Electricity System Operator

Markets Roadmap

March 2024

ESO

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Executive summary

Welcome to the 2024 edition of the ESO Markets Roadmap. This annual publication aims to provide transparency and clarity to our stakeholders about how and why we are reforming our balancing services markets, in anticipation of the impacts of system decarbonisation and transformation.

Our vision is a future where everyone has access to reliable clean and affordable energy. The ESO has many roles in this vision, from efficient whole energy system planning to system operation. But a key lever in this vision is the development of coherent markets and frameworks which enable market participants to make efficient investment decisions; drive competitive and efficient dispatch across the whole system; and ultimately deliver a secure system at least overall cost.

To do this we must:

- **Remove barriers.** We are improving our existing markets to remove barriers to emerging technologies and business models, driving down costs through increased competition.
- **Deliver clearer market signals.** We are now creating the suite of ESO markets that will deliver us to net zero, with a focus on delivering transparent investment and dispatch signals that are coherent across our markets as well as others.
- **Be more transparent and collaborative.** We have heard your feedback that we can be more transparent in our market development processes and in our operational decision making.

What we are doing to fulfill these ambitions is outlined on the next page.

In the long term, we believe that fundamental reform is needed to wider GB markets and policies if we are to meet net zero securely and affordably. We therefore fully support the government's Review of Electricity Market Arrangements (REMA). And we understand the importance of maintaining investor confidence through this period of uncertainty and change. We are working closely with DESNZ, supporting the REMA analysis, as well as ensuring that our balancing services markets are evolving in a way that is coherent with wider market reform (especially wholesale and DSO markets).

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Executive summary

Why and how we are reforming our markets to be fit for net zero

Remove barriers

Deliver clearer market signals

Be more transparent and collaborative

We understand how vital low carbon and emerging flexibility assets are to a decarbonised system, but that there are barriers to them participating in our markets. We are therefore taking a number of actions:

- We are investigating what the appropriate level of metering is to allow small-scale, aggregated assets access to the Balancing Mechanism (BM). In the interim, we are admitting aggregated assets of up to 300MW, with relaxed metering requirements.
- Over 2024, there will be three further releases on our Open Balancing Platform, which will enable new services such as Balancing Reserve and Quick Reserve, both of which provide new market opportunities for market participants.
- In the meantime, we have adjusted the current 15-minute rule for battery energy storage so that it is now a 30-minute rule. This change is scheduled to take place in March 2024 and will enable more batteries to be dispatched in the BM.
- The development of the ESO's new flexibility markets strategy will consider how flexibility can best participate across markets.

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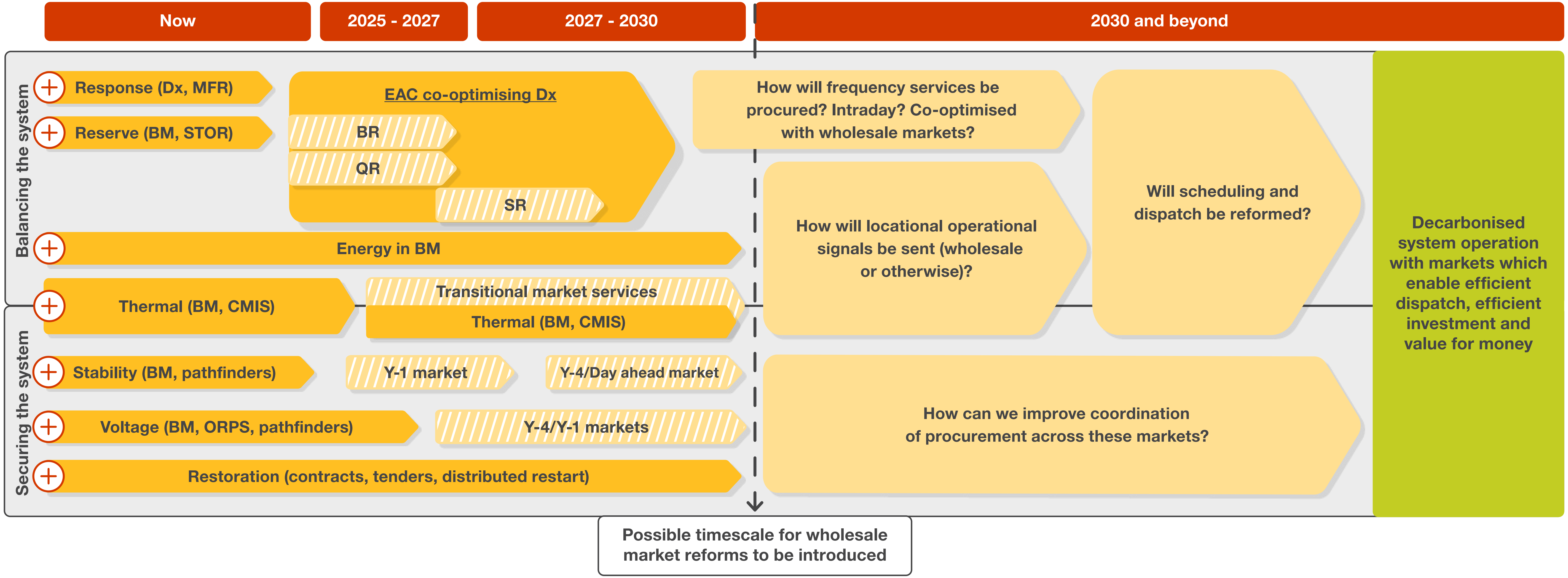
Executive summary

Forward-looking view of our markets



Key: Exisiting services / Planned services / Key questions for the future of ESO markets

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Executive summary

Story of 2023

Balancing costs dropped off from their exceptional high in 2022 as gas prices eased off, but the long-term trend is continued increase

We continued to drive down costs through enhanced market design

We increased participation of distributed and consumer flexibility to support the system

Enduring market design work

Balancing costs dropped off from their exceptional high in 2022 as gas prices eased off, but the long-term trend is continued increase

- Balancing costs reduced by 30% in 2023 to £2.9bn, largely driven by a significant reduction in gas prices in comparison to 2022. The long-term trend continues to be increasing balancing volumes and costs – 2023 costs were up 7% on 2021. Our Balancing Costs Strategy has been established in response to this trend.
- Thermal constraints made up over a third of balancing costs in 2023, and the volume of actions taken to manage voltage and stability system needs were significantly up due to outages, Scottish sub-synchronous oscillations and the retirement of older plant.

As the GB energy system transforms rapidly, we enter a different paradigm of system operation, with higher volatility, less inherent stability and very different geographic distribution of generation, meaning that balancing the system is a much more involved job. This is inevitably resulting in an upwards trend of increasing balancing actions and the associated costs (as shown in the chart). We launched our Balancing Costs Strategy in 2023 to set out everything that we are doing to mitigate against this, from system planning to network optimisation to enhanced tools and processes in our control room. A major part of this strategy is market reform.

Balancing costs 2017-2023

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Introduction

Introduction

What is the purpose of the Markets Roadmap?

The aim of roadmap is to provide stakeholders with a clear and transparent view of what we are doing to reform and improve ESO markets and why we are doing it. This will give the market the ability to build investment cases and the confidence that we are making the right design decisions. Ongoing reform of ESO's ancillary service and balancing markets is crucial if we are to ensure that we are able to operate a fully decarbonised electricity system by 2035. Additionally, markets, which are efficient and accessible to all, will drive down costs for consumers as well as creating a reliable revenue stream for market participants.

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Introduction

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Objectives and scope of the Market Roadmap:

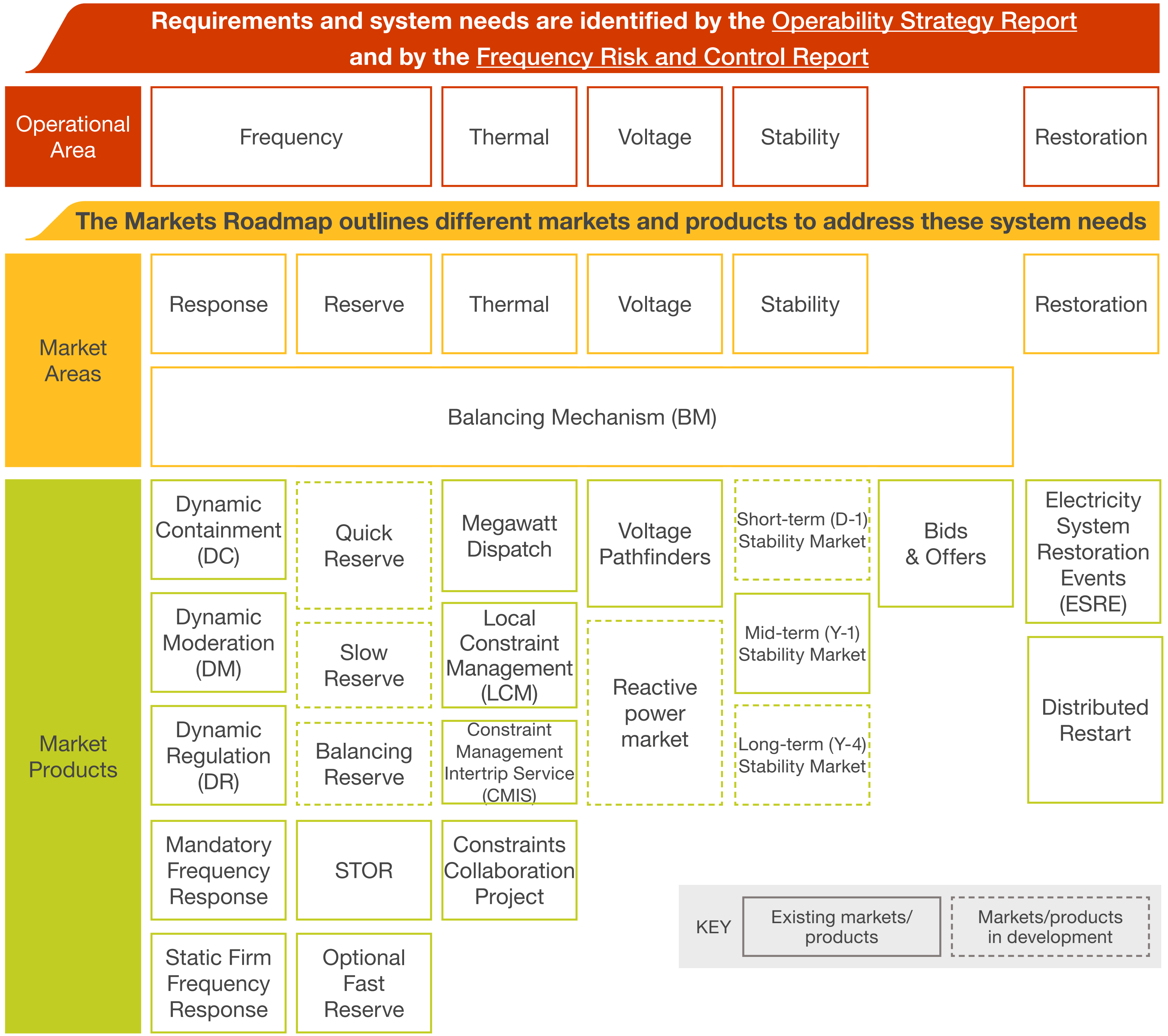
1 Give our stakeholders confidence that we are making the right market reform and design decisions.

2 Provide a clear and transparent view of market reforms.

3 Share strategic direction for ESO markets and how we are working to enable UK's 2035 decarbonisation target.

1 **Give our stakeholders confidence that we are making the right market reform and design decisions.**

When we consider market reform, any design options should be assessed against our robust Market Design Framework. See our market design framework section in the introduction chapter.



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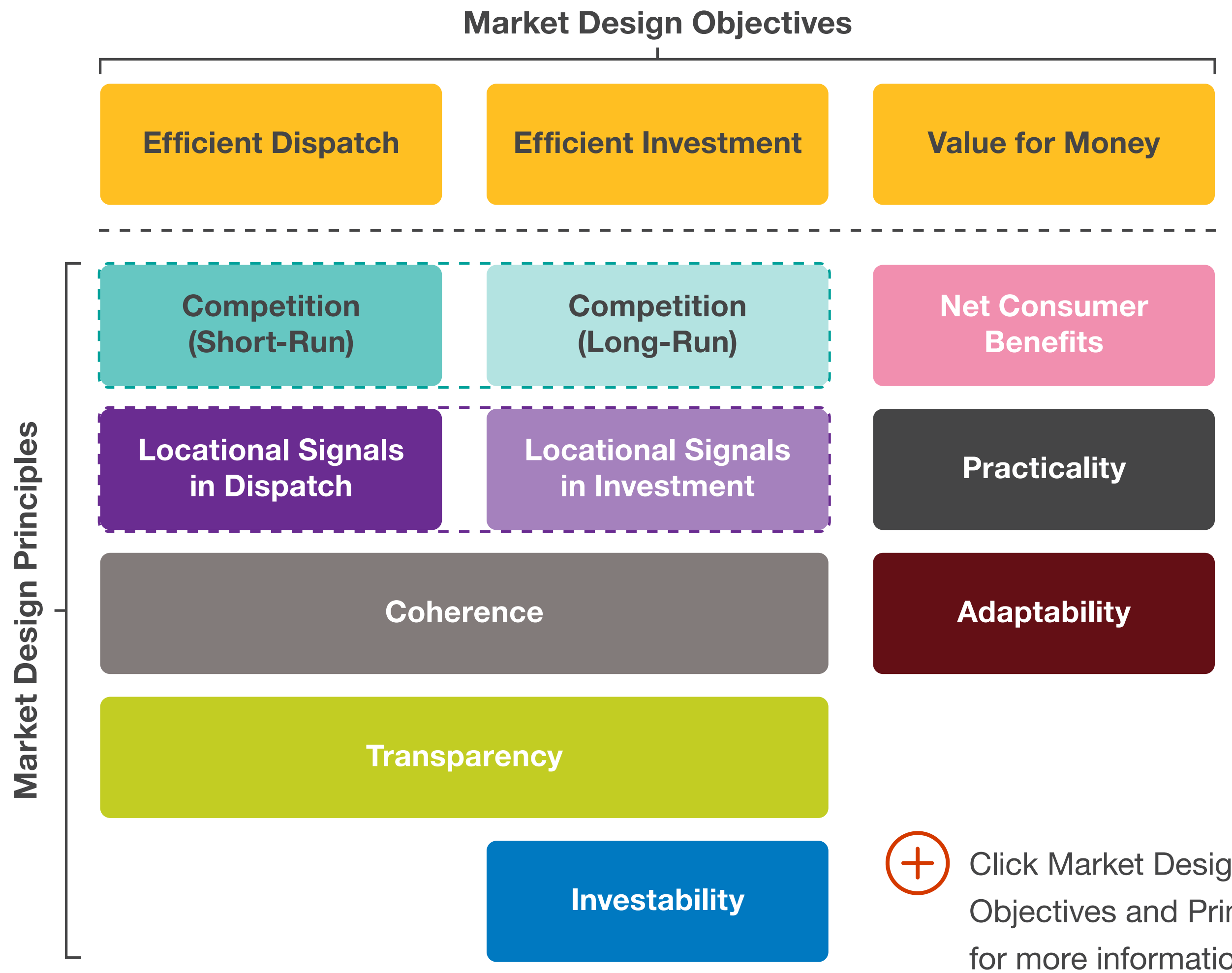
Introduction

Markets Design Framework

In 2021, we introduced our Market Design Framework (MDF), which underpins all of our market reform decisions, as well as being used to analyse the efficiency of our existing markets, helping to drive continuous improvement and identify new opportunities for reform.

In 2023, to complement our Markets Roadmap publication, we published an MDF assessment of the design of our markets (find out more here) LCP Delta, as an independent party, to conduct a qualitative assessment using the framework, to assess how we are faring against our market design objectives of efficient design, efficient dispatch and value for money. Consequently, in this year's report, we will be using key points from their assessment to inform our driver for reforms section in each market area chapter.

Any new market design needs to fulfill the market design objectives below. To do that, we test the design against each of the market design principles.



Click Market Design Objectives and Principles for more information.

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Introduction

How we work – markets as part of the bigger picture

As the UK progresses towards net zero, there will be many changes to the technological, economic, and political landscape of our electricity system. Both ESO and non-ESO markets will be evolving during this transition, as well as how they interact between one another. We recognise our customers' need for a coherent set of market principles across our networks as outlined in our Markets Design Framework.

The illustration on the right shows how we work with many different sources and stakeholders to ensure that our markets meet our customers' expectations need for coherency.

The ESO Markets team is responsible for developing new products, systems and industry codes to help ensure efficient operation of the system, maintain security of supply and deliver the best outcome for GB consumers.

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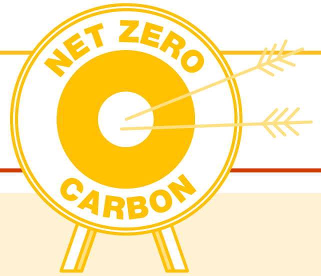
Markets Engagement



Stakeholder Engagement

Talking to our stakeholders to understand their perspectives and needs is a really important part of developing well-designed, cost-effective market solutions. To get in touch with our team, contact: box.market.dev@nationalgrideso.com

Markets Advisory Council

One of our key stakeholder groups is the Markets Advisory Council (MAC). The MAC has recently been established to inform our approach to strategic market design and delivery.

The group is made up of experts from all parts of the electricity value chain including networks, generators, flexibility providers and academia.

For more information click here.

Markets Forum

We hold these events four times a year and consider these as key milestones to engage with a wide range of industry stakeholders. We aim to reflect on the priorities of the energy industry and how the ESO role, and in turn Markets, is positioned to deliver against these.

Our Market priorities are structured into how the Market is operating now, how we are developing the Market and how we are designing our Markets fit for the future.

Aim:

- We will use these engagements to communicate on our strategy, decisions and policy positions.
- Explain the products and services we are developing now and designing for the future.
- To improve transparency, we will hold space for discussions and provide updates on industry blockers and opportunities.
- Signpost to how we are facilitating co-creation on how we develop, design and implement our market solutions.

All industry colleagues are welcome to attend.

More information can be found here: Markets Forum events.

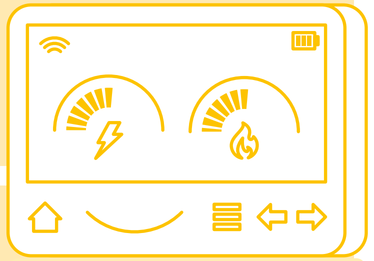
Power Responsive

Power Responsive is a stakeholder-led programme, facilitated by the ESO, that works with industry to unlock demand side flexibility through an agile, collaborative approach. It brings together industry and energy users, to work together in a co-ordinated way. A key priority is to grow participation in DSR, making it easier for households and businesses to get involved and to realise the financial and carbon-cutting benefits.

The role of Power Responsive is to:

- Remove barriers for Demand Side Flexibility (DSF) in ESO Markets.
- Raise awareness of Demand Side Flexibility opportunities.
- Act as a voice for Demand Side Flexibility with the ESO and wider industry.

More information can be found here



Market-specific engagement

In addition, we engage with stakeholders in smaller, more focussed, forums as needed when developing new markets. For example:

Constraint Collaboration Project (CCP): Over 2024, we will be running a Constraints Collaboration Project, where we invite ideas from industry about how market-based solutions can address thermal constraints. More information about CCP and ways to participate can be found here.

Stability market expert group has been providing vital feedback and insight to our market design process.

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Balancing the System

Balancing Mechanism

What is the Balancing Mechanism?

The Balancing Mechanism (BM) is the market we use to ensure that energy supply and demand are balanced and to manage system operability issues in real-time. Participants in the BM submit prices and volumes between 60 and 90 minutes before delivery up until a point which is termed 'gate closure'. The BM is also used to address any remaining system constraints that haven't been satisfied by self-dispatching generators who have indicated their intentions to run through Physical Notifications (PN's). Such system constraints include maintaining system stability, voltage management, and thermal constraints. The ESO control room issue Bids (actions to reduce generation or increase demand) and Offers (actions to increase generation or reduce demand) to units, which are either tagged for energy or system reasons. The volume of system actions is continuing to increase in contrast with the BM's original purpose as a residual market for energy balancing.

What services do we procure in the BM?

BM actions fall into two broad categories: 'energy' tagged and 'system' tagged. This is a best endeavours process although there is sometimes overlap. For example, there are occasions where a particular action can solve multiple system constraints or is the direct consequence of another prior action (e.g., energy actions taken following system bids for managing thermal constraints).

Energy	Energy tagged actions are ones where the ESO manages supply and demand imbalances, or positions units for providing an energy-related ancillary service, such as frequency response or reserve. Energy actions can be both bids or offers, but actions are mostly dominated by the ESO intervening after gate closure with offers to turn up generation to ensure supply adequately meets demand at all times. The price of the marginal action is used to determine the Energy Imbalance Price for each settlement period.
System	System tagged actions include management of system constraints, namely thermal, stability and voltage. These too can be either bids or offers depending on whether generation or demand needs to be turned up or turned down. System actions are tagged accordingly to remove them from the energy imbalance calculation and to highlight reasons where actions may have been taken out of energy merit order to solve a particular system-related issue.

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Balancing Mechanism - Summary of the Chapter

How is the landscape changing?

There was less price volatility in 2023 than in recent years, albeit balancing costs remain on an upward trajectory long-term. Several new records were set throughout the course of this year, including maximum wind generation and minimum carbon intensity, which demonstrates the UK's accelerated progress towards net zero. However, a system with a high penetration of non-synchronous generation, such as wind, solar and battery storage, can also present operability challenges. Many of these challenges, such as resolving thermal constraints and ensuring locational system stability, are currently done via the Balancing Mechanism. The BM was initially devised as a residual energy balancing market to solve any remaining energy imbalances following gate closure; however, it has rapidly evolved into a tool for resolving a multitude of both system and energy issues. In some circumstances, ESO can be re-dispatching a significant proportion of scheduled generation, owing primarily to the fact that constraints on the system are not reflected in wholesale market trading.

How have costs and volumes evolved in the last year?

The volume of actions taken in the BM was comparable to 2022, although the proportion of actions which are system-tagged increased to a share of 43%. This highlights the increased intervention by ESO in managing system constraints through the BM, notably ensuring sufficient volumes of stability and voltage services. For energy tagged actions, the volumes and costs for managing operating reserve and response reduced because of lower fuel prices and more volume procured through dynamic frequency response products.

What is driving the need for reform?

The total volume of energy instructed through the BM remains very high. While procuring in the BM can be efficient since the ESO has maximum visibility of system needs, it has significant disadvantages. For example, the BM does not provide a transparent signal for individual products and proximity to real-time can mean exposure to higher prices and greater system risk. We are therefore evaluating which services are currently being procured through the BM and to establish whether they are being accessed in the most transparent, practical, and cost-reflective way. Finally, the ESO's ambition is to promote competition everywhere and to ensure parties participate on a level playing field. Therefore, enabling new technologies to participate in the BM has been and will remain a key focus through trials and industry workgroups.

How are we implementing market reform?

We are actively establishing more explicit price signals for products currently procured through the BM which we believe are better suited to dedicated ancillary service markets. Balancing Reserve is set to deliver significant savings to the end consumer from 2024 onwards whilst a mid-term (Y-1) market is being established for stability. Complementing market reforms is the significant progress which has been made in technology transformation – spearheaded by the first release of the Open Balancing Platform (OBP) in December 2023. Initially, this will enable bulk dispatch for batteries and Small Balancing Mechanism Units (BMU's) which will allow control room operators to dispatch more units much faster.

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Balancing Mechanism - Market Insight: Volumes

Volumes & Providers

Total Bids & Offers | System and energy balancing volumes | Volumes by technology

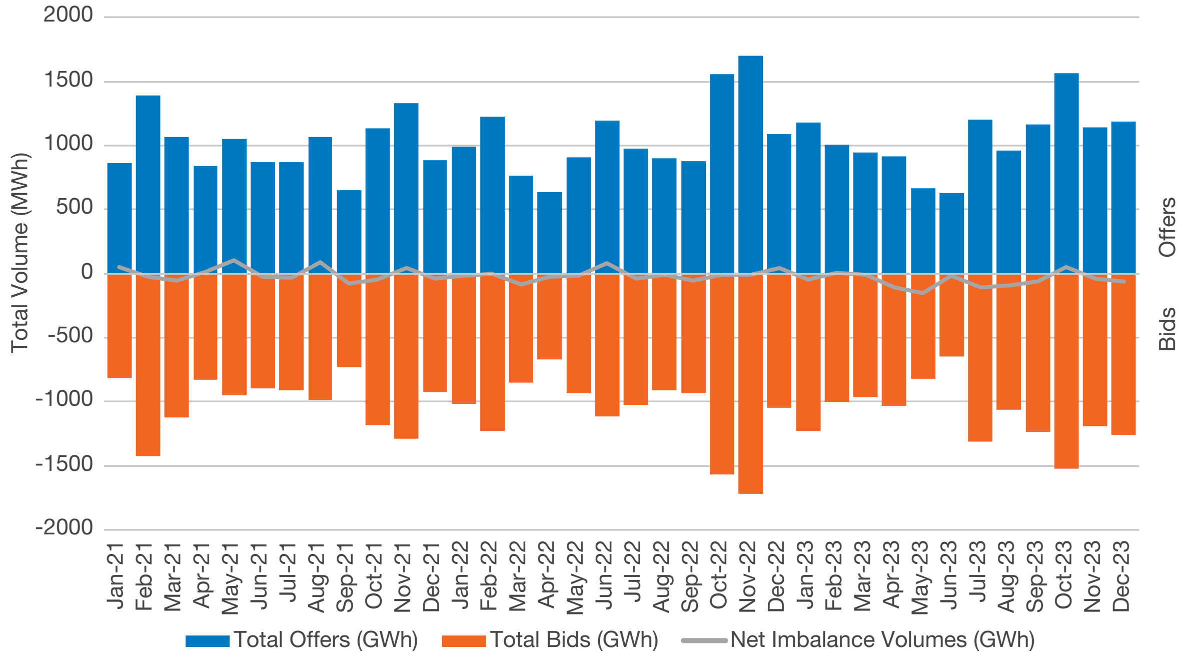
Total Bids & Offers

The ESO does not directly take actions to resolve energy market participant imbalance volumes but must continuously resolve the overall residual energy shortfall/surplus position after resolving any system requirements in order to regulate frequency while maintaining system security. The mismatch between supply and demand is driven by an extensive number of factors: forecasting errors; when generators, demand users and suppliers deviate from their contracted positions; and where rebalancing actions are required after ESO takes actions to resolve a constraint (e.g., wind curtailment to alleviate thermal constraints). The net of all these actions is termed Net Imbalance Volume (NIV) which indicates whether the system is long (oversupplied) or short (undersupplied).

As a general observation from BM Figure 1, the electricity system was often shorter in 2023, on average, versus the two previous years. Total NIV by month was negative in 11 out of 12 months in 2023, in comparison with 9 in 2022 and 7 in 2021. The average NIV by month was -50GWh in 2023 versus -8GWh and 5GWh in 2022 and 2021 respectively.

BM Figure 1 illustrates the total bid and offers volumes instructed through the BM between 2021 and 2023. Across 2023, the total volume of offers decreased by 2% whilst the total volume of bids increased by the same proportion. October was the month of highest total bid and offer volumes overall, corresponding with the month of highest wind output and therefore the period which requires highest intervention by ESO to manage constraints. Conversely, June represented the lowest total bid and offer volumes, which coincided with the month of lowest total wind output and least redispatch.

BM Figure 1: Total bids and offers instructed Jan 2021 - Dec 2023



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Balancing Mechanism - Market Insight: Cost

Costs

Total balancing costs

System actions are increasing

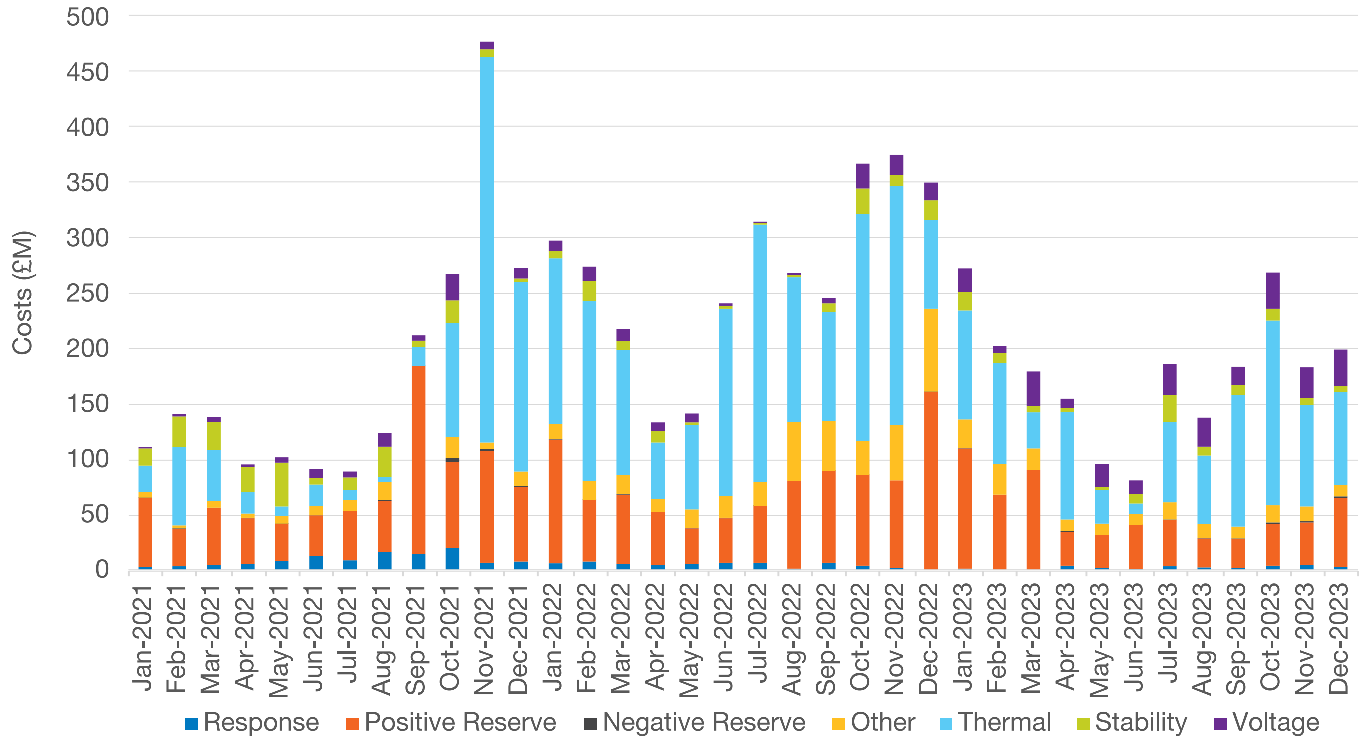
Monthly trends

Future costs

System actions are increasing

Despite the share of system tagged actions increasing, the absolute cost of system actions in the BM decreased overall. The biggest driver of this trend was the reduction in thermal constraint management costs via the Balancing Mechanism which reduced by ~40%. This coincides with a 25% reduction in the volumes of thermal constraints in 2023 compared with 2022, plus lower fuel costs for offers to instruct replacement energy when turn-up actions are required on the other side of a constraint. Costs for increasing system inertia increased by 5% despite a much greater increase in volumes (56%). Voltage constraint costs observed the sharpest increase in cost (~130%), and this too was a less proportional increase considering the volume of actions in 2023 increased by 180%.

BM Figure 4: System and Energy Balancing Costs Jan 2021 - Dec 2023



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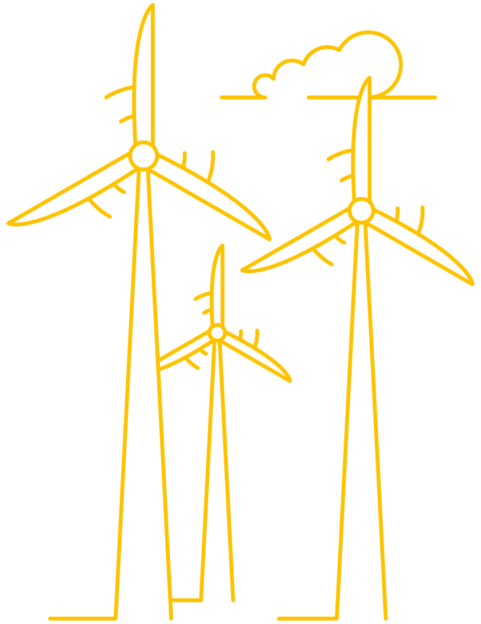
Balancing Mechanism - Drivers for Reforms

In LCP Delta's independent review of our markets, tied to our 2023 Markets Roadmap publication, several key drivers were identified as focus areas for ESO to ensure as effective a marketplace as possible within the current, more fundamental limitations of the BM.



Improve transparency

Improve short-run competition

Value for Money

Improve transparency

There is a high level of intervention required by ESO control room to manage energy imbalances and system constraints on a daily basis. It can sometimes be complicated to understand for what reason a specific action was taken and why the particular unit was selected over another. Part of this can be attributed to the tagging process and the fact that actions can be taken to satisfy multiple operability challenges simultaneously. Moreover, we are obliged through our licence conditions to take balancing actions in the BM on a total cost basis considering whole system issues; therefore, whilst we take actions in merit order, the BM is a continuous optimisation process. Hence, decisions taken earlier can impact actions later on.

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Balancing Mechanism - Market Reforms & System Improvements

In accordance with the drivers mentioned, significant work to reform the Balancing Mechanism, the corresponding ESO systems, and the codes which underpin it has continued in 2023. The launch of the Open Balancing Platform (OBP) in December 2023 represents a first major step in reforming ESO balancing systems and enhances our capability to optimise more bids/offers from batteries and small BMU's more quickly, and issue bulk instructions to hundreds of units simultaneously in real-time. Moreover, the ongoing REMA programme is considering much broader reforms to electricity markets, including different options for the BM. We are working closely with DESNZ to provide the system operator's perspective and to understand how widescale changes could affect residual balancing, ancillary services markets, and system operability more broadly.

Balancing Programme OBP Release 1

Power Responsive EV trial, launch of Battery Zone & GC0166 Storage modification

Code Modifications

Launch of new ancillary services to value services previously procured in the BM

Balancing Programme OBP Release 1

The launch of OBP Release 1 has enabled bulk dispatch for Electricity National Control Centre (ENCC) operators to send multiple instructions simultaneously for batteries and Small Balancing Mechanism Units. This major technological development has been in the ESO development pipeline for several years, much of which was co-created with industry through the Balancing Programme Strategic Capability Review and regular review through ongoing engagement events, and will address some of the feedback provided through Enhancing Storage workstream. Further reforms are also planned for 2024 and beyond; these will be articulated through the Balancing Transformation Roadmap which will enable the development of new ancillary services markets, namely new reserve products starting with Balancing Reserve.

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Within-Day Flexibility

What is within-day flexibility?

Within-day flexibility refers to the ability to adjust electricity generation or consumption to meet fluctuations in supply and demand over the course of a day. This dynamic responsiveness is crucial for balancing the grid in real-time and ensuring a stable and secure electricity supply, as outlined in our Operability Strategy Report.

Currently, dispatchable generation like gas-fired plants provide vast majority of within-day flexibility, which we access through the BM. However, as we decarbonise further, we need to find new ways to source within-day flexibility from zero carbon sources, such as demand.

Introducing the ESO's Flexibility Markets Strategy

ESO's markets have and will continue to play a key role in enabling flexibility in the immediate future. In order to grow flexibility in the mid-term from low carbon consumer and distributed resources, a Flexibility Markets Strategy is being co-created with our industry colleagues. This strategy clarifies the ESO's vision, desired 2035 strategic objective, along with targeted outcomes for 2028. It also sets out a roadmap of actions from now to 2028 to achieve these outcomes. The full strategy report is scheduled for publication in summer 2024. Please subscribe to our Flexibility Markets Strategy Newsletter for future updates and events information.

Within-day flexibility overview:

- Flexibility for delivery within-day, for a duration of 12 hours or fewer
- Purpose: primarily energy balancing, DNO flexibility services and constraint management
- Capability: mainly for time-duration limited assets, aggregated assets, consumer flexibility etc.

Current within-day flexibility activities:

Demand Flexibility Services (DFS)

DFS returned for the 2023/24 winter from 30th October 2023 to the 31st March 2024, with at least 6 one-hour 'test' events planned. This year more than 2.2 million households and businesses have signed up to DFS. This represents an increase of 40% compared to the previous winter. Volume has also grown over the winter, and we have achieved a consistent delivery of over 300 MW in various tests and live events including within day procurement. More information about the service and why the ESO National Grid has developed it can be found at DFS webpage.

Market-wide half hourly settlement (MHHS)

MHHS will require all energy suppliers to settle energy trades and payments on a half-hourly basis by late 2026. Following this change, we expect energy providers to introduce a range of new dynamic tariffs that expose consumers to varying prices throughout the day and present opportunities to alter their usage based on these variable prices. This will bring more consumer flexibility available to the ESO.

CrowdFlex

CrowdFlex is an innovation project, which aims to establish residential flexibility as a reliable energy and grid management resource, building on business-as-usual solutions such as network reinforcement or new thermal capacity. It also focuses on developing the statistical nature of flexibility into a reliable model to understand the impacts of consumer demand and domestic flexibility. More information about the project and why the ESO has developed it can be found here.

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Response

What is response?

Frequency response services react in real-time to automatically balance supply and demand and maintain frequency on the grid. Contracted assets achieve this through continuous measurement of system frequency. When frequency deviates away from 50Hz, units will change their generation or demand to counter this. Each of our response services is categorised either as a pre-fault service or a post-fault service and each of our Dynamic Services includes a high-frequency and low-frequency variant.

Link to frequency response webpages.

How our new Dynamic Services may be used alongside our future response and reserve products

How do we procure response services?

We procure the majority of our volumes at day-ahead through our pay-as-clear (PAC) markets for Dynamic Services and SFFR. Any within-day increase in the amount of response required has to be instructed using our MFR service in real-time by our control room.

For more information on our frequency response requirements, please read our Frequency Risk and Control Report.

RP Figure 1: How we procure

Service	Procurement timeframe	Contract length	Payment mechanism	Pre-fault/post-fault
Static FFR	Day ahead	4 hours	PAC	Post fault
Dynamic Containment	Day ahead	4 hours	PAC	Post fault
Dynamic Moderation	Day ahead	4 hours	PAC	Pre fault
Dynamic Regulation	Day ahead	4 hours	PAC	Pre fault
MFR	Real time	N/A	PAB	Post fault

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Response - Summary of the chapter

How is the landscape changing? As we continue our transition to net zero, we must move away from using fossil-fuel based sources of generation, which tend to provide inertia and dampen frequency changes, and rely more on non-synchronous energy sources such as wind and solar. This means the frequency of the system will become more unpredictable with faster and more significant movements.

How have costs and volumes evolved in the last year? Overall volumes procured dropped by 12% from 2022 levels. DFFR was retired this year and offset by the more efficient Dynamic Services which offer improved visibility and control, and faster response times for DM and DC. The increased performance of the Dynamic Services also helped reduce our MFR usage by 43%. Overall costs dropped by 36% partly driven by the decreased usage of FFR and MFR but also due to the drop in Dynamic Services costs. Dynamic Service costs dropped by nearly 50% compared to 2022 despite the increased volumes procured due to a dramatic drop in clearing prices from increased competition and our new EAC.

What is driving the need for reform? Increase renewable generation means more frequency volatility, which we manage in part using our response services. With the new Dynamic Services meeting our requirements for security of supply and increased flexible, low-carbon participation, our 2023 priority has been to reduce costs through increased competition and improved efficiency. Our MFR and SFFR services require review and reform as our derogation for MFR expires next year and SFFR is not currently co-optimised with other ancillary services. Additionally, whilst we aim to remain technology agnostic we must recognise that both services rely heavily on carbon intensive assets which we must facilitate a transition away from to achieve net zero.

How are we implementing market reform? In 2023 we transitioned our SFFR procurement from month-ahead to day-ahead, creating the option for co-optimisation with other day-ahead frequency services such as the Dynamic Services, if SFFR is migrated to the EAC platform. This Co-optimisation has the potential to bring similar cost savings as we have seen from co-optimisation of the Dynamic Services when they moved to the EAC in November 2023. In addition to SFFR reforms we are also considering a range of options to manage our within-day requirement including making MFR compliant and procuring Dynamic Services intraday.

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Response - Market Insight: Volumes

ESO Dynamic Services volumes

Participating technologies

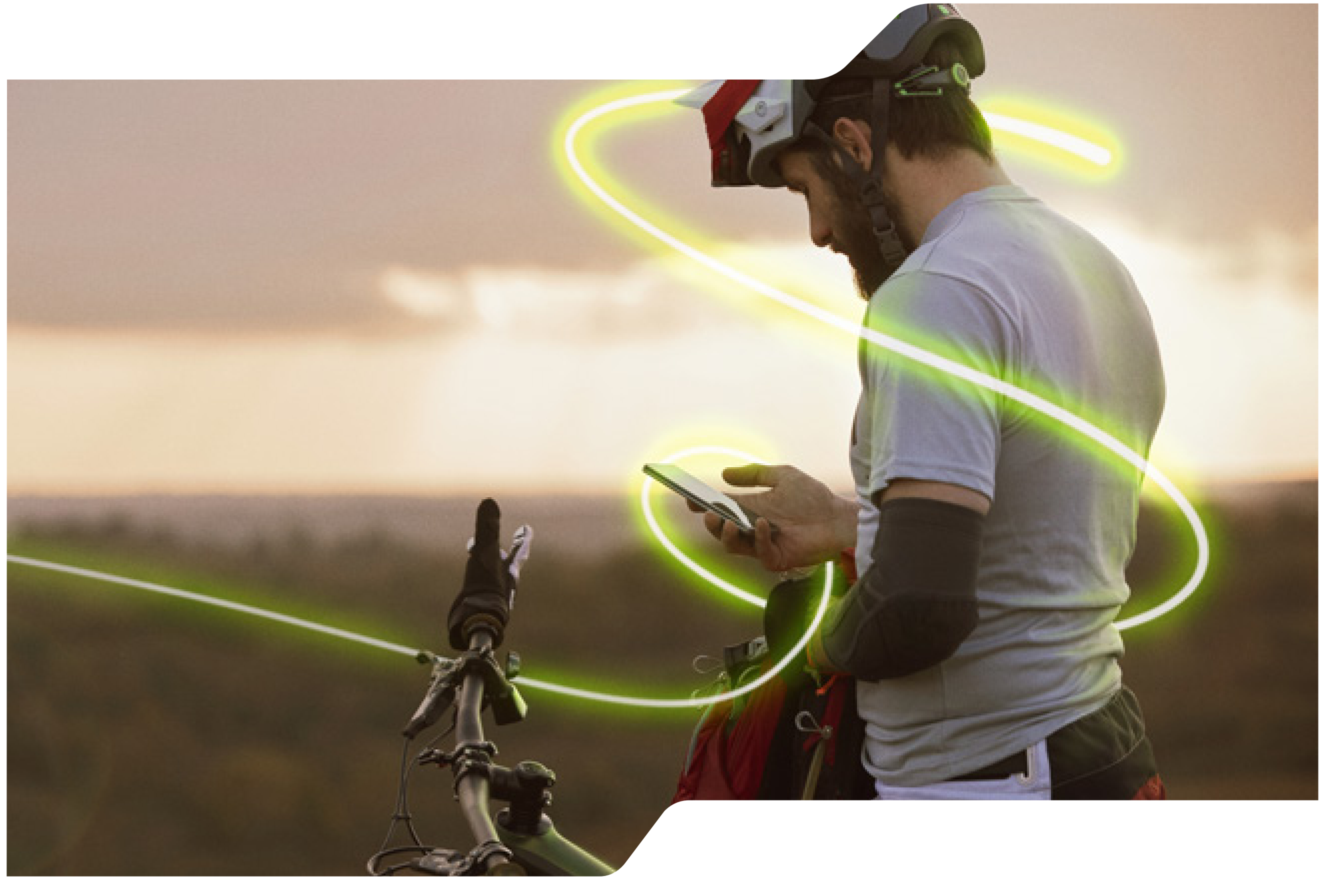
Static Firm Frequency Response

Mandatory Frequency Response

ESO Dynamic Services volumes

ESO Dynamic Services volumes saw an 89% increase across 2023. This includes a 57% increase in DC volumes from an average of 1781MW per EFA to 2798MW. Having only been launched in the second half of 2021, DC volumes were still being ramped up in 2022, with some precautionary limits applied. In 2023, DCH limit was further increased to better secure our largest loss risk. Procured volumes of DCL were also increased between 3 July and 14 Aug as part of an updated response policy to cover a largest loss risk associated with the sub-synchronous oscillations (SSOs) observed in Scotland.

These increased volumes of new Dynamic Services have replaced volumes from our older services in a more efficient and cost-effective way. In 2023 we used DR and DM to offset our entire 550MW requirement for DFFR and reduced our usage of MFR by 43%. This was enabled by the lifting of the 100MW volume caps in place for DM and DR in 2022 whilst we assessed the performance of the new services and increasing procurement throughout 2023 to the current levels of 330MW of DR and 150MW of DM.



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Response - Market Insight: Costs

Compared to 2022, costs for Dynamic Services in 2023 have reduced by nearly 50% from £136m to £71m. Given the increased volume requirements, this cost saving illustrates the liquidity of our Dynamic Services markets, where auction clearing prices have reduced by over 70%. With the launch of EAC bringing co-optimised procurement and negative clearing prices (please see the case study here) we have recently seen costs drop further however given its launch in November its impact on overall 2023 costs has been limited.

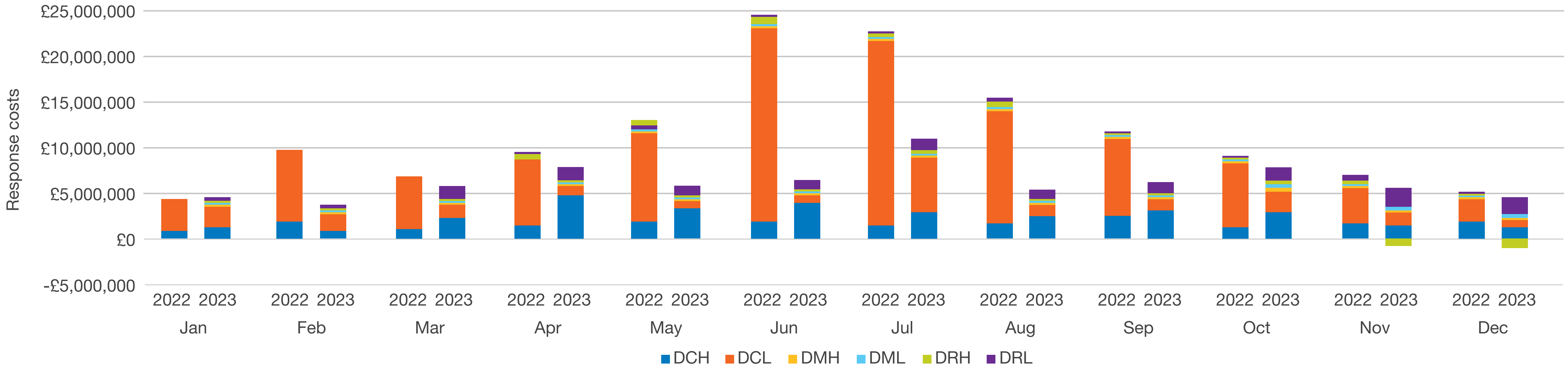
SFFR costs

Costs for SFFR averaged £177,000 per month ranging from a high of just over £220,000 in April to a low of £112,000 in June. Whilst SFFR costs remain a small portion of the overall response spend, regular peaks in the clearing price (over £10/MW/EFA) indicate a potential benefit from co-optimisation.

Mandatory Frequency Response costs

Costs for MFR dropped by 49% from £48m to £24m reflecting the reduced requirement due to the performance of the Dynamic Services and the reduced fuel costs from their peak in 2022.

RP Figure 5: Dynamic Services costs 2022 - 2023



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Response - Case Study: Enduring Auction Capability (EAC)

In November 2023 we launched the EAC, our new auction platform for response and reserve procurement. This new platform brings a lot of new functionality to help us improve our procurement efficiency and reduce balancing costs. It incorporates a new sell order design and clearing algorithm, which allows overholding as well as providing an overall improved user experience.

What impact has the EAC had?

The EAC has allowed us to introduce negative prices for Dynamic Services. This has been of keen interest to some service providers, as low frequency clearing prices were being distorted by linked high frequency offers at the previous floor price of £0/MW/h. Whilst eliminating this distortion has resulted in slightly higher DRL prices, negative pricing has reduced overall balancing costs.

The EAC also allows co-optimisation and splitting which allows the auctions to be cleared in the most effective way by more efficiently allocating units across all Dynamic Services, improving our auction liquidity and reducing the risk to providers of lost opportunity cost.

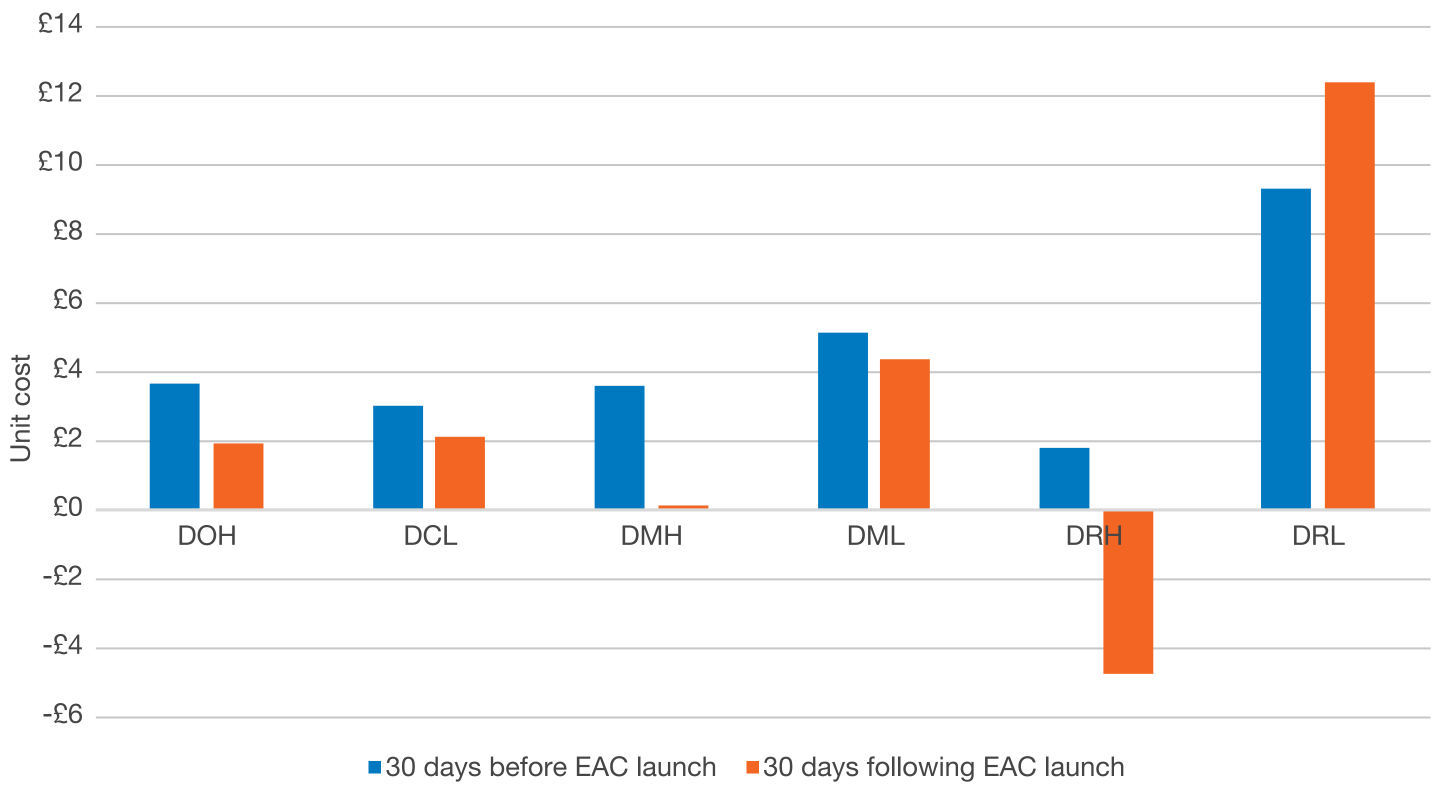
This additional functionality enabled by EAC has allowed the markets to clear at lower prices, reducing the total cost of Dynamic Services contracts by around 40% and saving £2.5m in its first month.

Feedback and next steps

The majority of the user feedback we have received has been very positive with a well-designed user experience which allows providers to access the results more easily without needing to use the data portal.

In the short term the launch of the new reserve services remains the priority for the EAC but we will also be considering the options for migrating existing ancillary services to EAC and launching other new services on the platform.

RP Figure 6: Average unit costs before and after EAC launch



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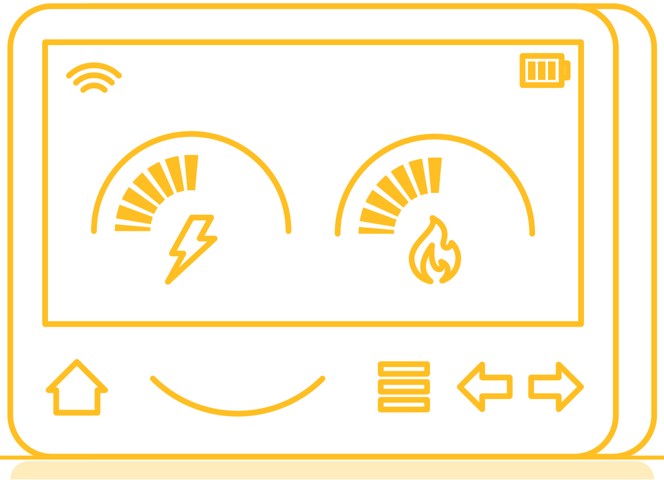
Response - Drivers for Reforms

To ensure that our response services remain effective and efficient at managing frequency on the increasingly volatile system, we continuously review all aspects of our markets and service design. The actions we are planning are detailed in the Market Reforms section that follows.



Keeping costs low for consumers

Costs remain a key driver for us and with significant savings achieved for our Dynamic Services through the increased market liquidity and the improved clearing efficiency enabled by the EAC, we must consider the options for reducing the costs of our other response services, SFFR and MFR.

Peak prices in the SFFR auction are typically caused by a need to accept high offers for the final 20-50MW of our 250MW requirement which drives up the overall clearing price. At the current prices, our static requirement might be covered as effectively by an increased procurement of DC. With a growing number of units available and competing for similar prices in the Dynamic Services, improving options for assets to participate in both markets could prevent these high peaks reducing SFFR prices and enable it to remain competitively priced.

With a continuing requirement for MFR we must consider how any reforms or replacement could bring cost savings as MFR remains a significant proportion of the overall response spend and this percentage may grow as increasing competition and efficiency bring down day-ahead costs further.

Supporting the transition to a decarbonised electricity system

MFR and SFFR both rely on significant volumes of fossil-fuel based assets and so will need to transition to more renewable sources for us to achieve net zero. Dynamic services are dominated by batteries, so we need to explore how to diversify the provider mix. MFR remains predominantly delivered by CCGT units with only a small proportion of low carbon assets used. Future reforms to the service could allow increased participation from low carbon assets supported by the overall transition towards decarbonised units in the Balancing Mechanism. Any further offset of our MFR requirement with Dynamic services would also represent a benefit to decarbonisation.

SFFR as a relatively simple service should represent an easy option for a broad range of asset types to participate in. However, its consistently low pricing and volumes offer limited value to many assets. With the drop in prices for Dynamic Services, battery assets may now have more interest in participating in SFFR which would help decarbonise the service. Due to the highly infrequent activation of SFFR its overall carbon impact is minimal.

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Response - Market Reforms

Looking forward, we will address the drivers mentioned on the previous page when reviewing and improving our suite of response products.

SFFR

High peak prices and reliance on fossil-fuel based assets demonstrate a need for reform of the service. In the short term we may see providers increasingly participating in the morning SFFR auction ahead of the Dynamic Services auction in the afternoon. To support this, we aim to continue publishing our SFFR results ahead of the cut-off for Dynamic Service auction submissions. Although the immediate priority for the EAC remains the launch of new reserve services, we could further improve the efficiency of the auctions by migrating SFFR to the platform to allow co-optimisation with other ancillary services.

MFR

MFR represents a priority for reform given its expiring derogation, high carbon intensity and high costs. A range of options are available to achieve this reform either through direct reforms to the MFR service or offsetting some, or all, of the requirement for the service. Reforms could include changes to make the procurement of the service compliant, removing the need for a derogation. Broader changes to the service requirements could improve low carbon participation and reduce costs. Additionally, as demonstrated by the 2023 results our MFR requirement can be significantly reduced with procurement of the Dynamic Services. Forecasts at day-ahead are not accurate enough to remove all requirements for within day adjustments using MFR but intra-day procurement options for Dynamic Services could all but eliminate this requirement.

Dynamic Services

With good liquidity, low pricing and no participation from carbon intensive generation, the reforms over the past couple of years to launch the Dynamic Services have delivered a lot of value. However, as a core part of our long-term response plans, we must continue to improve the Dynamic Services in addition to the intra-day option we may consider to reduce our MFR requirement. In the short term we are reviewing potential barriers to entry such as the single unit cap and ramp rate control as well as seeking to improve our ability to monitor assets and their performance. In the longer term we are considering options to improve our integration and coordination between our ancillary services and more locational factors such as constraints and DSO requirements. These reforms should allow our services to remain efficient, supporting market competition and cost effective.

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Reserve

What is Reserve?

Reserve is the capability to deliver upward or downward energy to manage pre-fault imbalances and post-fault losses of generation or demand. Where response services automatically activate in sub-second timescales, reserve services are manually dispatched with a ramp-time to full delivery time within a minute or more. Reserve delivery can typically be sustained over longer timescales than assets delivering response.

Reserve services provide a vital role in maintaining frequency on the system, helping us to manage energy imbalances and securing losses on the network. With increasing volatility on the system, from both supply and demand, it is increasingly important for us to have access to effective options to balance these energy requirements. To do this, we have a suite of products to help us manage frequency.

Link to frequency reserve webpages

Link to Frequency Risk and Control Report

Operating Reserve (BM bids and offers)

Short Term Operating Reserve (STOR)

Optional Fast Reserve

Legacy/Bespoke arrangements

Operating Reserve (BM bids and offers)

Operating Reserve is procured in operational timescales (between real time and about 4 hours ahead) to manage pre-fault and post-fault imbalances. Procurement is primarily through the acceptance of offers and bids to reposition Balancing Mechanism Units (BMUs) but also includes some trades. The availability of these bids and offers is not secured ahead of real-time so no availability payments are made. The high frequency, downward variant of Operating Reserve is referred to as Negative Operating Reserve.

Note: Price determination procured volume (availability) vs dispatched volume (utilised)

For each of our services we pay a utilisation cost based on the volume of energy delivered following instruction, this rate is given in pounds per megawatt hour (£/MWh). For STOR we also pay an availability fee this is to secure access to volumes at day ahead and for Optional Fast Reserve we pay an arming fee to place assets into rapid delivery mode. Both of these costs are based on pounds per megawatt per hour (£/MW/h).

Reserve - Summary of the chapter

How is the landscape changing?
Volatility on the system is expected to continue to rise as non-synchronous, renewable generation increases. This change in generation profile will also be reflected in the range of assets available to deliver reserve services, as traditional high-carbon assets are replaced with more renewable generation sources. Alongside this increase in uncertainty and volatility we are expecting an increase in the size of the largest loss that we must secure with our frequency services.

How have costs and volumes evolved in the last year?
Overall reserve costs fell in 2023 from £870m to £589m, primarily attributable to a £200m reduction in Operating Reserve costs due to reduced fuel prices and utilised volumes. Utilised reserve volumes were lower across all services apart from Negative Operating Reserve, which showed a significant increase. STOR costs and utilised volumes dropped by 52% and 66% respectively, whilst Fast Reserve costs dropped around 12% despite having similar volumes utilised.

What is driving the need for reform?
We have a need for increased participation in our reserve services from low carbon alternatives to support net zero. We also require faster and more efficient services designed to manage more volatility on the system, which will further reduce balancing costs. With the current procurement within operational timescales for BR and FR we are not able to send the appropriate market signals for our requirements and secure access to the most cost-effective units.

How are we implementing market reform?
In response to rising balancing costs, we have developed a new firm operating reserve product (BR) to procure capacity at day-ahead, while continuing to reform our suite of pre- and post-fault reserve services. Quick Reserve is designed to replace our Fast Reserve (FR) service reacting to pre-fault disturbances to restore the energy imbalance quickly. Slow Reserve will replace STOR and provide more sustained delivery in a post fault event following our Dynamic Containment response service to recover the frequency back to 50Hz. The new services should be more efficient and effective, and allow us to signal and secure our more of our requirement at day-ahead.

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Reserve - Market Insight: Volumes

Overall reserve utilisation volumes have dropped 8% from 11.4TWh to 10.5TWh.

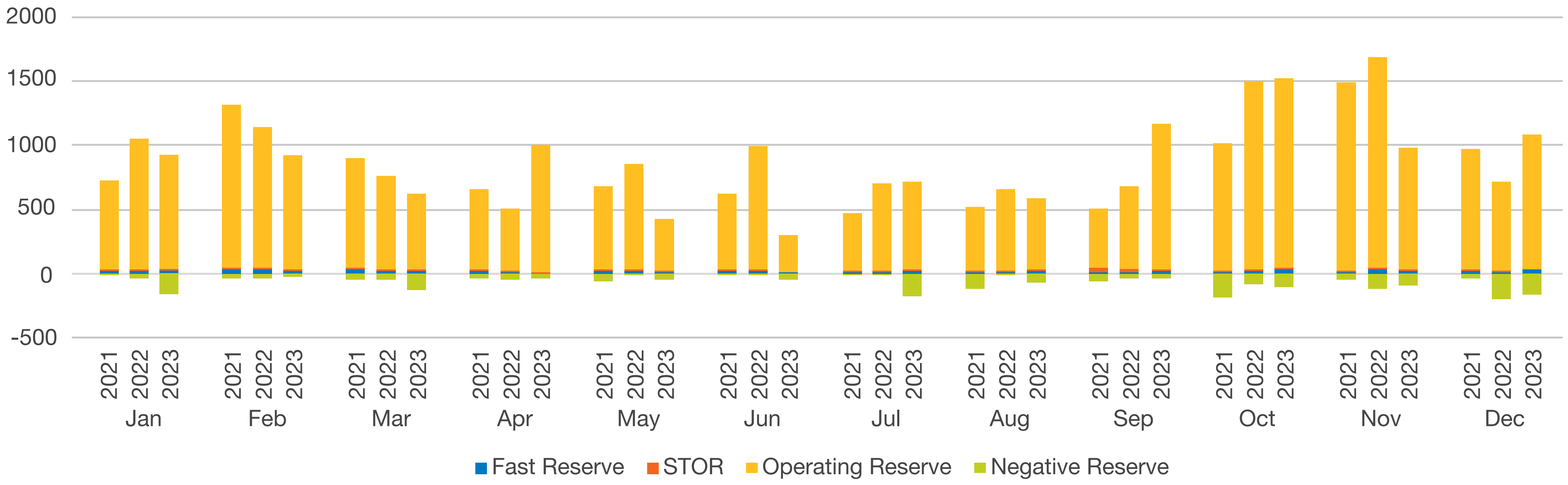
The most significant contribution to this decrease was from Operating Reserve with a reduction of 0.9TWh compared to 2022 due to a reduction in the constraint sterilised headroom component reflecting improvements made to managing constraints. The other components of Operating Reserve saw a slight increase reflecting the increased volatility on the system and volumes remained high.

STOR utilisation volumes have continued to significantly decrease over 2023 with just 21GWh dispatched representing a 66% drop from 2022 levels. This has been partly due to fewer system trips, combined with better performance from our new dynamic response services and also a revised and lowered procurement requirement (introduced due to increased delivery performance from our STOR assets).

Negative Operating Reserve utilisation volumes have significantly increased from -288GWh to -408GWh (~42%) reflecting the overall trend in increased system volatility and the need to secure varying supply and demand during high-frequency events.

Fast Reserve utilisation volumes have remained stable with a 3% drop from 204GWh of bids and offers in 2022 to 198GWh in 2023.

RV Figure 1: Reserve volumes 2021-2023



Reserve volumes 2021-23

Fast Reserve 2021-23

STOR 2021-23

Operating Reserve 2021-23

Negative Operating Reserve 2021-23

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Reserve - Market Insight: Costs

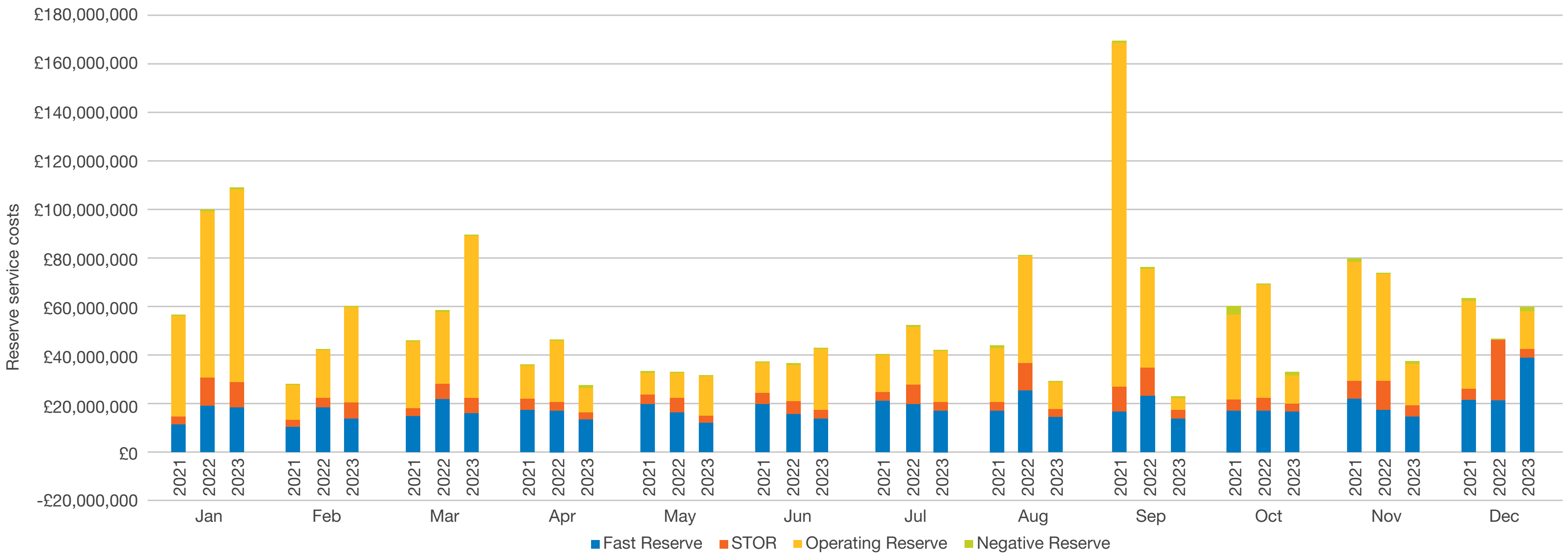
Overall reserve costs have dropped around 30% from £870m to £589m, much of this being by a reduction in Operating Reserve costs of £200m. Reduced volumes dispatched and lower fuel prices are the primary drivers for this saving, helping to reduce our Operating Reserve utilisation costs by around 35%.

Fast Reserve utilisation prices have dropped significantly by around 35%, again due to lower fuel prices whilst the arming payments have only dropped in line with slightly reduced volumes.

STOR availability and utilisation costs have both dropped massively reflecting the decreased volumes procured and dispatched. STOR utilisation costs in particular have dropped by 82% as a result of increased use of our more efficient dynamic response products as well as the decrease in the price of gas from the peaks of 2022.

Negative Operating Reserve costs have increased significantly reflecting the increase in volumes procured but remaining below the high levels seen in 2021.

RV Figure 6: Reserve costs 2021-2023



Reserve costs 2021-2023
Fast Reserve 2021-23
STOR 2021-23
Operating Reserve 2021-23
Negative Operating Reserve 2021-23

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Reserve - Drivers for Reforms

Costs and system security

Market signals

Coherence

Competition

Costs and system security

With volatility on the system increasing, it is important that we ensure that our services remain efficient and cost effective. Failure to do so will result in escalating costs and compromise system security. To prevent this, we have designed a new suite of services (BR, QR and SR) which will enable us to more effectively manage the system, improving system security and reducing balancing costs.

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Reserve - Market Reforms

With the development of new reserve services significantly progressed since 2022, we are focused on prioritising the delivery of these and making sure that they address the drivers for improvement outlined on the previous page.

Balancing Reserve

Balancing Reserve is expected to deliver a net benefit to consumers of £639m between 2024 and 2027. Given this significant consumer saving, we are prioritising the design and delivery of this service, which will also create an explicit value and price signal for reserve outside of the BM. This will help to inform market participants' decision making and ensure providers are rewarded for the value they provide.

We are aiming to launch the service in spring 2024 so we can begin to realise the benefits the service will bring, securing volumes at day-ahead and reducing our Operating Reserve requirements and costs.

Quick and Slow Reserve

In addition to BR, we are planning to launch our QR and SR services.

The introduction of QR will help us make our procurement more efficient as well as creating a separate day-ahead revenue stream. This will enable providers to take advantage of revenue stacking opportunities.

We have listened to industry so that changes to QR recovery periods have been made based on industry feedback to better balance a unit's ability to deliver against system needs. Phase 1 of QR will be dispatched via Bids and Offers in the Balancing Mechanism and is planned to be launched in the summer of 2024. Additional development of OBP is planned for summer 2025 to enable QR dispatch instructions to be sent outside of the Balancing Mechanism.

We are proposing to deliver SR alongside QR phase 2 in 2025, providing us with a more efficient service to replace STOR in providing our post-fault requirement. These new services should collectively help reduce barriers to entry and create fair and competitive markets, ultimately reducing balancing costs and improving consumer value.

Design Element	Balancing Reserve service design
Direction	Positive and Negative
Minimum Contract Size	1MW
Providers	BM Units with back up means of dispatch (control or system telephony) during contracted windows
Time to full delivery	10 minutes
Notice to start ramping	As per Grid Code – 2 minutes
Service window	30 minute block
Auction platform and timing	Daily procurement on Enduring Auction Capability (EAC), Gate Closure at 08:15
Payment structure and mechanism	Pay-as-clear availability + pay through BM utilisation
Cap on reimbursement	Max (BM Accepted Offer/Bid Price for Energy or ESO Trade for Energy) per MW per SP. Applicable to each Contracted and Undelivered MW.

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Securing the System

Stability

What is stability?

Stability is the inherent ability of the system to quickly return to acceptable operation following a disturbance. The term is used to describe a broad range of topics, including inertia, short circuit level (SCL) and dynamic voltage support. If the system becomes unstable it could lead to a partial or total system shut down leading to the disconnection of consumers. To maintain power system stability, we need to maintain sufficient amounts of inertia, SCL and dynamic voltage support. We are obliged to maintain a minimum amount of inertia on the network, which along with frequency response services, maintains system frequency. From a more locational perspective, we are also required to ensure the system remains strong and resilient to disturbances by maintaining fault levels.

Stability services have traditionally been provided by synchronous generation, which can contribute inertia and Short Circuit Level (SCL) when supplying the grid with electricity, as well as by dedicated network assets. Some forms of low-carbon generation do not automatically provide the same level of stability needed by the network as they are non-synchronous. Therefore, we need to procure additional stability services to ensure the system can be operated securely and cost-effectively in a low-carbon world. We have procured a series of stability pathfinders, some of which are now live and contributing vital stability to the grid, with more units to come online this year. Yet, our stability needs continue to evolve, with our future requirements outlined in the Operability Strategy Report.

Link to stability webpages

How do we procure stability services?

Stability Pathfinders

Balancing Mechanism

Trading

Stability Markets

Stability Pathfinders

Through our Stability Pathfinder initiatives, we have procured a total of 36 GVA.s of inertia and sufficient SCL to resolve local system strength issues across the GB transmission network. We have completed three long-term pathfinder tenders for stability services which have all concluded and now will be replaced by the Long-term (Y-4) Stability Market.

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Stability - Summary of the chapter

How is the landscape changing? As more non-synchronous generation connects to the network and displaces synchronous generation, we recognise the need for additional stability throughout this decade. Our inertia requirements are becoming more dynamic as they fluctuate according to weather-driven generation and demand. In the near term, we are seeking to reduce our minimum inertia operating threshold below 140GVA.s which should reduce the volume of actions required to manage system stability. We are also maintaining a view of locational stability such as short circuit levels and dynamic voltage which are impacted by increased penetration of non-synchronous generation.

How have costs and volumes evolved in the last year? The volume of actions issued to increase system inertia has increased significantly for the second successive year in 2023 in comparison with 2022. This corresponded with slightly higher costs overall however, costs did not increase proportionately to the increase in volumes because of lower energy prices linked to lower gas costs. No additional long-term procurement was conducted in 2023 as stability pathfinders are being replaced by three enduring stability markets. However, all units from Stability Pathfinder Phase 1 are now operational and assets contracted under phases 2 and 3 will come online from 2024. Volumes and costs of actions taken to reduce the largest loss via the Balancing Mechanism and trades remain very low.

What is driving the need for reform? Our desire to procure inertia more economically remains a core driver for reforming the way we procure stability services. Inertia is a fairly new phenomenon for ESO to manage and we must ensure that sufficient capability is accessible to provide these services on a high-availability basis. New technologies (e.g., grid-forming technology) and modifications to synchronous plant to be able to operate at 0MW export present a significant opportunity to diversify our technology mix and meet our stability requirements more dynamically.

How are we implementing market reform? We are actively implementing three enduring stability markets to meet our stability needs more effectively. As recommended by the Stability Market Design Network Innovation Allowance project which concluded in 2023, we are implementing new Long-term (Y-4), Mid-term (Y-1) and Short-term (D-1) stability markets. These will allow us to signal new investment when and where we need it, and more immediately provide a route to market for assets capable of delivering stability services in the present, and those which could do so in the future with additional investment. The first tender round under the mid-term (Y-1) stability market was launched in 2023 procuring stability services for delivery from 1st October 2025 until 30th September 2026.

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Stability - Market Insight: Volumes

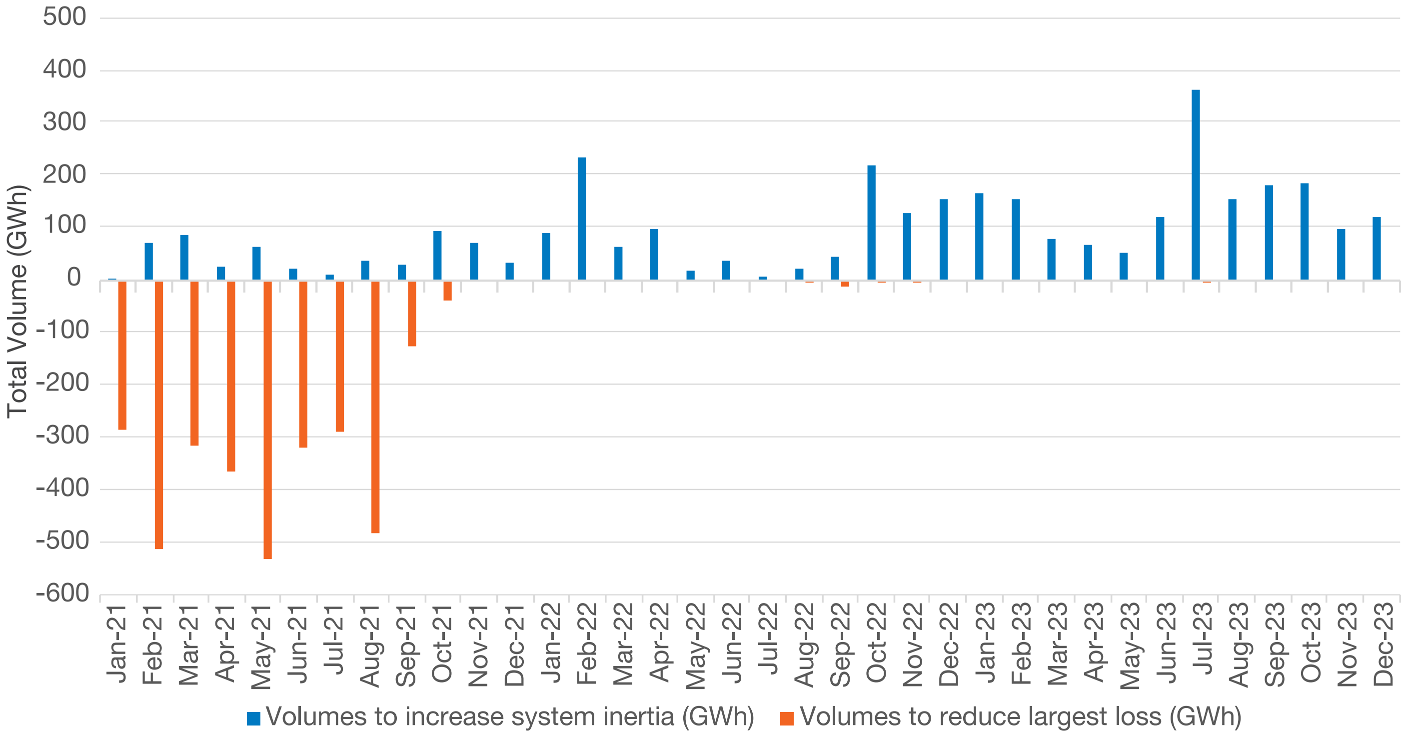
Balancing Mechanism and Trades

In the last 12 months, the volume of actions taken to increase system inertia (1,750GWh) has increased by 56% in comparison with 2022 (1,122GWh). This figure does not include the contributions of stability pathfinder units which have been commissioned. July 2023 was the month of highest intervention (365GWh) with May out turning the lowest (51GWh). As in 2022, there is a correlation between the highest months of ESO intervention in managing system inertia and GB metered wind output. This supports the trends projected in the Operability Strategy Report which suggest that system stability will become more challenging in an increasingly inverter dominated power system.

Nevertheless, July 2023 is an anomalous data point with almost double the volume of actions to increase system inertia observed than in any other month. This is due to defensive measures taken in response to Sub-Synchronous Oscillations (SSO) observed in Scotland during this period. ESO frequently dispatched units in this region throughout July to increase local system strength and total inertia as a precautionary measure. Through analysis post-event, it was concluded that system inertia or locational system stability issues were not drivers of the SSO originally, so these defensive measures were stood down. More detail on these observations can be found here.

It is worth noting that we expect these volumes to reduce in the near future as the minimum operating inertia threshold reduces, as signposted in FRCR.

ST Figure 1: Stability management volumes Jan 2021 - Dec 2023 (GWh)



Balancing Mechanism and Trades

Stability pathfinders

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Stability - Market Insight: Costs

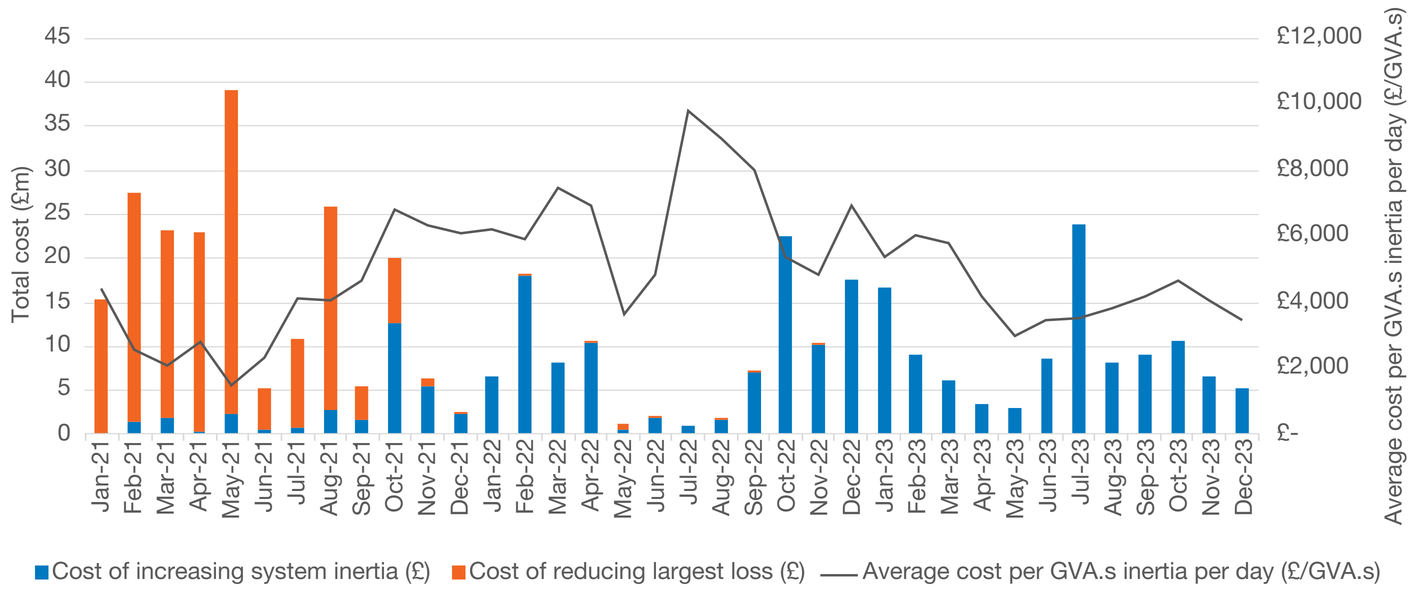
Balancing Mechanism and trades

As the volume of actions tagged as 'increasing system inertia' increased in 2023, so too did the associated cost of these actions. The sum of costs for 2023 (£109m) increased by 5% in comparison with 2022 (£104m), therefore not as sharply as the volume of actions. This is likely due to lower short-run marginal costs for thermal synchronous generators that were often instructed to increase system inertia, especially in the latter half of 2023. This statement is supported by the dataset summarising average total cost per GVA.s inertia per day plotted on the chart; this shows an average of £4,926/GVA.s in 2023 versus £6,575/GVA.s in 2022.

Furthermore, July is once more a standout data point as the most expensive month in 2023 with costs totalling ~£24m. As described in the previous section, this is again a result of the defensive measures put in place following SSO events. May (£2.6m) was again the least expensive month with the fewest MWh instructed.

All three of the highest cost days in 2023 occurred during the period where SSO had been observed on the network and extra defensive measures were put in place as a precaution (25th June, 2nd July, 23rd July).

ST Figure 3: Inertia management costs Jan 2021 - Dec 2023



Stability - Drivers for Reforms

The drivers for reforming the way we procure stability services remain largely consistent with those reported previously. The LCP Delta assessment of our markets last year highlighted that more competition and transparency in how we procure for stability would be beneficial. We recognise the importance of clear, transparent price signals to facilitate competition to build the cheapest solutions, whilst also improving our tools and market mechanisms to enable efficient dispatch in real-time.

Increasing value for money to deliver benefits for consumers

The volume and cost of actions required by ESO to manage system stability are both on an upward trajectory. This means significant amounts of redispatch within-day, often unwinding nominated positions on non-synchronous units to instruct additional synchronous machines to provide inertia and/or SCL. ESO typically take these actions in the Balancing Mechanism - a pay-as-bid, within-day marketplace where market participants are rewarded for utilisation in real-time. Given its design as a residual balancing market and the timescales for issuing instructions, actions have limited certainty for ESO and prospective bidders have little foresight as to whether their unit will be instructed on the day, often leading to significant costs. During low inertia periods where lots of intervention is required, these can be high-cost days. We have identified better ways of replicating these actions outside of the BM, providing an opportunity to procure these services more cost effectively and more transparently, whilst offering more certainty to investors and more appropriately rewarding assets for their availability to deliver a service.

Drive efficient investment

Explicit management of system stability on a large scale is a fairly new phenomenon, driven principally by the increase in non-synchronous generation and a lesser proportion of the energy stack being made up of synchronous generation. Instead of implicitly co-optimising these actions in the Balancing Mechanism by issuing Bid Offer Acceptances, we know we need to be more explicit in how we value stability services and ensure maximum transparency in our market mechanisms. We want to establish more competition across more technology types and send long-run investment signals for providers seeking to deliver these services in the future. Better long-term forecasting of requirements is being developed through the Centralised Strategic Network Plan (CSNP) and it is important that routes to market are developed in parallel.

Ensuring efficient dispatch in the short run

LCP Delta's independent assessment of stability procurement identified that a limited range of technologies have come through pathfinders. However, through the continuing development of grid-forming technology and more flexible assets, the volume of stability-capable providers is growing. We recognise the different operating models across different technologies; some requiring longer-term certainty through guaranteed availability payments, others preferring much closer to real-time optionality to allow revenue stacking between different markets. In response to this, ESO recognises the need to promote investor confidence in the long run; however, we must also retain the ability to instruct the cheapest units on the day to deliver the required service over the required time periods.

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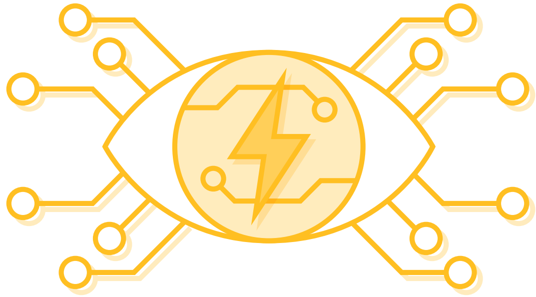
Stability - Market Reforms

Stability Market Design

In our 2023 Markets Roadmap, we set out the outline of our enduring stability markets, as recommended through Stability Market Design Network Innovation Allowance innovation project. We highlighted the benefits of procuring stability via a blend of long and short-term procurement and the rationale for designing three discrete stability markets. A long-term (Y-4) market provides regular opportunities to signal new investment where required and contract services on 10+ year contracts, providing certainty to both ESO and market providers seeking significant funding. A mid-term (Y-1) market allows us to access stability services on a high availability basis from existing and incremental capability for 1-year duration contracts. Finally, a short-term (D-1) market will help us to meet our inertia needs more dynamically and provide flexibility for non-dedicated stability providers who are able to provide multiple ancillary services or energy products, depending on market conditions closer to real-time.



Mid-term (Y-1) Stability Market

Interim Short-term (D-1) Stability Market

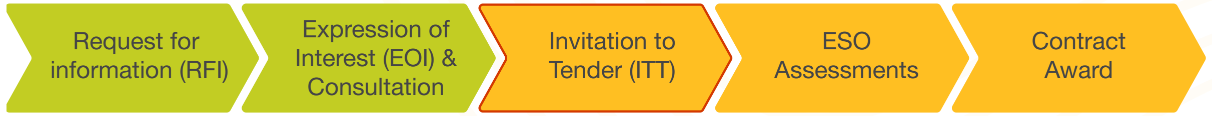
Long-term (Y-4) Stability Market

Mid-term (Y-1) Stability Market:

As articulated in last year's Roadmap, we successfully launched the mid-term (Y-1) stability market in 2023 for the first delivery year commencing 1st October 2025. The first step in initiating this market was to run a Request for Information (RFI) to gather information from prospective participants on our high-level design of the mid-term (Y-1) market and to seek insight into the indicative volumes which may be available from the market.

Next, an Expression of Interest (EOI) process was launched in October 2023 to formally request intentions from market participants that they would like to be invited to tender for the first delivery year (DY 25/26) of the mid-term (Y-1) stability market. Another opportunity for consultation with industry was combined with the EOI which has allowed us to refine service design, contract & technical specifications, and tender rules.

In December 2023, we formally launched the Invitation to Tender (ITT) for DY 25/26 and at the time of writing, will soon be evaluating these submissions based on the technical and economic criteria set out in the tender documents. Contracts will be awarded and tender results published by October 2024.



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Thermal

What is a thermal constraint?

Thermal constraints refer to an area of the network where the physical infrastructure is overheating due to too much electricity overloading the network. At times, to ensure system security, the ESO must reduce generation/increase demand behind a constraint and increase generation/decrease demand in front of the constraint to ensure generation and demand remain in balance.

Thermal constraint volumes and costs are on an upwards trend due to renewable investment in Scotland outpacing the investment in the network needed to transport the electricity to centres of demand. A holistic approach to addressing thermal constraints is needed, which balances new network, network optimisation and commercial solutions. The Centralised Strategic Network Plan will look at the infrastructure challenge and wholesale market reform will help provide the right investment and dispatch signals in the long term.

Network Build:

Network optimisation:

Constraint Management Intertrip Services (CMIS):

Balancing Mechanism (BM):

Trades:

Local Constraint Markets (LCM):

MW Dispatch Service:

- Post fault intertrip
- Yearly contracts
- Arming fee (£/Settlement period or £/MWh) and tripping fee (£/trip)

The CMIS secures a pre-determined volume of generation capacity which can be reduced to 0MWs almost instantaneously in the event of a fault. Our control room, knowing that there is a pre-defined volume of generation that can be instantaneously removed from the system post-fault, can transfer greater volumes of generation across the network boundary pre-fault. The CMIS is currently operational at the B6 (Anglo-Scottish) boundary, and we are due to launch a tender in the coming months for a service on the EC5 (East Anglia) boundary.

This page is interactive. Click ⊕ for more information.

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Thermal - Summary of the chapter

How is the landscape changing? Our 2023 Future Energy Scenarios show just over 50GW offshore wind on our networks by 2030. The impact of this is outlined in our Electricity Ten Year Statement, which looks at the potential for constraints across the GB network and shows growing congestion in the next decade. In 2023, the UK government's Review of Electricity Markets Arrangements (REMA) was initiated, which includes looking for ways to manage constraints more efficiently. The new Strategic Spatial Energy Plan and Centralised Strategic Network Plan will also both look at the issue holistically, identifying network and non-network solutions for developing the GB electricity system.

How have costs and volumes evolved over the last year? Thermal constraint management costs amounted to £985m in 2023,[1] which represents a reduction of over 40% on last year's costs. The cost reduction reflects the fact that wholesale gas prices are lower after spiking in the wake of the Ukraine invasion. Volumes have also decreased, to 6.1 TWh from 8.2TWh. This reduction has been possible because of the initiatives that have been implemented by the ESO that are outlined in our balancing costs portfolio. Examples include the B6 and EC5 CMIS contracts that went live in 2023, greater dispatching and utilisation of flexible storage assets in the BM and improvements to our operational tools in trading and outage optimisation.

What is driving the need for reform? As well as needing significantly more network, we need to find ways in the interim to use the existing network more efficiently by developing market solutions, which can send locational and temporal signals, which will help us more cost effectively manage constraints.

How are we implementing market reform? In addition to the continued build out and reinforcement of the transmission system, our Constraint Management Intertrip Service (CMIS) is now successfully operating at the B6 boundary. Our Regional Development Programme has delivered MW Dispatch for NGED and UKPN regions, with a view to rolling out to other distribution areas where possible. Additionally, we are continually looking for ways to maximise the use of our network through technical and market solutions, such as our Local Constraints Market. We initiated in January 2024 a co-creation project with industry, which will allow us to work with industry to develop and test new, market-based solutions to help reduce the impact of thermal constraints in the short term. We are also working closely with DESNZ and Ofgem on wholesale market reform, including specially constraint management options, both intended to reduce the cost and volume of constraints.

1 This figure represents the costs of addressing thermal constraints only, and does not include the reducing of largest loss cost, inertia costs and voltage constraint costs.

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Thermal - Market Insight: Volumes

Overall constraint volumes were down in 2023 in comparison to 2022, however it must be noted that 2022 was the highest year to date for overall balancing costs and thermal constraints specifically. ETYS shows the continued rise in thermal constraints volumes (and associated costs over the coming years, before significant levels of new network are available in the early 2030s.

Export Constraints

The volume of export constraints reached 5.6GWh in 2023, a decrease of 13% vs 2022 (TH Figure 1). Export constraints represent the constraints on the network between Scotland and England, which are caused by high levels of wind generation being located in Scotland and most demand being in England.

In June 2023 constraints were particularly low. Wind output in that month, particularly in Scotland, was at a five year low. The volume of actions decreased due to less wind causing fewer actions to be taken and because there were fewer outages in June 23 in comparison to June 22.

Over September and October, volumes increased again as winds picked up. September 2023, compared to August 2023, saw an increase in 325GWh of wind generation; October again increased wind generation by another 300GWh. Combined with outages over this period, the volumes of export constraints were higher than the rest of the year.

Breaking down export constraint volumes by technology (TH Figure 2) we see that wind and gas units continue to dominate, as both are turned down behind constraints while and gas units are typically turned up in front of constraints to ensure sufficient margin. Gas actions decreased by over 50% in 2023, compared to 2022, which can be attributed to more wind in England and Wales, fewer outages and less requirement for sterilised headroom and replacement energy.

Import Constraints

The volume of import constraints (TH Figure 3), typically linked to interconnectors supplies into the South East of England, dropped in 2023 to ~570GWh, almost 70% lower than 2022.

Over 2023, there were more interconnector supplies into GB due to more favourable conditions on the continent (French nuclear at fuller capacity and more availability from hydro in Norway). However, as there were no particular periods of high demand in urban areas caused by hot summer or a cold snap as in 2022, there were fewer import constraints.

Constraint Management Intertrip Scheme

The ESO has awarded CMIS contracts through two tenders to help manage the B6 (SCOTEX) constraints boundary, In the first round we procured 1,700MW of intertrip capacity in for use between October 23 and September 24 and 1,600MW contracted for use between October 2024 and September 2025. Over the course of 2023, these two schemes helped us to avoid 86GWh of curtailment by enabling more power to travel across the constraint boundary.

TH Figure 1: Constraint Volumes
TH Figure 2: Export Constraints
TH Figure 3: Import Constraints

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Thermal - Market Insight: Costs

Constraint costs continue to make up the most significant portion of balancing cost actions in 2023. We recognise this trend is likely to continue until the end of the decade until new, much-needed, transmission build is able catch up with the high increase in renewable generation that has recently connected to the transmission network.

The ESO's balancing costs strategy outlines a wide range of activities to ensure we are minimising balancing costs by leveraging initiatives in:

1. Network planning and optimisation

2. Commercial mechanisms

3. Research, innovation, and engagement

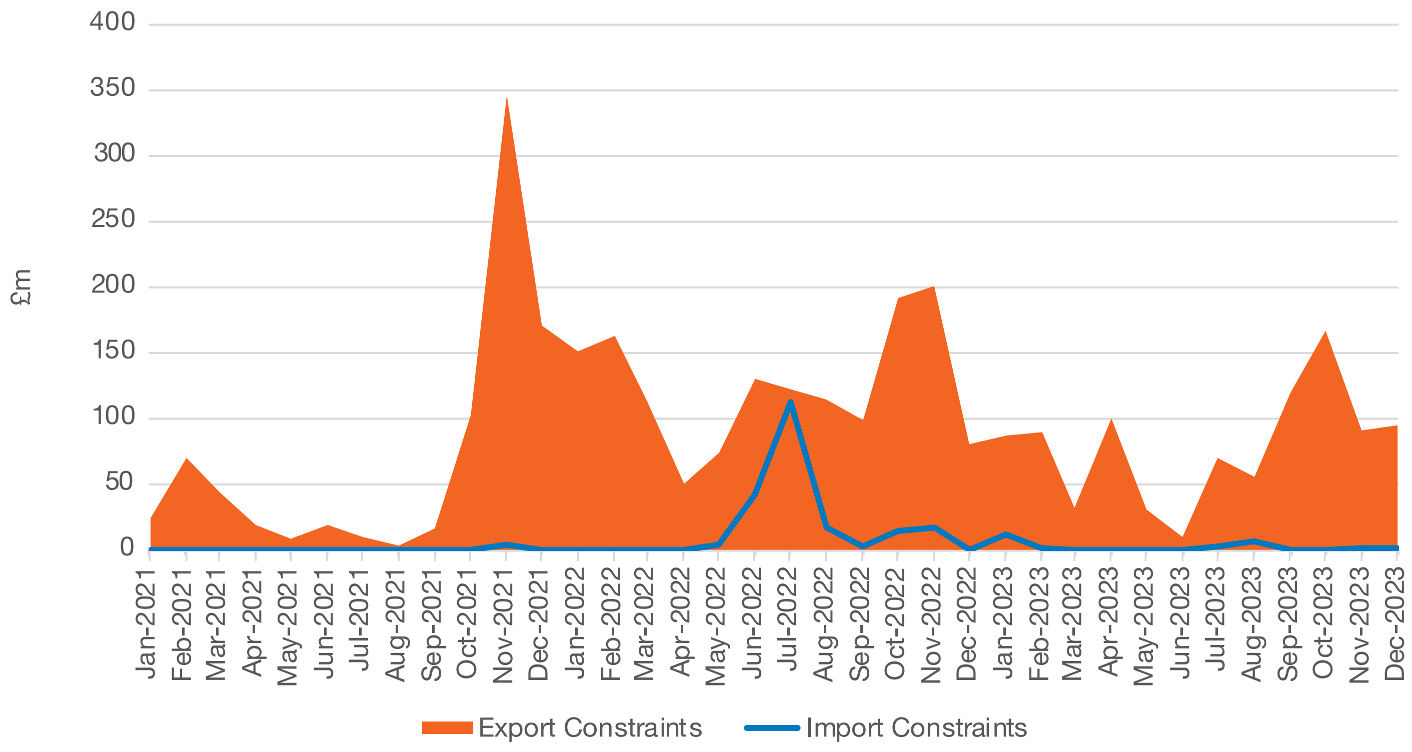
4. Control room processes

The activities and dates for implementation in each of these areas can be found in our balancing costs strategy.

Thermal constraint managment costs in the BM and trades

Constraint managment Intertrip scheme

TH Figure 4: Thermal constraint costs: 2021-2023



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Thermal - Drivers for Reforms

There are some clear drivers for market reform with regards to how thermal constraints are managed. Last year's Market Design Framework assessment, conducted by LCP Delta, highlighted some key areas for us to address in our existing markets.

Constraint volumes and costs continue to increase year on year

Across all our FES scenarios, by 2030 we forecast at least 31GW of offshore wind connected, with 51GW under the Leading the Way scenario. Even with planned network build, our Electricity Ten Year Statement (EYTS) forecasts an increase in the volume of constraints across several boundaries, while our Network Options Assessment (NOA) modelling forecasts see increased costs across all of our FES scenarios. Furthermore, our FES scenarios all forecast GB as a net exporter of electricity by 2030, so we must consider how to address locational thermal constraints in regions with interconnectors.

A need for greater locational signals for dispatch and investment

Generation, flexibility and demand assets across the electricity system need effective locational signals, both in investment and dispatch timeframes. The current suite of signals sent through network charging and the balancing mechanism are proving insufficient and are resulting in inefficient investment and dispatch.

Greater transparency

The BM and trades have been the ESO's primary tools for managing thermal constraints, however the operational decisions made are not always completely transparent to the market. We understand that any new market service needs to be transparent about how services are selected, therefore ensuring a level playing field. There is also an opportunity for us to capitalise on the growth of emerging flexible technologies. The operational characteristics of many of these potential service providers will differ from conventional units, in terms of size, location on the network and visibility to the ESO and so we need new ways to access and dispatch them.

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Thermal - Market Reforms

The drivers for reform for how we manage thermal constraints are very clear. However, the actions with the potential for the most impact, new network build and wholesale market reform, take time to be planned, designed and implemented. In the meantime, we're committed to finding new ways to manage thermal constraints better, so that we can reduce costs to the end consumer.

- New project to develop short-term solutions
- Local constraint management and wholesale market reform
- Maximising the existing network

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Voltage

What is Voltage?

Voltage is the ‘push’ that causes electrons to move in an electrical conductor, measured in volts. Voltage must be kept within set limits (as set by the Security and Quality of Supply Standards) across the transmission system to maintain safe and efficient operation. We manage the voltage of the network through absorbing, or injecting, reactive power onto the network. By absorbing reactive power, the voltage reduces in the surrounding network area, whereas injecting will increase the voltage in the surrounding networks. We often refer to absorbing as a ‘lead’ action, and the injection as a ‘lag’. Synchronised generators may provide either a lead or lag action through adjusting their active power output, however the need is highly locational.

Our voltage requirements are increasing, whilst our traditional routes to accessing these services are reducing. We have forecast increased requirements for 2027 and 2029 of 2000MVars and 2400MVars respectively, due to synchronous generation being increasingly displaced in the merit order by embedded and offshore generation, as well as by interconnectors. For more information on this and our evolving system requirements, refer to our Operability Strategy Report.

How do we access voltage services?

- Self-dispatching generation
- Network Assets
- Balancing Mechanism and trades
- Network Services Procurement (NSP)
- Short Term Tenders

Self-dispatching generation

The Grid Code requires all transmission-connected generators to have the capability to both absorb and inject reactive power. For generation plant, such as wind, solar and battery storage, the grid code only mandates reactive power capability when the asset is generating at >20% of the asset’s rated MW. Assets which provide these services are currently paid the Obligatory Reactive Power Services (ORPS) price.

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Voltage - Summary of the chapter

How is the landscape changing? In the last Markets Roadmap, we reported a residual requirement need in 2025 of 2,225MVAr. Following planned asset investment, this has reduced to 1,300MVar although over the coming years, we see the residual need increase again as more synchronous plant comes offline. System requirements are still dominated by absorption (lowering high voltage) requirements, due to the decline of reactive power demand from distribution networks with more embedded generation.

How have costs and volumes evolved over the last year? There are two aspects which are categorised as reactive power payments: a synchronisation payment to instruct a unit on to become available to provide reactive power (paid per MWh) and the utilisation payment (paid per MVAr). Synchronisation costs have increased by ~130%, linked to over 180% increase in the volume of synchronisation offers. Utilisation costs have decreased by over 20%, whilst volumes have increased by only 18%. This is due to ORPS payments being linked to wholesale gas prices, which have reduced over 2023. The large increase in synchronisation volumes is due to less reactive power being available from self-dispatched generation assets, such as CCGTs. The increase in renewable generation means that the ESO is issuing more instructions in the BM to synchronise additional units for voltage reasons. Long-term outages of some reactors is also a reason for increased intervention, as well as fewer interconnector exports (needing fewer synchronous generators to run).

What is driving the need for reform? More volatile supply and demand patterns due to decarbonisation and decentralisation means voltage requirements are likely to become more dynamic depending on system conditions. Meeting this need by synchronising generation out of merit in the BM is expected to become increasingly costly.

How are we implementing market reform? Over the last year, we have continued to progress our Future of Reactive Power Market project. We're working on the development of a Y-4 and a Y-1 market and reviewing the feasibility of a D-1 market to ensure value for consumers. Through Network Services Procurement (formerly Pathfinders) we are currently running the 'Voltage 2026' tender. This tender is seeking reactive power services through a 10-year contract which should provide 200Mvar in London and 400Mvar in the north of England. Additionally, we are enhancing how we procure services from existing assets via code modifications (e.g. CM085 and the Review of ORPS).

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Voltage - Market Insight: Volumes

Synchronization and Utilisation volumes

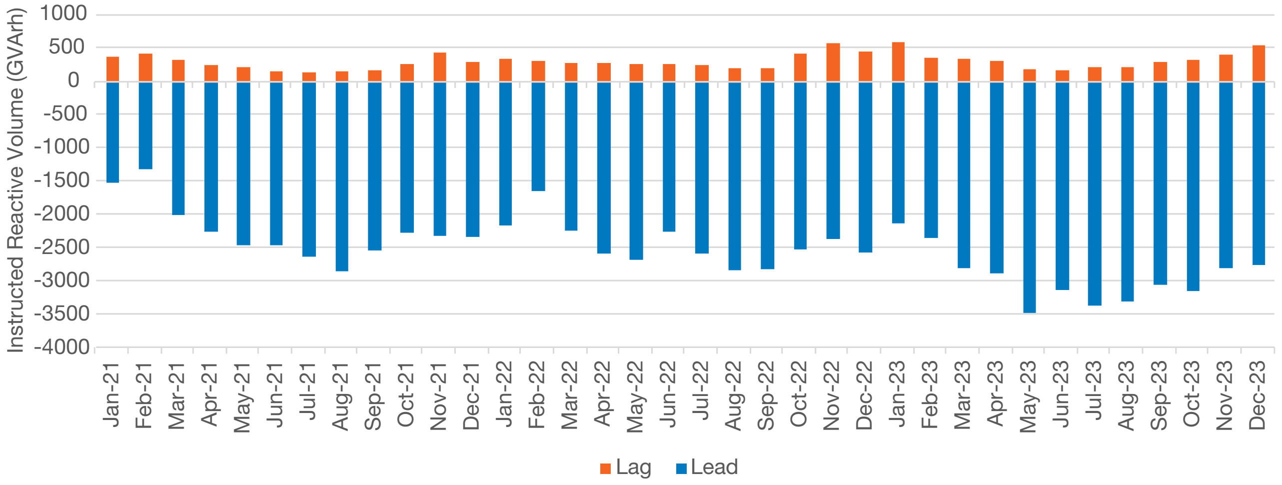
Across the past year, the total volume utilised under ORPS rose 18%, primarily driven by the need for the absorption of reactive power (lead requirements) as shown by VT Figure 1. By breaking down the total into lead and lag requirements, we can see that lead volumes rose just over 20% to 35,000GVArh, whereas lag volumes stayed stable at approximately 4,300GVArh.

Synchronisation volumes increased ~180%. There was the usual seasonal need for reactive power services with higher absorption volumes over the summer months, owing to a more lightly loaded network and higher injection in the winter months due to higher power flows. However, the summer of 2023 was more pronounced than normal, owing to some significant outages as well as the permanent decommissioning of some legacy reactor infrastructure, which left a big voltage gap in certain regions.

Additionally, over the course of 2023 some traditional units that provide reactive power (such as nuclear plant and CCGTs) have seen a significant decrease in output, in part due to lower interconnector exports and more wind in England and Wales, so they self-dispatched less.

VT Figures 3a and 3b illustrate the technologies which contributed to meeting our reactive power absorption requirements by region between 2021-2023. Due to the locationality of reactive power provision, it is unsurprising that regions with high levels of zero carbon generation, such as Scotland, met over 85% of their lead requirements from these technologies. It's also clear the ongoing importance of fossil-fuelled generation to the provision of reactive power in certain regions, outlining the challenge to decarbonising this particular aspect of operability.

VT Figure 1: Lead and lag volumes



+ Lead and lag volumes
+ Voltage synchronisation offers
+ Lead providers
+ Lag providers

Network Services Procurement (NSP) volumes (formerly Pathfinders)

The successful units from the Mersey long-term NSP, a battery facility and a reactor, are now operational in the northern region. This represents 240MVAr of reactive power volume within the Mersey region and reduces our reliance on a CCGT unit in the area (as evidenced by the drop in requirements shown in VT Figure 3a and 3b). The successful units from the Pennines long-term NSP, a mix of TO assets and the Dogger Bank offshore wind farm, are expected to be operational in 2024. This will provide 700MVar of effective reactive power volume to the North region. All NSP units contracted have been zero carbon, supporting our 2025 zero carbon operability ambition.

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Voltage - Market Insight: Costs

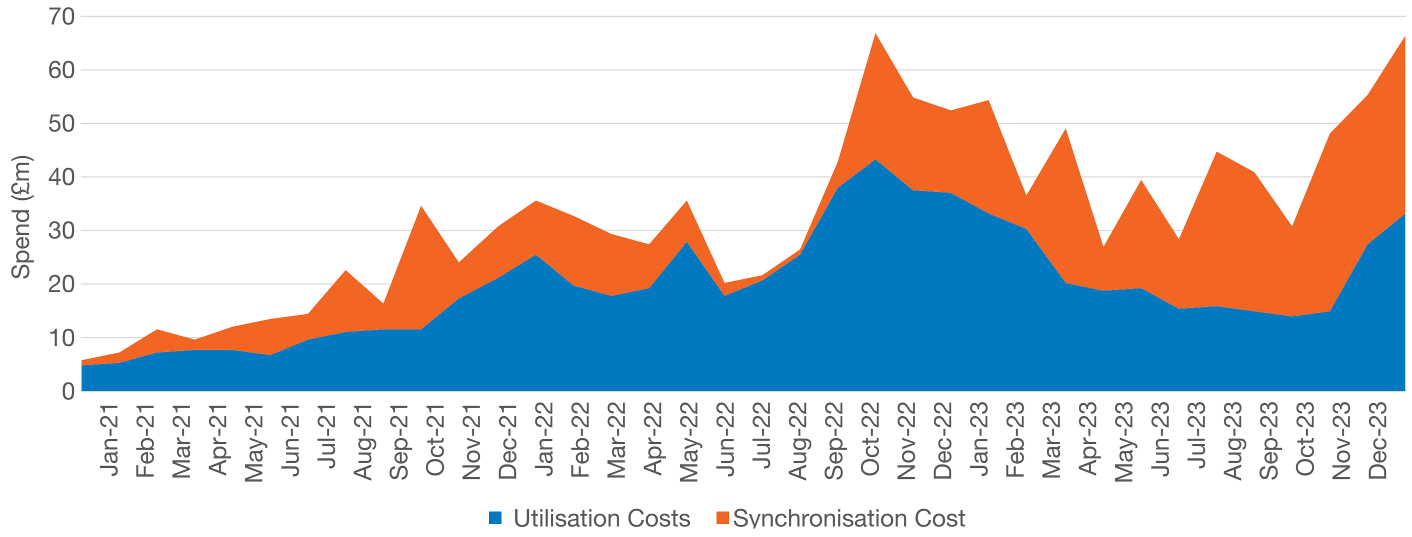
Synchronisation and utilisation costs

Synchronisation costs increased by ~130% compared to 2022, with a cost of just over £263m whilst utilisation costs reduced by a fifth to £258m due to reduced gas prices (ORPS is linked to wholesale gas prices, which is no longer reflective of our generation mix, hence the current review).

Network Services Procurement Costs

The long-term Mersey contracts have saved £22m between May 2022 and December 2023. These savings stem from securing our reactive power needs at a fixed price lower than procuring via traditional sources. This reduces our reliance on transmission connected generation and therefore provides value for money for consumers against potential volatile energy prices. Additionally, there is an environmental benefit as we do not need to utilise fossil fuel plant in some regions to meet our voltage needs.

VT Figure 4: Synchronisation and utilisation costs 2021-2023



Synchronisation and utilisation costs

Lead and Lag dispatch instructions

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Voltage - Drivers for Reforms

Our voltage requirements will continue to change as more decentralised and decarbonised generation is connected to the system. Points highlighted in bold relate to areas identified as needing to be addressed by the Market Design Framework assessment conducted by external consultants, LCP Delta, last year.

Investment signals needed for voltage assets

Locational signals vital for voltage management

Existing capacity needs to be more efficiently used

Investment signals needed for voltage assets

We need to improve the forecasting of our voltage needs to take better account of constantly changing variables. This will provide clearer investment signals as well as enhance the transparency in how we procure and pay for services to increase investor certainty. This includes our ORPS methodology, which is not clear to the market and was developed at a time when most generation was fossil-fuelled, meaning that its payments are based on gas prices. This is clearly no longer relevant today as it does not reflect the actual cost of providing reactive power services for many generators.

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Voltage - Market Reforms

Reactive Power Market Design

Over 2023, work on the reactive power markets resumed, looking at the business cases and value of long-, medium- and short-term voltage markets and how they can address the drivers outlined previously. The procurement of services across different timescales should aim to help incentivise new investment in the right locations, as well as realise the benefits of widening market access, enhancing competition and bringing overall costs down.

We are also designing our enduring voltage markets with the parallel development of stability markets in mind, aiming to maximise coordination between markets. Where possible, stacking of services will be permitted and similar timelines established to enable co-procurement of complementary products in the future.

The review of ORPS

Voltage 2026

Code changes and commercial agreements

The review of ORPS

We recognise that the current ORPS methodology needs reviewing as it is leading to sub-optimal cost outcomes for our consumers. This review will look at the current charging methodology to assess if it is still for fit for purpose against the backdrop of a changing generation technology mix. The aim is to ensure that all providers are remunerated in a way which is proportional to the costs incurred in providing the reactive power services. We are looking to undertake an innovation project to do this review and the details will be available on the Smarter Networks Portal, once the project is live.

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Restoration

What is restoration?

Restoration refers to the process of restarting the grid following a National Power Outage (NPO). It is a requirement for the ESO to have processes in place in the event of a partial or total shut down. Restoration service providers are generators, energy storage assets, or interconnectors with the ability to self-start and generate without external electrical supplies. These providers power up their local network, creating a power island, which enables other generators to start up and some demand to be restored. This power island grows and links up with other power islands, until the full grid is restored.

World-first trials, performed on the GB grid, have shown that the restoration of supplies can be achieved using distributed assets. In future, the distribution and transmission networks will need to work together to restore demand fast enough to meet the ESRS requirements.

How do we procure restoration services?

Most restoration tenders are procured locationally, apart from the wind tender, which was a one-off initiative launched in 2022, to prove that wind can provide primary service requirements. For each region of the GB grid, a competitive tender, known as an Electricity System Restoration Event, is run to determine which assets will provide restoration services for the next three or more years. In 2023 three tenders were run: the southeast, the northern, and the wind tender.

Once a service is procured, the ESO works closely with the local network owners and operators to create a plan that enables the system to be restored as fast as is safely possible.

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Restoration - Summary of the chapter

How is the landscape changing? The GB grid is transitioning away from large synchronous generators towards smaller non-synchronous assets. Regulatory changes will help to allow these newer technologies to participate in the restoration market by encouraging competition in the transmission connected market and allowing them to provide top-up services in restoration plans. The Distributed ReStart Redhouse trial showed that non-synchronous assets, like batteries, can be used at a distribution level to perform system restoration.

How have costs and providers evolved in the last year? Costs have reduced as compared to last year, which is due to fewer capital contribution costs and lower availability payments. The latter cost reduction, of about £5 million or 15%, is caused by the expiration of bilateral contracts, which have been replaced with competitively tendered contracts.

Tenders allowing Distributed Energy Resources (DER) providers are seeing a large increase in renewable and low carbon technologies, with the most common applicant to the northern tender being batteries, followed by wind.

What is driving the need for reform? The two main drivers for reform are the transition away from fossil fuels and the minimum restoration times set out in the Electricity System Restoration Standard (ESRS). Some areas of the GB grid will find it more difficult to meet these minimum times, so changes to the restoration market will be required to accommodate their transformation.

How are we implementing the reform? Three new categories of providers are being introduced to the restoration service market to help us meet the restoration times set out in the ESRS. These are transmission connected top-ups, anchor generators (distribution), and top-up services (distribution).

Learnings from the Distributed ReStart live trials of non-synchronous assets as restoration providers, are being implemented, which allows technologies that historically did not participate in the restoration market to find a new source of income. We are replacing bilateral contracts as they expire with new contracts, which are being competitively tendered, reducing the overall cost to consumers.

Link to restoration webpage.

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Restoration - Market Insight: Providers

Non-renewable providers make up the majority of current Electricity System Restoration (ESR) providers, but storage and renewable sources as a percentage are increasing year on year.

2023 Regional Tenders

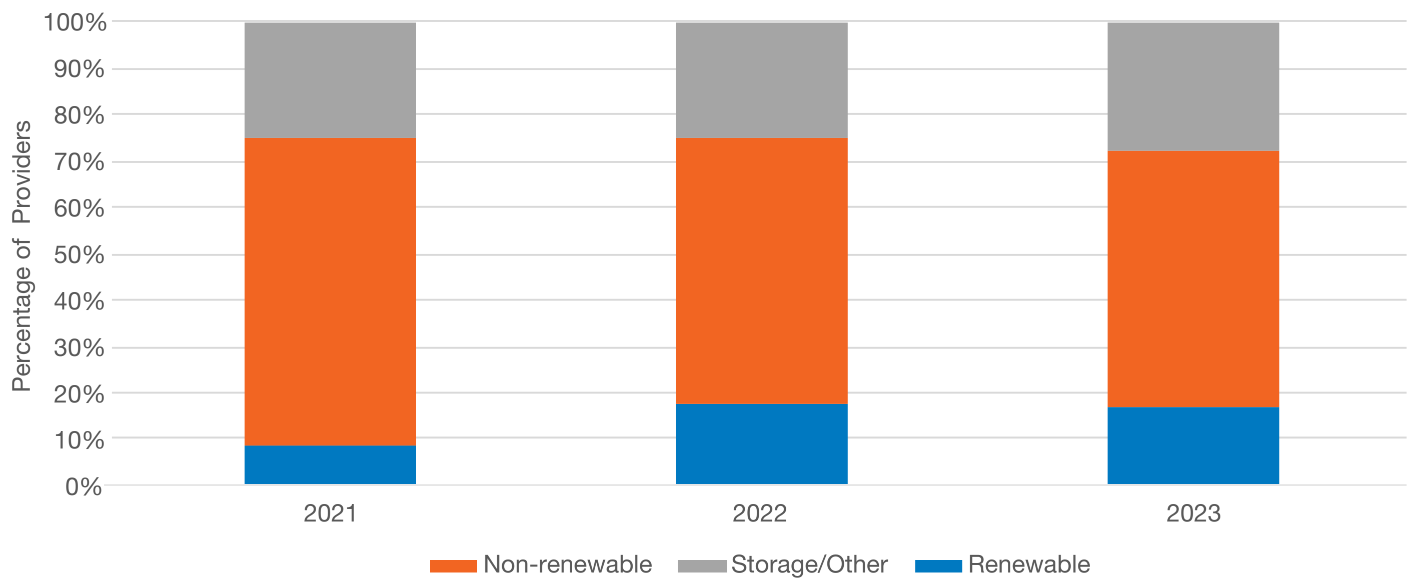
The northern and southeast tenders started in 2022, and the successful applicants will start providing services in the latter half of 2025.

The main reason why there is a greater uptake of renewables and storage assets in these tenders is the introduction of three new categories of providers; transmission connected top-ups, anchor generators (distribution) and top-up services (distribution). These new categories of service allow a more diverse range of technologies to participate in the restoration market, as compared to transmission-connected anchors, the majority of which are traditional thermal plants.

As some of the tenders are still ongoing, the tender participants may not fully reflect the final contracted providers. The increased interest in ESR from renewable energy generators shows that restoration services can adapt to a more decarbonised grid. For example, the northern tender has a lower percentage of fossil fuels in part due to more renewables in the northern parts of the GB grid.

Batteries and wind make up a large percentage of the total applicants to both tenders, indicating that in the future, the restoration market could be much more technologically diverse, avoiding uniformity of generation types in restoration regions. There are 12 different primary energy sources across both the northern and southeast tender, as compared to 6 in the current pool of ESR providers.

RT Figure 1: Simplified Current Restoration Providers



Simplified current restoration providers

Simplified breakdown of tender participants

Detailed breakdown of tender participants

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Restoration - Market Insight: Costs

Restoration costs over the last three years (2021-2023) have seen a slight downwards trend.

The two key elements in restoration costs are:

1. **Availability Payments:** We agree a fixed annual price with providers, which is converted to a £/settlement period payment, paid monthly. Providers are only paid for settlement periods they have declared their availability for.

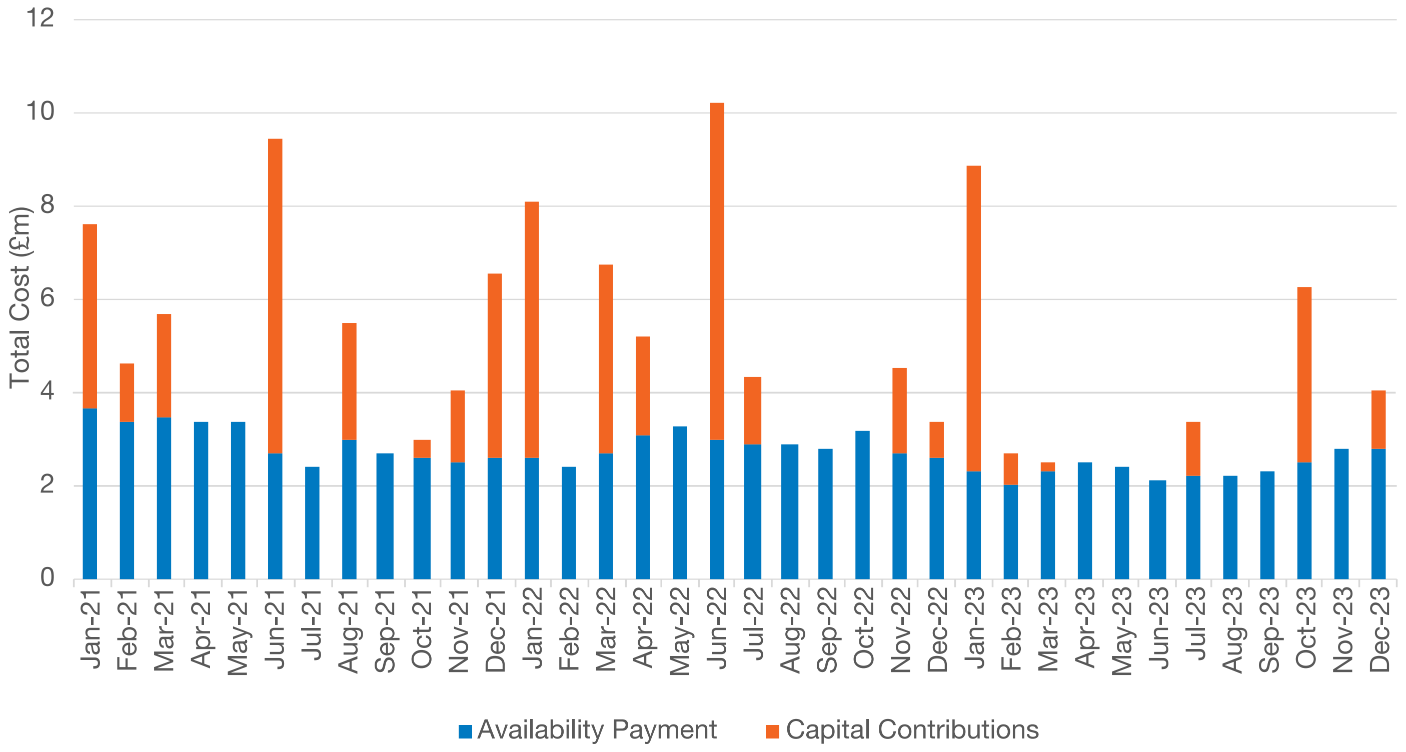
2. **Capital Contributions:** New restoration services are likely to require significant capital investment. Each contract will include a breakdown of costs including, where necessary, a milestone payment schedule. These costs are therefore quite ad-hoc.

There are a few other much smaller payments, including feasibility studies and testing, but as these are not market related, they have been excluded.

Overlaying last year's availability payments on this year's shows that costs have decreased by 16.7%, or £5.7 million. This decrease is caused by the expiration of bilateral contracts, which are being replaced with more competitively priced tendered contracts.

Capital contributions were significantly lower this year, ~£14 million, as compared to last year, ~£23 million. This number is expected to grow from 2025, when the northern and southeast tenders come into effect and new technologies are introduced, requiring upfront payments to ensure they are equipped to provide restoration services. For more information on costs associated with restoration and the relevant calculations, see here.

RT Figure 4: Restoration Costs Jan 2021 - Dec 2023



Breakdown of Restoration Costs

Breakdown of Availability Payments

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Restoration - Drivers for Reforms

To adapt to a decarbonising grid and meet the time requirements laid out in the ESRS, some challenges in restoration services will have to be addressed using market solutions. LCP Delta conducted a Market Design Framework assessment showing some key areas to be focused on.

A need for more efficient dispatch

In the short term, restoration costs are expected to increase as the older generation of plants that currently provide ESR services near their end of life. To meet the requirements of the ESRS, pre-existing assets will need to assist in restoration plans using the three new categories of service. Upgrading these often-intermittent sources of energy to be able to provide restoration services will likely cost more in the short term, but increased competition from new providers will help drive down these costs in the long run.

Changing regulatory standards

When the ESRS is introduced in 2026, it will require all restoration regions of the GB grid to be able to restore 60% of demand in 24 hours, and 100% of demand in five days. The reduction in available fossil fuel providers in some regions will require newer technologies to fill the gap, speeding up restoration times to the levels stated in the ESRS.

Increased adaptability

Due to the long-term nature of restoration contracts, swapping service provider takes far longer than other ancillary services. Changing providers requires coordination of the local transmission and distribution networks, and planned disruption on the grid, so that significant testing of new restoration plans can be done. This means changes to restoration plans can only occur every three years on a regional basis. In place of reduced contract lengths, restoration could seek greater adaptability via increased competition in tenders.

Legacy providers of restoration services, the majority of which are larger thermal or hydro plants, are more easily able to control their power output, whereas newer technologies like wind and solar cannot. To reach the restoration times set out in the ESRS, more providers will be required to make up for the smaller unit size and lower availability.

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Restoration - Market Reforms

Traditionally, the approach the ESO has taken to restoration has been a top-down one. Whilst this process works well in a system dominated by large synchronous generators, it is not optimal for a decarbonised grid. A holistic strategy must be taken to restoration, involving both top-down and bottom-up methods being used where required. A more detailed explanation of both current and new restoration approaches can be found in Electricity System Restoration Assurance Framework 2023/24. Reaching the restoration times set out in the ESRS, both regionally and nationally, will require some market reforms.

New Categories of Providers

To meet the times set out in the ESRS, three new categories of providers will be introduced; transmission connected top-ups, and anchor generators (distribution) and top-up services (distribution). Traditionally, restoration was a market that only large transmission connected assets with the ability to self-start and produce electricity without external supplies could participate in. These new services will provide a new market for both distributed assets and assets which cannot self-start. As distribution connected assets tend to be much smaller than traditional ESR providers, many more distributed assets will have to be contracted by the ESO to make up a useful part of the restoration plan.

The increased number of providers in the restoration market will create more competition, driving down prices in the long run and providing our consumers with a greater service for their money. Distributed ReStart, which uses distributed anchor generators and top-up services, is anticipated to save consumers £115 million by 2050 through increased competition.

Increased Involvement of Distribution in Restoration

The Redhouse trial was the third and final live trial carried out in the Distributed ReStart project, which was a joint innovation project between SPEN (Scottish Power Energy Networks), ESO, and TNEI (The Northern Energy Initiative). This trial showed it was possible to start and maintain a section of the distribution network without a synchronous generator, opting instead to use a battery energy storage system (BESS).

Learnings from these trials have already been incorporated by applicants to both ongoing regional tenders. Battery systems are now the most common applicant to the northern tender, making up over 40% of current applicants. Other non-synchronous machines make up a further 30% of applicants. Whilst the increase of distribution assets won't increase the speed at which restoration services are procured, they will increase the number of options available when procuring restoration services, allowing a more dynamic restoration plan to be developed.

Movement Away from Bilateral Contracts

Availability costs have moderately reduced this year as compared to last year, in part due to previous reforms to the market where bilateral contracts have been replaced by competitively tendered contracts. This reduction in cost is expected to continue in the near future, as more bilateral contracts expire. By restructuring how these services are procured, greater value for money can be provided to consumers, without sacrificing restoration performance.

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Revenue stacking

Revenue stacking

What is revenue stacking?

The ability to stack revenues from different products, services and markets, operated by different organisations, maximises the efficiency of flexible assets. It also boosts competition in markets, allowing the ESO to meet system need at a reduced cost to consumer.

The benefits of revenue stacking have been evidenced by the recent launch of the Enduring Auction Capability, which enabled full stacking of dynamic response products, increasing market liquidity and bringing down average prices.

We are committed to maximising the ability to stack services, so that there is increased market participation across the whole system, better ESO-DSO coordination, and improved competition and value for consumers. Our current focus on enabling stacking includes:

- Stacking Balancing Reserve with response services.
- Evolving legacy services to facilitate stacking with response and reserve services.
- Ensuring flexible demand services can be stacked with other services including DSO level.

Revenue stacking types breakdown[1]:

Revenue stacking: receiving multiple revenues from different markets/services with a single asset.

Co-delivery

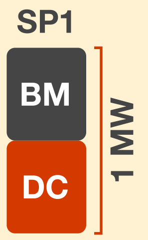
Being paid multiple revenues using the same MW, in the same time period.

Examples:

Splitting

Being paid multiple revenues from different MWs, from the same asset, in the same time period.

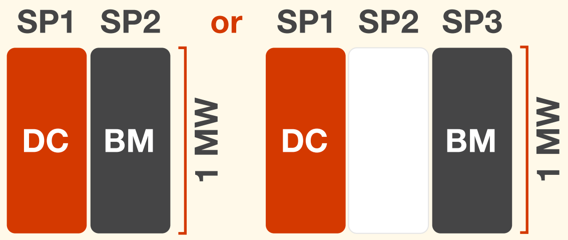
Examples:



Jumping

Being paid multiple revenues from the same asset, in different time periods (either adjacent or non-adjacent).

Examples:



SP = Settlement period CM = Capacity Market BM = Balancing Mechanism DC = Dynamic Containment

1 We consider generation and demand as different MWs. Therefore, we consider a storage device providing DC high and DC low, as splitting.

Markets Roadmap / Revenue stacking 62

Revenue stacking: Stacking tables explainer

This page is interactive.
Click the ⊕ to expand or enlarge content.

The tables on the following pages are designed to give some clarity on stacking. They show how our products can stack with each other and across the Capacity Market, Balancing Mechanism and wholesale market. For the purposes of these tables, we show only two colours: green and red.

- Green indicates the services can be stacked, given a specific use case that is performed correctly but it does not indicate that the services can be stacked for every technology and every use case.
- Red indicates the services cannot be stacked in any use case.

We have included markets and services that are established or soon to be established and therefore have a high degree of certainty over their design. DSO services are an important and growing part of the revenue opportunities available to flexibility service providers.

We are currently working with Open Networks to analyse ESO and DSO revenue stacking opportunities but we are not ready yet to include these findings in these tables. Additionally, DSO services are going through a transition to a new set of aligned services (for more information see here). The value of local flexibility is clear and we are committed to including DSO services in future versions of the Markets Roadmap.

The information presented here is indicative and represents our best view at the time of publication. This view is likely to change with the introduction of new markets and evolution of existing ones. Individual technologies have varying revenue stacking capabilities and it is the flexibility service provider's responsibility to adhere to all service terms. If you have questions regarding a revenue stacking use case, please contact us here: box.futureofbalancingservices@nationalgrideso.com

Co-delivery

Splitting

Jumping

Markets Roadmap / Revenue stacking 63

Revenue stacking: Co-delivery

This page is interactive.
Click the ⊕ to expand or enlarge content.

		CM	WM	BM	STOR	BR Positive	BR Negative	DC High	DC Low	DM High	DM Low	DR High	DR Low	SFFR	DFS	LCM
	CM				1										2	1
	WM			3	4	3		5								
	BM				6										2	7
	STOR															8
BR	Positive															9
	Negative															
DC	High															8
	Low															
DM	High															
	Low															
DR	High															
	Low															
	SFFR															
	DFS															2
	LCM															

DSO services haven't been included in these charts because our ESO-DSO revenue stacking project is currently investigating this. We are working alongside Open Networks to establish our view on revenue stacking with the updated DSO flexibility services published in Flexibility Products Review and Alignment. We will publish the outcomes in our Flexibility Market Strategy due in summer 2024.

Co-delivery

Stacking in the same delivery window allowed

Stacking in the same delivery window not allowed

Markets Roadmap / Revenue stacking 64

Revenue stacking: Splitting

This page is interactive.
Click the ⊕ to expand or enlarge content.

		CM	WM	BM	STOR	BR Positive	BR Negative	DC High	DC Low	DM High	DM Low	DR High	DR Low	SFFR	DFS	LCM
	CM	1														
	WM				2	3		4								4
	BM					5		6						7	8	9
	STOR					10										11
BR	Positive						12	13						7		
	Negative															
DC	High								14							
	Low															
DM	High															
	Low															
DR	High															
	Low															
	SFFR															
	DFS															8
	LCM															

1
The Capacity Market cannot be split, as it is a long term capacity contract without defined delivery periods.

Splitting

Stacking in the same delivery window allowed

Stacking in the same delivery window not allowed

Markets Roadmap / Revenue stacking 65

Revenue stacking: Jumping[2]

This page is interactive.
Click the ⊕ to expand or enlarge content.

						BR		DC		DM		DR				
		CM	WM	BM	STOR	Positive	Negative	High	Low	High	Low	High	Low	SFFR	DFS	LCM
	CM															
	WM															
	BM														1	2
	STOR															
BR	Positive															3
	Negative															
DC	High															
	Low															
DM	High															
	Low															
DR	High															
	Low															
	SFFR															
	DFS															1
	LCM															

DSO services haven't been included in these charts because our ESO-DSO revenue stacking project is currently investigating this. We are working alongside Open Networks to establish our view on revenue stacking with the updated DSO flexibility services published in Flexibility Products Review and Alignment. We will publish the outcomes in our Flexibility Market Strategy due in summer 2024.

Jumping

Stacking in the same delivery window allowed

Stacking in the same delivery window not allowed

2 All jumping is subject to crossover requirements, where service terms require full delivery at the beginning and/or end of the delivery period and may require ramping either before or after the delivery period.

Markets Roadmap / Revenue stacking 66

Get in touch

Contact the team:

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ESO