and geography**	• **May be difficult to estimate for some providers, particularly for those in new products**

Competition (5/6)

Metric	Definition	Pros	Cons
Who is likely to enter and what are they likely to build (capacity)?	N/A	• A more structured approach to assess how many future participants there is likely to be in a market	• **Views on who is likely to enter and their respective capacity is prone to subjectivity and optimism bias**
What would HHI for capacity be if we saw comparable entry response to what we have seen in previous similar situations	Index measuring the degree of market concentration. Calculated as the sum of the squared market shares of all market participants (scaled to include comparable entry in similar situations)	• Enables the ESO to place a quantitative metric against competition • Guards against optimism bias in the assessment of likely entry	• **Comparability of entry response and similarity of situations are open to subjectivity**
What is the year-on-year trend in RSI since introduction of the procurement method? [if RSI is trending down, service becoming more competitive => suggests it is sending investment signals that result in better outcomes]	It measures the percent of supply capacity remaining in the market after subtracting the supply of the largest firm. The smaller the RSI the greater the market power as it indicates the largest firm is pivotal	• A quantitative metric that can provide an indication of how the existing market design is impacting competition	• **Only works for existing products** • **Other factors may cause trends in RSI (e.g. investment signals from other products)**
Given projected demand from ESO, existing plant, and existing plant retirement decisions, how many new "typical" plant would be needed to ensure RSI never exceeds a set threshold?	**ESO would calculate RSI as previously described. ESO can then scale up participation (now and with future plant projections) to ensure RSI does not exceed a defined threshold (such as lower than 1)**	• **Produces a quantitative metric that can be tracked and compared across time**	• **Subjectivity: definition of what a typical plant and threshold is** • **Requires modelling (and the assumptions behind) future demand and existing plant retirement decisions** • **Does not directly tackle the question of interest. The assumption that the more plant required, the less competitive a market is may not be true**

Competition (6/6)

Metric	Definition	Pros	Cons
Who is failing qualification? Do you need all the qualification rules? If you change rules, would it impact bids or winners?	A qualification rule is any attribute (technical, locational etc.) that a provider must fulfil to operate the service	• Can be used to understand which technology groups face barriers to entry	• **Only applicable for existing products** • **Prone to subjectivity**
Ratio of interested participants excluded for technical reasons to interested participants allowed to bid	The proportion of interested parties excluded on technical grounds to those allowed to bid. A higher ratio would raise concerns around market power	• A quantitative metric that helps ESO to understand the technical constraints that may be deemed "arbitrary" (participants with "obvious" technical constraints expected to not register interest)	• **Only works for existing products** • **A large ratio may not be revealing about market power if the absolute numbers are large**
Does the design provide a performance test for eligibility? (Y/N)	N/A	• Qualifying test ensures non- discrimination against new and existing participants who do not meet standards	• **Does not consider whether the performance test is well designed**
Number of participants technically capable of providing a discretisable part of the service but not all of it (where service is bundled)	**The percentage of participants who are able to provide a part of the service to those who are able to provide all of the service**	• **Addresses the risk that bundling is a form of discrimination**	• **May be hard to judge for new products** • **Does not account for question of whether separate procurement for discretised service would be viable**

Net Consumer Benefits

Metric	Definition	Pros	Cons
What is ESOs best estimate of the annual cost of procurement using this method?	Analyse the total cost of procurement for ESO for each service using historical bid and price data	• Directly addresses the question of interest. • Can be used to compare existing and future services • Can be informed by historical procurement costs and volumes	• **Estimate may be subject to optimism bias**
For short-term markets, assessment of short-term cost savings	ESO could compare the relative price due to short-term price dispersions for each strawman with the capacity ESO must procure for each	• Directly addresses the question of interest. • Can be used to compare existing and future services • Can be informed by historical procurement costs and volumes	• **Estimate may be subject to optimism bias**
What is the impact on redispatch requirements in the BM?		• Addresses potentially hidden cost considerations	• **Difficult to quantify**
If procurement involves long-term contracts, assess extent to which they provide opportunities to earn rents relative to short-term procurement	**ESO can model the difference in the market clearing or bid price for each provider under a long-term contract relative to shorter-term procurement**	• **Addresses consumer value concern that a provider with a long-term contract and a utilisation fee above its marginal cost will not bid into a short-term market if it expects the clearing price to be below its utilisation fee, even if the clearing price is above its marginal price. Dispatch is still efficient – provider called in both cases.**	• **Requires market modelling**

Adaptability

Metric	Definition	Pros	Cons
Does the procurement method include utilisation payments? (Y/N)	N/A	Practical to implement in each market Enables the ESO to vary what it pays for in line with what it uses whilst ensuring sufficient participation should a need arise.	• **Does not work for "insurance" services e.g. restoration**
What is the contract length?	The relevant (hours, days, etc.) period for which the contract spans	• Practical to implement in most markets	• **May not be known for new markets**
How often is ESO able to adjust the volumes procured for this service?	The number of times per period (days, months etc.) for which ESO can adjust volumes procured	• Easy to quantify and provides an indication of whether ESO is locked in	• **Taken alone, it may be difficult to define whether this is 'optimal'**
What is the balance of costs between availability and utilisation payments under each strawman?	A binary rating of whether the service includes both. If a service offers both, a weight for how much providers are compensated through each	• Practical to implement in each market	• **Does not work for "insurance" services e.g. restoration**
What is the difference between ESO's 'baseload' need for the service and the amount of service procured under the alternative contract	A weighting of the importance of the contract for the new design with ESOs requirements	• Addresses the market's ability to account for changing requirements	**Only applicable for existing products/markets**
In the past year how variable has ESOs procurement of the service been?	**Calculate variance in ESO's procurement of the service**	• **A quantitative metric that is implementable in many markets**	• **A backward-looking measure only**

Coherence (1/3)

Metric	Definition	Pros	Cons
Is the method of procurement consistent with the procurement of services with similar cost profile	A qualitative comparison of procurement methods across services (ESO could consider the auction format, how providers are paid etc.)	• Takes advantage of learnings from existing procurement • Provides a check on both the procurement method being designed and the existing procurement method	• **Requires "similar" to be defined**
Is the method of procurement consistent with the procurement of services with similar technical requirements?	As above	• As above	• **As above**
How robust is the procurement method to changes in policy/legislation? What is the risk of this procurement method becoming feasible/non- compliant?	ESO can analyse whether there are any policy/legislative constraints that impacted the design of the strawman and how these may be subject to change	• Recognises that the context is not static • Short-term procurement may work well if investment is supported by policy measures, but if those policy measures are removed LT contracts may be needed to incentivise investment	• **May be hard to quantify and/or assess** • **There is a subjective nature to the question** • **May require market modelling**
To what extent does the procurement method prevent a generator that is technically capable of providing multiple services from doing so?	**ESO can analyse the services a generator can provide and tally which services the rules prevent them from doing so**		• **The list of services a generator can provide may be subject to optimism bias or is uncertain**

Coherence (2/3)

Metric	Definition	Pros	Cons
How consistent are procurement decisions over the last X periods?	ESO can analyse how many times over the last defined number of periods that procurement decision-making has changed	• Directly addresses the question of interest • Potentially quantifiable (depending on the definition of 'consistent')	• **Data and time intensive: requires the analysis of a large number of procurement decisions with various decision factors)**
How consistent are decisions to procure via this mechanism rather than an alternative over the last X periods?	As above	• As above	• **Data and time intensive: requires the analysis of a large number of procurement decisions with various decision factors)** • **May be hard to quantify and/or assess**
Use a "shadow committee" – check how often decisions are the same	ESO can appoint an internal team to check whether procurement decisions are the same	• True check of "in the same scenario" (comparison of historical decisions are not exactly the same scenario)	• **Only works for existing procurement that involves a committee stage; costly to implement; may not work in practice (e.g., if members of committee need expertise that is not widespread); may be more useful if built into the decision process**
What is the impact of this procurement design for complementary services?	ESO to assess how the procurement design may impact the functioning of complementary services in terms of price, participation etc.	• Directly addresses the question	• **May be hard to quantify and/or assess** • **Subjective in nature**
If a generator is capable of providing another rival service, check that the generator switches from one to the other in response to changes in ESO needs	**ESO can build a market model and flex different parameter assumptions to analyse such**	• **Assesses whether procurement mechanism allows generator to make socially efficient decisions between two services**	• **Complex to implement – requires market modelling**

Coherence (3/3)

Metric	Definition	Pros	Cons
How many distinct services are being procured in the same bundle?	An absolute measure of the number of different services being procured in the same bundle. Can be compared across time	• Practical, implementable metric that gives a rough indication of opportunity cost from bundling, rather than allowing providers to optimise across services	• **Crude metric** • **Does not consider whether required combination of services in the bundle is flexible**
Assessment of the distortion to short term market from existing/future policy tools	**ESO can analyse whether there are any policy/legislative constraints that impacted the design of the strawman and how these may be subject to change**	• **Recognises that ESO procurement operates in context – e.g. CFDs may affect market bidding decisions**	• **May be hard to quantify and/or assess** • **Subjective in nature**

Locational Signals (1/2)

Metric	Definition	Pros	Cons
Does the design allow the quantity and price of procurement to vary by location? (Y/N)	Does ESO have the capability to adjust this through market signals and/or technical requirements?	• Directly answers the question of interest	• **Not a quantitative metric so does not address the extent to which they differ** • **Does not assess effectiveness of the investment signals or cost efficiency**
How frequently can ESO update the locational signal (level and granularity)?	The number of times per period (days, weeks etc.) that ESO can update the locational signal	• Practical and implementable	• **Does not consider whether ESO is updating the signal in practice – if ESO can update the signal but never does, then this metric may suggest lower locational signals for investment than is actually the case**
Is the design such that ESO can set procurement parameters such that for two otherwise equivalent plants in different locations, one plant would be built and another would not? (Y/N)	ESO can model the procurement decision for a generic plant and by adjusting locational signals it can analyse the impact on the investment decision for the plant	• A flexible exercise that can be scaled up or down depending on the time requirement	• **Assumption-driven** • **Which/to what extent parameters are varied to test this is unknown**
Does the contract length match the shorter of: the period for which the locational need is likely to persist, or the lifetime of a typical asset? (Y/N)	ESO to forecast the lifetime of the asset and the period for which the locational need is required for	• Assesses whether locational signal provides a sufficiently strong incentive for investment	• **Binary – does not consider degree of discrepancy** • **Does not assess effectiveness or cost efficiency**
How much would the total cost of procurement change by if signals were more granular?	**ESO can model total costs of procuring the system and can vary the locational input parameters to compare with the base case**	• **Assesses effectiveness of locational signals**	• **Requires market modelling**

Locational Signals (2/2)

Metric	Definition	Pros	Cons
Does the design include a mechanism for ESO to adjust the signal of locational needs over time or is it fixed by location? (Y/N)	Does ESO have the capability to adjust this through market signals and/or technical requirements?	• Directly answers the question	• **Not quantitative** • **Does not assess effectiveness or cost efficiency**
Does the design allow the cost of procurement to vary by year, month, week, day, EFA blocks, hour half-hour? (Y/N)	As above	• Similar to the above	• **Not quantitative** • **More a question about time signals in dispatch**
Does the design allow the cost of procurement to vary by both time and location simultaneously? (Y/N)	As above	• Adjusts for the fact that locational dispatch needs change over time	• **Not quantitative** • **Does not assess effectiveness or cost efficiency**
What is the granularity of the signal? Does it vary by: (i) meter level, (ii) distribution/sub-node, (iii) node, (iv) GSP Groups, (v) region?	**As above**	• **Sliding scale rather than simple Y/N, so gives a sense of the degree of locational signaling**	• **Not quantitative** • **Does not assess effectiveness or cost efficiency**

Transparency (1/2)

Metric	Definition	Pros	Cons
Can ESO publish the method for setting demand for this service? How often?	N/A	• Directly answers the question of interest	• **No consideration of detailed the method as published is**
Would it be possible, given published information (ex post) to reconstruct the procurement decision (Y/N)?	For instance, can ESO model the merit order given publicly available information?	• Directly answers the question	• **It may not be possible to quantitatively assess all the factors the ESO must consider to replicate the procurement decision**
Can ESO publish the rules for picking winners for this service? (Y/N)	N/A	• Directly answers the question of interest	• **Highly specific metric, needs to be interpreted in context and combined with others**
To what extent is there scope for subjective judgement in picking winners for this service?	ESO analysis on the extent to which procurement decisions are formulaic	• Directly answers the question of interest	• **Highly specific metric, needs to be interpreted in context and combined with others**
How long after the procurement decision is made can the decision be released and reconstructed?	**The length of time (hours, days etc.) between the procurement decision being made internally and being made publicly replicable**	• **A non-binary answer and can be an indicator of how transparent the decision process is**	• **Indirect – there are other factors beyond transparency that impact this length** • **Highly specific metric, needs to be interpreted in context and combined with others**

Transparency (2/2)

Metric	Definition	Pros	Cons
Number of stakeholder complaints received per year about the lack of transparency?	A running tally of the number of stakeholder complaints per year, which can be tracked over time in absolute and relative terms	• Can be scaled relative to the number of participants in the market to understand relative complaints • Could be tracked over time to understand how changes in the procurement strategy impact transparency	• **Only applicable for existing services** • **Does not place weight on what the barriers are nor whether concerns are well-founded**
Can ESO publish forecasts of demand for this service? Can it do so ahead of procurement? (Y/N)	N/A	• Directly answers the question of interest	• **Highly specific metric, needs to be interpreted in context and combined with others** • **If forecasts are not accurate transparency is hindered regardless of whether the forecast is publicly available**
Does any information about procurement have to be withheld from the market? (Y/N)	N/A	• Directly answers the question of interest	• **Does not consider how much information is being withheld, importance of that information**
Would it be possible, given published information (ex post), to reconstruct the decision to procure via this mechanism rather than another (e.g. BM)? (Y/N	**N/A**	• **Directly answers the question**	• **Difficult to quantitatively assess and/or gain large insights on due to the quantity of real-time information involved in procuring through the BM.**

Practicality

Metric	Definition	Pros	Cons
Does the procurement method require ESO to increase its operational capacity (more staff, extra software)?	ESO to analyse the ongoing operational requirements for each strawman to provide an absolute difference between the two	• Addresses one-off cost considerations	**Does not provide an indication of the extent of these costs**
Is the lead time to procurement under this method less than the timeline within which the service is required?	The forecasted difference between the expected service requirement and the lead time to procure the service	• Addresses the ability of the strawmen to meet the identified need within relevant timeframes	
What is ESO's best estimate of the cost to implement this procurement method?	ESO to estimate all the costs involved in implementing each strawman	• Directly addresses question of interest	**Estimate may be subject to optimism bias**
What is ESO's best estimate of the lead time to implement this procurement method?	ESO to estimate the technical and capability requirements to implement the procurement method	• Directly addresses question of interest	**As above**
Stress testing – investigate whether this procurement method will still ensure security of supply under adverse conditions	ESO can model the risks to supply for providers and how stressing one or a combination of these risks impacts supply capability	• More structured assessment of deliverability risk as a component of practicality	• **Complex to implement** • **Results rely upon numerous assumptions inducing uncertainty**
What is the additional ongoing operational cost to ESO of this procurement method?	ESO to analyse the ongoing operational requirements for each strawman to provide an absolute difference between the two	• Can be used for existing and future products • A quantitative metric (non-binary like the above)	• **May be difficult to estimate for future products**
Does the procurement method require a pre-qualification process? (Y/N)	**A pre-qualification process is any assesses suppliers based on technical grounds prior to the tender process**	• **Addresses potentially hidden cost considerations**	• **Does not provide an indication of the extent of the pre-qualification process or costs involved**

Disclaimer

About LCP Delta

LCP Delta is a trading name of Delta Energy & Environment Limited and Lane Clark & Peacock LLP. References in this document to LCP Delta may mean Delta Energy & Environment Limited, or Lane Clark & Peacock LLP, or both, as the context shall require.

Delta Energy & Environment Limited is a company registered in Scotland with registered number SC259964 and with its registered office at Argyle House, Lady Lawson Street, Edinburgh, EH3 9DR, UK.

Lane Clark & Peacock LLP is a limited liability partnership registered in England and Wales with registered number OC301436. All partners are members of Lane Clark & Peacock LLP. A list of members' names is available for inspection at 95 Wigmore Street, London, W1U 1DQ, the firm's principal place of business and registered office. Lane Clark & Peacock LLP is authorised and regulated by the Financial Conduct Authority and is licensed by the Institute and Faculty of Actuaries for a range of investment business activities.

LCP and LCP Delta are registered trademarks in the UK and in the EU. Locations in Cambridge, Edinburgh, London, Paris, Winchester and Ireland.

https://www.lcp.uk.com/emails-important-information contains important information about this communication from LCP Delta, including limitations as to its use.

Disclaimer and use of our work

This work has been produced by LCP Delta under the terms of our written agreement with National Grid for the Client's sole use and benefit, subject to agreed confidentiality provisions, and for no other purpose. To the greatest extent permitted by law, unless otherwise expressly agreed by us in writing, LCP Delta accepts no duty of care and/or liability to any third party for any use of, and/or reliance upon, our work. This document contains confidential and commercially sensitive information. Should any requests for disclosure of information contained in this document be received, LCP Delta request that we be notified in writing of the details of such request and that we be consulted and our comments taken into account before any action is taken.

Where this report contains projections, these are based on assumptions that are subject to uncertainties and contingencies. Because of the subjective judgements and inherent uncertainties of projections, and because events frequently do not occur as expected, there can be no assurance that the projections contained in this report will be realised and actual events may be difference from projected results. The projections supplied are not to be regarded as firm predictions of the future, but rather as illustrations of what might happen. Parties are advised to base their actions on an awareness of the range of such projections, and to note that the range necessarily broadens in the latter years of the projections.


LCPDelta