ESO

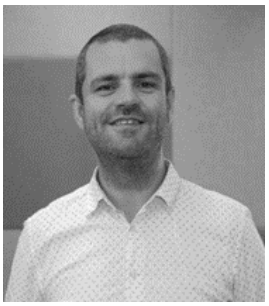
power responsive

Annual Report 2023

A roundup of developments in demand side flexibility markets in GB

Contents

Foreword



Matt Magill
Head of Markets, ESO

The Power Responsive team are pleased to publish our Annual Report, which reflects on policy, regulatory and market developments over the past 12 months as well as trends in demand side flexibility participation. This report also provides a forward-looking view of future key developments in this space, and is designed to help stakeholders navigate industry change and support the continued development of demand side participation in flexibility markets.

All our programmes across ESO market reform are targeted at increasing competition to reduce overall system costs. Power Responsive plays a key role in enabling this by removing barriers to entry to flexibility providers. Two of the biggest steps over the last year to enable this include the Demand Flexibility Service (DFS) and small-scale assets entering the Balancing Mechanism.

We saw groundbreaking progress as the first aggregated small-scale assets (in this case electric vehicles) participated and were dispatched in the Balancing Mechanism through Power Responsive's Small-Scale Assets in the Balancing Mechanism trial and then through a more enduring initiative for up to 300MW of Small Scale Assets utilising less stringent operational metering standards.

The ESO's Demand Flexibility Service (DFS) evolved for a second winter, seeing an increase in participation from 1.6 million MPANs in 2022/23 to 2.6 million MPANs in 2023/24. We continue to take major steps to integrate new clean and flexible technologies into our markets and over the last year and we have been working closely with stakeholders and industry to establish innovative ways to manage the system.

Power Responsive has really set the direction for how the ESO works with and engages our stakeholders, driving the growth of DSF solutions for the energy industry through its wide industry engagement and focused working groups all looking to reduce current barriers to entry and enable more domestic and commercial assets to provide demand side flexibility in our ancillary services.

We are acutely aware that there are still hurdles to overcome, but with the continued support and engagement of the demand side community, we firmly believe we can continue to make great progress towards our net zero ambitions. We have said it before, but collaboration is key to Power Responsive's continued success, and this is a great opportunity for me to thank everyone who has contributed to the various ongoing workstreams, without you progress is not possible.

1.0 Executive summary

Over 2.6 million households and business have participated in the Demand Flexibility Service during 2023.

Headlines from the 2023 report

1 The Demand Flexibility Service continues to grow

In the Demand Flexibility Service (DFS) 2023/24, 2 Live Events and 14 Test Events occurred up to end of March 2024, building on the success of last year's programme. New for 2023/24 is the introduction of within-day as well as day-ahead test notifications, to ask consumer households and businesses to change their electricity usage at shorter notice than last year. For the first 7 Test Events, all service providers delivering demand reduction received £3,000/MWh. For the subsequent 7 Test events the procurement mechanism was altered to remove the guaranteed acceptance price of £3000/MWh to allow for a competitive bidding process. This saw prices as low as £150/MWh achieved.

2.6 million households and businesses signed up to deliver services through 25 providers. 3.6GWh of energy demand was delivered in events up to the end of March 2024, with business and households being rewarded with £11.9 million of payments.

2 The Enduring Auction Capability platform launches for Frequency Response Services

The ESO launched a new procurement platform for Frequency Response Services in November 2023. The Enduring Auction Capability makes stacking of services simpler for service providers and brings efficiency to the procurement process. One notable impact since its launch is the presence of negative clearing prices seen in Dynamic Containment High, Dynamic Moderation High and Dynamic Regulation High services.

Since its introduction in October 2023, the Enduring Auction Capability platform has proved to be a successful collaboration between National Grid Electricity System Operator and N-SIDE. The Response services have been procured on this platform since November 2023 with significant reduction in wholesale prices. Balancing Reserve services can now be procured on this platform giving market providers a single enduring auction platform to procure National Grid Electricity System Operator services. The Quick and Slow Reserve services will be introduced in the future expanding the services portfolio on the Enduring Auction Capability and giving market providers the simplicity and access to be able to procure as many services as possible.

3 Frequency Response Services clearing prices fall as procured volumes continue to grow

Contracted volumes of Dynamic Containment, Dynamic Moderation and Dynamic Regulation grew steadily throughout 2023. Dynamic Containment continued to be the biggest market of the dynamic services with over 2 GW per day contracted across both Dynamic Containment High and Dynamic Containment Low services.

Clearing prices across all dynamic response services decreased and became more stable compared to 2022, signalling some saturation of the market. This is not surprising given the volume of grid connected storage assets that came online and the increase in contracted volumes made available by the ESO.

Dynamic Firm Frequency Response was phased out as planned, and Static Fast Frequency Response transitioned to day-ahead procurement to align with the dynamic response services. Contracted volumes and prices in the Static Fast Frequency Response market remain stable.

4 Energy Flexibility delivered by Distribution Network Operators remains stable

Through RIIO ED2 (the price control mechanism for GB Distribution Network Operators), the Distribution Network Operators are incentivised to deliver distribution-level flexibility through entities known as Distribution System Operators. Although the volumes of flexibility tendered in 2023 increased significantly compared to 2022, the volume of contracted flexibility remained similar, highlighting a constraint in service providers in the right locations with appropriate market signals.

5 Demand Side Flexibility asset participation in the Capacity Market and Balancing Mechanism increases

The participation of Demand Side Flexibility assets such as batteries in the Capacity Market and Balancing Mechanism continued to grow in 2023. New initiatives such as the Open Balancing Platform, launched in December 2023, should facilitate increased participation through 2024 and beyond. A Small Scale Aggregated Asset Live trial was also successfully introduced to the Balancing Mechanism in 2023 as well as a new increased 300MW capacity for aggregated assets.

2.0 About Power Responsive

2.1 What is Power Responsive?

Power Responsive is a stakeholder-led programme, facilitated by National Grid ESO, to stimulate increased participation in the different forms of Demand Side Flexibility (DSF). It brings together industry and energy users, to work together in a co-ordinated way.
The role of Power Responsive is to:

1. Remove barriers to entry for DSF in ESO Markets.
2. Raise awareness of DSF opportunities.
3. Act as a voice for DSF within the ESO and wider industry.

This fast-growing market is all about using energy more intelligently. It provides flexibility that enables National Grid ESO to balance Britain's electricity system cost-effectively, while our energy landscape changes rapidly. If your business has the flexibility to increase, decrease, or shift its electricity usage, then the power is in your hands to take full advantage.

2.2 2024/25 focus areas

Power Responsive will continue to champion increased DSF participation in markets in 2024/25 by focusing on four strategic areas:

1. Stimulating market participation from small scale and residential DSF through market reforms such as reviewing the operational metering standards for the Balancing Mechanism (BM) while continuing to support the development of all of our ancillary services.
2. Working closely with industry stakeholders and Government to ensure appropriate regulation is maintained for small scale flexibility.
3. Investigating new ways to help unlock Industrial and Commercial (I&C) flexibility and bring new volumes into ESO markets.
4. Growing consumer confidence in participation in flexibility through the support and development of Codes of Conduct and Compliance schemes, such as Flex Assure and HOMEFlex.

2.2 Stakeholder commitments

Power Responsive maintains its commitment to providing stakeholder value through continuous engagement and has delivered upon the following commitments in 2023/24:

1. Hosting and attending industry events to promote discussion around DSF, determine barriers to market entry and raise awareness of current and future stakeholder opportunities.
2. Convening the Power Responsive Steering Group comprised of representatives from across the industry to ensure the programmes strategy continues to be aligned with stakeholders' priorities.
3. Promoting industry participation in innovation projects and trials that will support the development of the DSF sector.
4. Facilitating industry working groups that tackle significant barriers to market entry for DSF.
5. Support and provide oversight of the Flex Assure and Home Flex code of conduct schemes that set common standards for aggregators and establish minimum standards of practice.

Meet the Power Responsive team

Callum Wright
Power Responsive Manager
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Callum has been in the industry for nearly 15 years with a background in short and long term gas and power trading, certificate trading, portfolio optimisation, demand and generation forecasting with a focus on domestic energy supply, renewable energy, asset management, energy market insight, risk management and analysis. Callum joined National Grid ESO in 2022 to focus on Power Responsive and help drive the future of Demand Side Flexibility.

Calum McCarroll
Power Responsive Lead
calum.mccarroll@nationalgrideso.com

Calum has over 8 years' experience in the electricity industry starting out in network management for the National Grid Transmission business before moving to the ESO to develop the customer and stakeholder strategy for National Grid Group. More recently, Calum has worked on agreement management for the UK Capacity Market and spent the past 4 years in Power Responsive specialising in Demand Side Flexibility, market development and stakeholder engagement.

Vanessa Jones
Power Responsive Officer
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Vanessa has had a long and distinguished career in Aviation and Health sectors, specialising in customer liaison, service delivery and stakeholder management. As an avid proponent of sustainability and the goal of decarbonisation, Vanessa joined National Grid ESO to support the drive to net zero as Power Responsive Officer and plays a key role in bringing our stakeholder engagement strategy to life through sponsorships, events and supporting the delivery of Power Responsive market development workstreams.

Boluwatife Adeyemo
Power Responsive Officer
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Bolu brings extensive experience from the Nigerian oil and gas industry to the utilities sector. With a background in oil and gas, Bolu understands the importance of transitioning to cleaner energy sources and is dedicated to supporting decarbonization efforts within the industry. Committed to sustainability and achieving net-zero emissions, Bolu joined the ESO's Power Responsive team. With a key focus on supporting market development workstreams, focusing on customer relationships, service delivery, and stakeholder engagement.

James Kerr
Power Responsive Engagement Lead
james.kerr@nationalgrideso.com

James is the Power Responsive Engagement Lead at National Grid ESO. He's worked in a variety of roles at the ESO including Connections to the grid, RIIO-2 strategy, and developing the ESO's first Consumer Strategy which included being part of the team that delivered the Demand Flexibility Service (DFS). James was seconded to the Citizens Advice's Energy Policy team where he championed consumers across the energy industry, working across all networks and with a wide variety of stakeholders.

Contact power.responsive@nationalgrideso.com

3.0

State of the industry

3.1 Policy, regulatory and market development

3.1.1 Government

The section below summarises the key policy developments related to demand side flexibility (DSF) that occurred in 2023 and were primarily driven by Government.

At the beginning of 2023, a new department for Energy Security and Net Zero (DESNZ) was established, taking on the full energy remit of the UK government.

In 2023 energy was still top of the political agenda despite some stability around residential energy prices, and the Energy Act (2023) was legislated for during the year. Key legislative changes in the Energy Act were the establishment of the Future System Operator (FSO), the application of a Net Zero mandate for Ofgem, the regulation of heat networks and granting DESNZ to deliver government supported business models for hydrogen production and Carbon Capture and Storage (CCS).

The Government's discount on energy bills, the Energy Price Guarantee does not end until 2024, but as wholesale energy prices reduced after the highs of 2022, the Energy Price Cap fell beneath it in summer 2023. As well as easing energy prices, 2023 also saw record low energy demand. According to the Energy Trends bulletin, Q3 2023 was the lowest quarterly UK power demand in the published data series (since 1998), and the highest percentage of renewable power generation (over 44%).

The Smart Energy Savings Competition (SENS), which allocated £6.25m for innovative services that use smart-meter data to reduce domestic consumption, concluded in 2022, with the evaluation published in 2023. An important conclusion of the trials was that novel, tailored and actionable feedback was particularly valuable for facilitating domestic energy demand reduction.

In relation to Power Responsive, DESNZ are continuing to deliver against the joint Government/Ofgem Smart Systems and Flexibility Plan from 2021, which sets out a work programme for delivering the smart and flexible electricity system needed to deliver the transition to net zero.

In March 2023, the government published a response to the 2022 consultation on interoperability and cyber security of energy smart appliances and remote load control. This confirmed a desire for load controllers to be regulated by Network and Information Systems (NIS) regulations, and for load controllers of 300 MW or greater to be classified as Operators of Essential Services. Government will soon be publishing in 2024 a bundle of consultations further developing the policy and implementation for how to encourage energy smart appliances to participate in domestic DSR.

Energy storage and flexibility are being promoted via the Flexibility Innovation Programme which funds up to £65m of innovation projects under the flexibility theme. There are several topic areas making up the flexibility theme, sorted into three separate themes: 1) Integrating Systems for Flexibility, 2) Data and Digitisation, and 3) Markets for Flexibility. Alongside these, the longer duration energy storage demonstration (LODES) programme has given up to £68 million for actual and first-of-a -kind prototype demonstrations; these are now in the build and commission phase.

The first review of electricity market arrangements (REMA) consultation closed in 2022, with the responses reviewed and published in early 2023. A second consultation was published in March 2024 and closed in May. Certain options were excluded on the basis of the consultations; however, several of the options still on the table could have major implications for DSF assets, including an optimised capacity market (perhaps with additional flexibility enhancements), centralised reliability options, and revenue cap and floors. Most other flexibility options have either been discounted or are being shelved unless the outlook changes.

In summer 2023, the government published a policy paper on the vision for the future of the retail market. A key driver for Power Responsive was a desire to be flexible around regulation to allow for novel supply solutions. The policy paper links directly with the flexibility innovation programme where the work stream 'Alternative Energy Markets' is exploring how market solutions can enable large-scale demand side flexibility. With the smart-meter roll-out and market-wide half hour settlement coming towards fruition, the government will want to ensure that market regulations are fit to make the most of these technical changes.

The main impacts of the Energy Act on DSF asset investors and operators was creating the legislative framework for the independent National Energy System Operator (NESO) and the introduction of the regulatory framework for load control. In 2022, the UK government also consulted on the ownership of Elexon, who administers the balancing and settlement code (BSC) and is currently owned by the National Grid Electricity System Operator. In March 2023 a decision was made to keep Elexon in industry ownership with the 13 largest energy suppliers and generators mandated to take shares in Elexon.

3.1.2 OFGEM

The section below summarises the key regulatory developments related to DSF that occurred in 2023 and were primarily driven by the energy regulator Ofgem.

As noted in the DESNZ section above, Ofgem are also continuing to deliver against the joint Government/Ofgem Smart Systems and Flexibility Plan which sets out a work programme for delivering the smart and flexible electricity system needed to deliver the transition to net zero.

A key component of Ofgem's regulation is the RIIO price control framework for the regulated monopolies that run GB's gas and electricity networks. RIIO-ED2, the current electricity distribution price control, covers the 5-year period from April 2023 – March 2028. RIIO-ED2 includes mechanisms that support the use of flexibility to manage network constraints, including the ability for DNOs to procure flexibility to defer network reinforcements through an uncertainty mechanism called the secondary reinforcement volume driver.

On the 26th of October 2023, Ofgem published the framework design for future network price controls, Future Systems and Network Regulation (FSNR), that will update RIIO-2 when it comes to an end in March 2026 (ET- electricity transmission) and March 2028 (ED- electricity distribution). Ofgem is now developing the methodology for applying this framework for the gas distribution and transmission networks and the electricity transmission networks, to ensure the price control framework remains fit for purpose.

On the 15th of November 2023, Ofgem published their decision to reform local governance arrangements. The work will include reforms to energy system planning, market facilitation of flexible resources, and real time operations. The aim of the reforms is to make sure that the distribution system has the right institutional arrangements to enable the transition to net zero. Ofgem confirmed that DNOs will retain accountability for real time operations and the maintenance of network and system reliability and resilience. Under the changes, the FSO will have the role of the delivery body for Regional Energy Strategic Planners (RESPs) responsible for the development of energy strategies across regional energy systems. There will be 10 to 13 RESPs in GB and how they plan the energy system could impact how flexibility develops across different regions. There will be a single Market Facilitator for flexibility to align national and regional flexibility markets; the FSO and Elexon have been consulted on as potential candidates for this role.

On the 1st March 2023, Ofgem published a Call for Input on The Future of Distributed Flexibility. The Call for Input identified key challenges across ESO and DSO flexibility markets, including a need for transparent information, coordinated access and operations, and trusted governance. Ofgem believes overcoming these challenges is crucial to ensure distributed flexibility assets can participate at scale across multiple markets. Ofgem proposed the need for common flexibility digital infrastructure for coordination and alignment across flexibility markets and also highlighted the importance of underpinning enabling work to align processes and standards. This work is being taken forward through industry workshops and exercises ahead of intended future consultations.

Work to deliver the underpinning enablers for flexibility is currently with the ENA Open Networks Project and will transition to the Market Facilitator in due course to deliver more effective governance and accountability. Ofgem highlighted the importance of this ONP work and timely delivery in an Open Letter to the ENA ONP.

Ofgem is also expected to become the regulator for the new licensing regime for load controllers – as set out in Government's consultation on "Smart Secure Energy Systems", and provided for in the Energy Act. This regime will also introduce product standards for Energy Smart Appliances aimed at ensuing interoperability and cyber security..

On the 6th of October 2023, Ofgem announced their decision to approve the industry modification the Balancing and Settlement Code (BSC) to allow access to the wholesale market in GB for Virtual Lead Parties (VLPs) via modification P415. Currently, consumers must have an arrangement with their energy supplier to flex their energy use from the wholesale market. The P415 modification should allow more consumers to participate in whole flexibility via VLPs acting as independent aggregators for consumers.

3.1.3 The ESO

The section below summarises the key market developments related to demand side flexibility (DSF) that occurred in 2023 and were primarily driven by the ESO.

The Demand Flexibility Service (DFS) was first launched as an enhanced action in the winter of 2022/23. The aim of the DFS is to provide grid flexibility when margins are tightest by incentivising households with smart meters, and industrial and commercial users, to voluntarily change the times that they use their electricity through a registered service provider. In the first DFS, 31 service providers were registered. The inaugural DFS successfully reduced over 3,300 MWh of electricity across 22 events, with participation from around 1.6 million households and businesses, with the ESO deciding to continue the scheme in winter 23/24 (DFS 2.0). The ESO used input from industry and consumer evaluation research, followed by consultation, to design the DFS 2.0 scheme. Ofgem announced the approval of the updated terms of the DFS on the 27th of October 2023, with DFS 2.0 officially launching on the 30th of October. Results of the DFS 2.0 are described in section 4.5 of this report.

To optimise the procurement of the ESO's day-ahead Frequency Response and Reserve products, the ESO is co-optimising the procurement of services through the Enduring Auction Capability (EAC). The EAC aims to deliver increased efficiency while enabling providers to participate in multiple markets. It alters the way the frequency response market works and how providers bid for the market services. The EAC is deigned to co-optimise procurement of the product bids through the use of "baskets"; providers bid across multiple services that act in the same direction (high frequency and low frequency) and can stack services. Prior to the EAC, bids had to be for high or low frequency services and stacking of services was prohibited. Bidders will be allowed to split their BESS capacity so that different megawatt capacities of their total BESS capacity can participate in different services. The EAC introduces new complexity to the bidding and delivery process of dynamic frequency response services, however the overhaul of the process offers a more effective bidding solution for service providers. The first round of auctions on the EAC platform took place on the 2nd of November 2023.

The ESO are trialling a new Local Constraint Market (LCM) as an interim measure to manage the electricity grid across one of the most constrained transmission boundaries in GB, the B6 boundary between the SP Energy Networks transmission area in Scotland and the National Grid transmission area in England; the boundary runs roughly along the border of the two countries. The ESO aims to develop the LCM into a market that facilitates access to new providers of flexibility and delivers competition to the Balancing Mechanism – the existing market for the majority of transmission constraint management

The LCM has been open regularly since December but is yet to realise cost savings. Higher than expected energy prices and challenges around a lack of energy compensation for aggregators makes demand side response significantly less competitive. Whilst the market is more open, constraints are mostly being more cost effectively managed via BM actions. Savings are expected to remain very small in 2024 and work is ongoing by the project to learn how to grow volume and unlock value.

The first Balancing Reserve (BR) auction for day ahead capacity ran successfully on our Enduring Auction Capability (EAC) platform, also utilising the capabilities of our Single Markets Platform (SMP). The Balancing Reserve service enables us to move to day-ahead procurement of the energy reserves we need and respond to system demand in real time, rather than the current on-the-day system. This allows us to reduce the cost of procuring energy reserves and improves system security.

The ESO are making a number of changes in the Balancing Mechanism which are designed to increase participation of DSF assets. The first stage of the Open Balancing Platform went live in December 2023, and is designed to support the bulk dispatch of battery storage and small Balancing Mechanism units. After a Power Responsive Small Asset Trial in June 2023, the ESO is removing barriers to entry in the BM for 300 MW of aggregated assets, allowing technologies such as EV-chargers and electric heating systems to participate.

3.14 Distribution Network Operators

In 2023, Distribution Network Operators (DNOs) entered a new 5-year long RIIO price control framework (RIIO-ED2), which governs the priorities and incentives for all six GB DNOs (Scottish & Southern Energy Networks, Scottish Power Energy Networks, Northern Power Grid, Electricity North West, National Grid Electricity Distribution, UK Power Networks). DNOs have been required to submit a DSO (Distribution System Operator) strategy as part of their business plan submission to ensure that they continue to evolve into smart and flexible DNOs, with financial incentives based on annual performance assessments.

The Energy Networks Association (ENA) acts as a trade body for the energy networks in the UK, and has been particularly active in promoting DNO flexibility schemes through the Open Networks scheme, which continued through 2023 with a focus on increasing participation and volume in local flexibility markets. Nevertheless, the ENAs annual figures on DNO flexibility showed that the growth in contracted flexibility services flatlined between 2021-22 to 2022-23. There was also great disparity in volumes between the different DNOs, with both UKPN and NGED contracting over 1/3 of the total volume of contracted flexibility each (in terms of MW), and NPG and ENWL both contracting only a fraction of a % of the total volume.

The other big issue for new flexible assets is connections, and the ENA have announced a three-step plan to try and free up capacity and speed up construction of new assets:

1) Reforming the distribution network connections queue, promoting mature projects that are closer to delivery above those that may be ‘blocking’ the queue.

2) Changing how transmission and distribution networks coordinate connections, improving their interactivity.

3) Greater flexibility for storage customers through new contractual options, including phased connections and using intertrips and active network management (ANM) schemes to speed up grid connection dates

The biggest change for all new connections once connected will be the widespread use of intertrips and ANM schemes to balance out the systems. Flexible assets will potentially benefit from this, as they can accommodate and potentially alleviate the uncertainty that these systems provide for others.

3.2 Technologies and providers

Smart-meter roll out update

2023 was the second year of a new 4-year smart-meter rollout obligation for energy suppliers, which will end in 2025. During this period the government sets targets for the number of new smart-meters to be installed by each supplier, and assesses the performance retrospectively, rewarding those that meet their targets.

The launch of the demand flexibility service last year has potentially added a new reason for domestic customers to want to get a smart electricity meter installed, but an impact is not visible in the installation numbers which have increased almost linearly since a quarterly installation peak in 2017, with 18.2m domestic electrical smart meters in operation at the end of Q3 2023. This corresponds to over 62% of the total domestic electricity meter stock, with now only 11 million non-smart meters in operation.

With the smart meter roll-out passing 10 years in total, there have been a number of technological developments and two domestic variants of the smart meter equipment technical specification (SMETS) over this period. SMETS only became the main smart-meter installation type for non-domestic installations in 2020. Any other meters with the capability of storing 30-minute data are termed “advanced meters”.

Half hourly metering update

Half-hour metering enables more granular wholesale electricity trading and since 2017 Elexon have worked with Ofgem on developing a targeted operating model for Market-wide Half Hourly Settlement (MHHS). In 2021, Ofgem empowered Elexon to programme manage the transition of GB’s retail electricity market to MHSS in October 2025.

MHHS will require four new services for electricity market suppliers and other stakeholders which will be delivered through Elexon’s online cloud platform, Elexon Kinnect:

- Load Shaping Service to create load shapes for suppliers and to allow for more accurate load forecasting;
- Market-wide Data Service (MDS) to aggregate non-smart supplies in an accurate way;
- Volume Allocation Services (VAS), which will replace the legacy Supplier Volume Allocation Agent by producing energy volume forecasts for individual Balancing Mechanism Units (BMUs) from the MDS;
- Industry Standing Data, which will be an enhanced automated version of the existing Market Domain Data and Line Loss Factor services.

Participation in the MHHS will require qualification from the regulator. This process has now been mapped out for all roles after consultation, and presented to suppliers and other stakeholder groups. Suppliers will have to be fully qualified by the MHHS programme milestone M14 (currently 16/03/2024) in order to be allowed to register new customers. Potential market participants have volunteered to take part in the System Integration Testing (SIT) phase, which was scheduled to take place between October 2023 and April 2025.

Distributed generation

Distributed generation (DG) is an electricity generating plant that is connected to a distribution network rather than to the GB transmission network. GB now has relatively large amounts of intermittent distributed generation. Large amounts of DG can present challenges, such as the volume of generation being unobservable and uncontrollable.

Distributed storage
Lithium-ion batteries still dominate the BESS market, with well-established manufacturing facilities and supply chains. The dominance of lithium-ion may be bolstered by the rapidly growing EV market, with EV's overwhelmingly using lithium-ion batteries powering electric motors for traction.

Outside of lithium-ion batteries, the roll out of alternative technologies is very limited and mostly involves long-duration energy storage (LDES). The GB market is a relatively small player in LDES (excluding around 3 GW of pumped hydro storage), with most LDES battery installations being commissioned in the Asia Pacific region. LDES solutions being explored in GB include flow batteries, mechanical storage, thermal storage, and hydrogen (or hydrogen derivatives).

Transmission-connected storage
Transmission connected storage feeds directly to the GB transmission network. As part of the ESO's connections five-point plan, it was announced in November 2023 that 10 GW of transmission connected battery projects representing 19 BESS projects will have their connection to the grid accelerated. On average, these 19 projects will be offered connection dates four years earlier than their current grid connection agreement, due to a new approach which reduces the need for certain engineering works prior to connection.

Domestic flexibility
Electrification of transport via electric vehicle (EV) use is growing rapidly, and their smart-charge and Vehicle-to-grid (V2G) potential is starting to come to fruition, both with innovation projects and day-to-day for householders on a growing scale. The parallel electrification of heat with heat pump use is starting to spread, allowing for smart use to make the most of flexible tariffs and DFS opportunities. Alongside domestic PV, batteries are increasingly being used in domestic settings, primarily to offer the household the ability to use their own distributed generation, but also to make the most of grid opportunities via flexible tariffs or aggregated flexibility services.

Limitations on smart energy product manufacturers application programming interfaces (APIs) continue to be a challenge for the delivery of domestic flexibility. However, government initiatives like the introduction of new regulations around smart energy appliances are aiming to address issues around integration and protection. The continued adoption of smart meters is also crucial for allowing households to participate in domestic flexibility.

4.0 Market metrics

4.1 Dynamic Containment

During 2023, volumes of the Dynamic Containment rapid frequency response service, which is procured to protect against sudden demand or generation loss, continued to increase. Dynamic Containment Low (DCL) auction clearing prices have stabilised after volatility in 2022, and apart from a number of spikes, prices of both Dynamic Containment High (DCH) and DCL were commonly below £10/MW/hr though 2023.

Service description

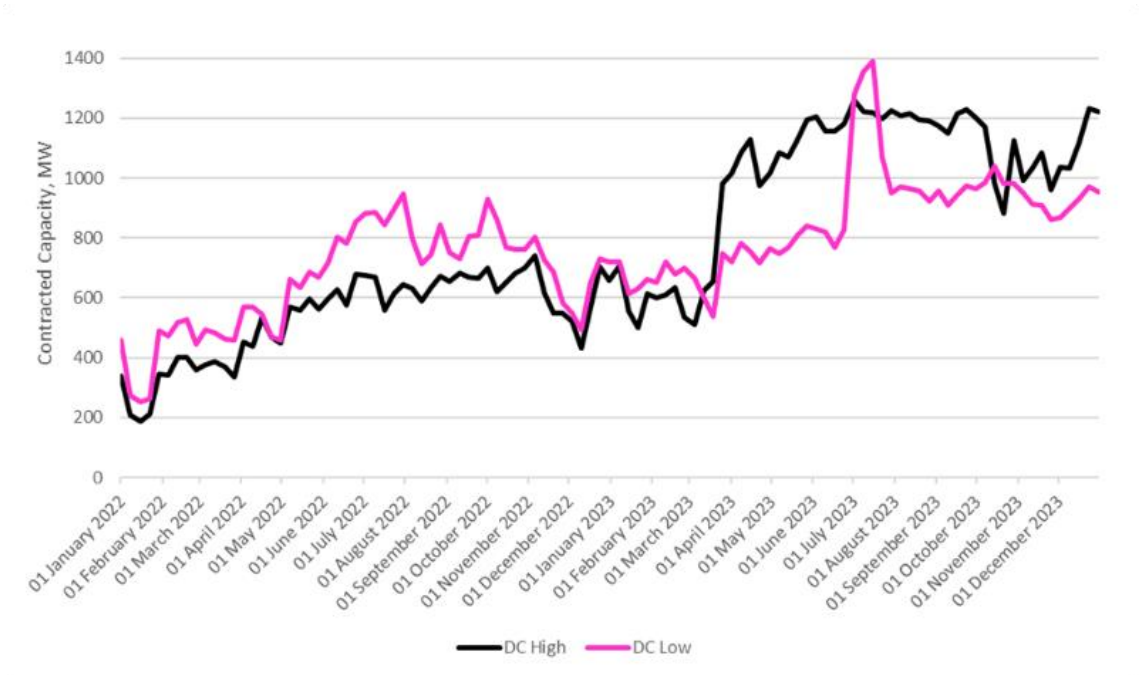
Dynamic Containment is a frequency response product designed to keep the transmission network within safe operating limits of frequency after a system fault. Key features of the service are:

- **Rapid frequency containment**: DC is rapid response service designed to maintain the nominal frequency of 50 Hz within operational limits of +0.5Hz/- 0.8Hz.
- **Quick speed of response**: The service requires full response in under one second, with output sustained for 15 minutes
- **Export and import**: DC is split into two services, one responding to high-frequency events (where there is more generation than demand) and the other to low-frequency events (when there is less generation than demand). The high-frequency service was introduced in November 2021. Both can be provided from the same asset.
- **High-resolution metering**: The service requires 20 Hz high-resolution metering capability.
- **Intra-day auctions**: Pay-as-clear auctions run each day for each Electricity Forward Agreement (EFA) block. There are six EFA blocks throughout the day, each lasting four hours in duration. Payment is based on an availability fee (£/MW/hr).

4.1.1 Volumes and technologies

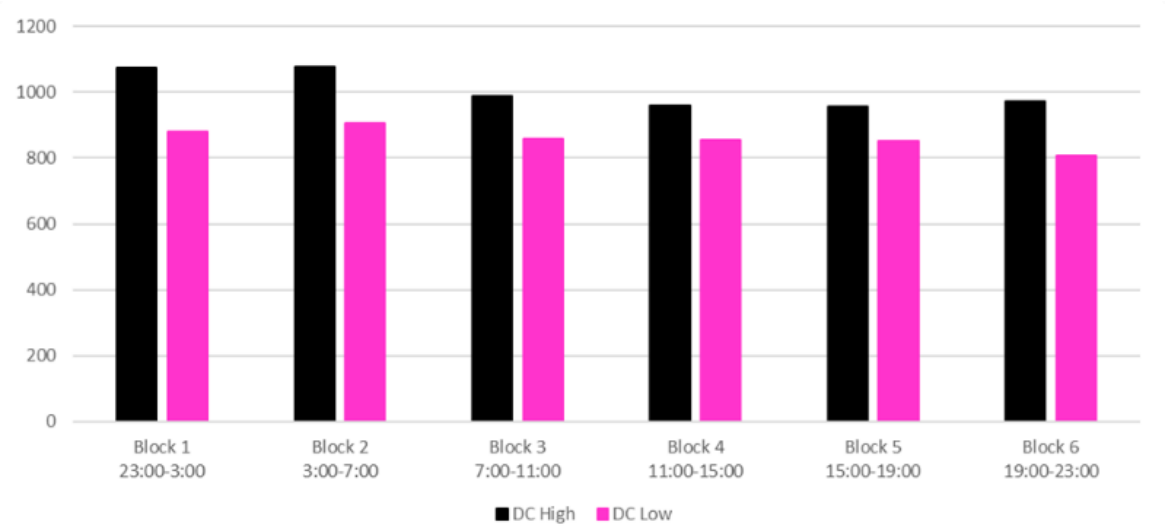
Over the course of 2023, daily volumes of DCH increased from around 600 MW (weekly average) to over 1200 MW in July. The biggest increase came in March, where contracted capacity almost doubled in the period of a month (see Figure 1), meaning the ESO procured more DCH than DCL, reversing the trend seen in 2022. Volumes of contracted DCL also increased from around 700 MW at the turn of the year, to reach nearly 1000 MW by the end of 2023.This was driven by an increase in the requirement from the ESO. One noticeable spike in DCL volumes was seen in July, when contracted volumes reached nearly 1400 MW – which was required to cover oscillations.

Figure 1 - DC Weekly average contracted capacity of DCH and DCL, MW



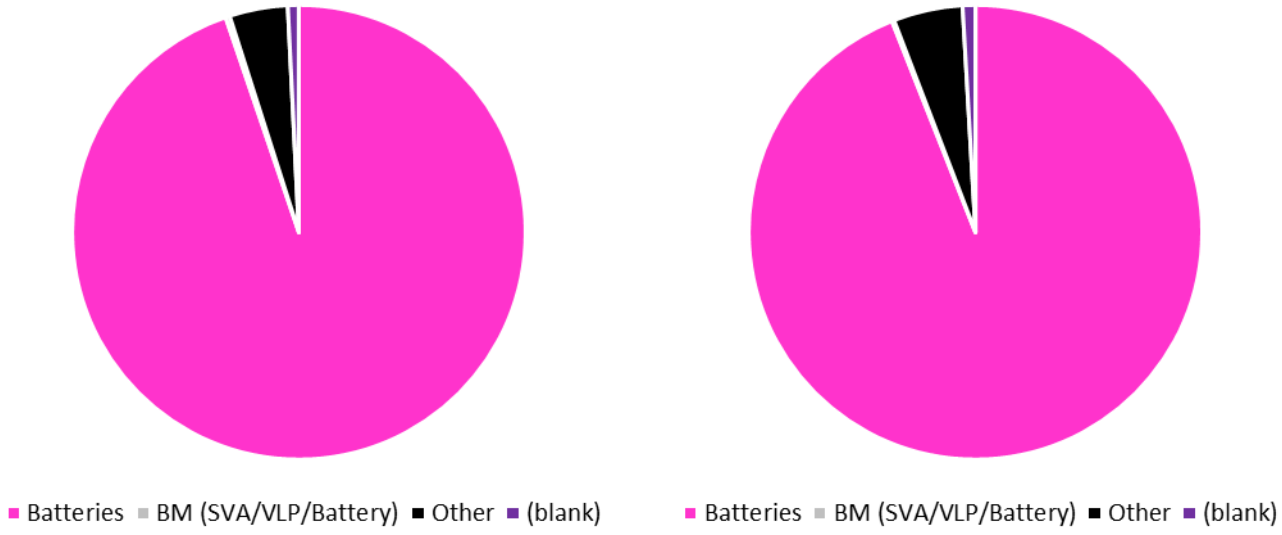
The ESO contracts for DCH and DCL capacity in 4-hour EFA blocks. As was seen in 2022, slightly higher volumes of contracted capacity were seen overnight and into the morning (EFA blocks 1, 2 and 3). Although common across DCH and DCL, the trend is slightly more prominent in DCH (see Figure 2)

Figure 2- Average contracted capacity of DCL and DCH per EFA block, 1/1/2023 to 31/12/2023, MW



Since the EAC began in November 2023, the ESO has recorded the technology type of assets contracted to deliver DC services through the EAC. As shown in Figure 3, batteries made up 95% (DCH) and 94% (DCL) of executed quantities from when the EAC began in November 2023 to the end of 2023. For both DCH and DCL the remaining 4-5% of executed quantities was comprised of 'other', and less than 1% comprised of BM (SVA/VLP/Battery) or 'blank' where the technology type was not recorded.

Figure 3- Breakdown of 'technology type' for 'executed quantities' (MW) of DCH (left) and DCL (right) between 4/11/2023 to 31/12/2023

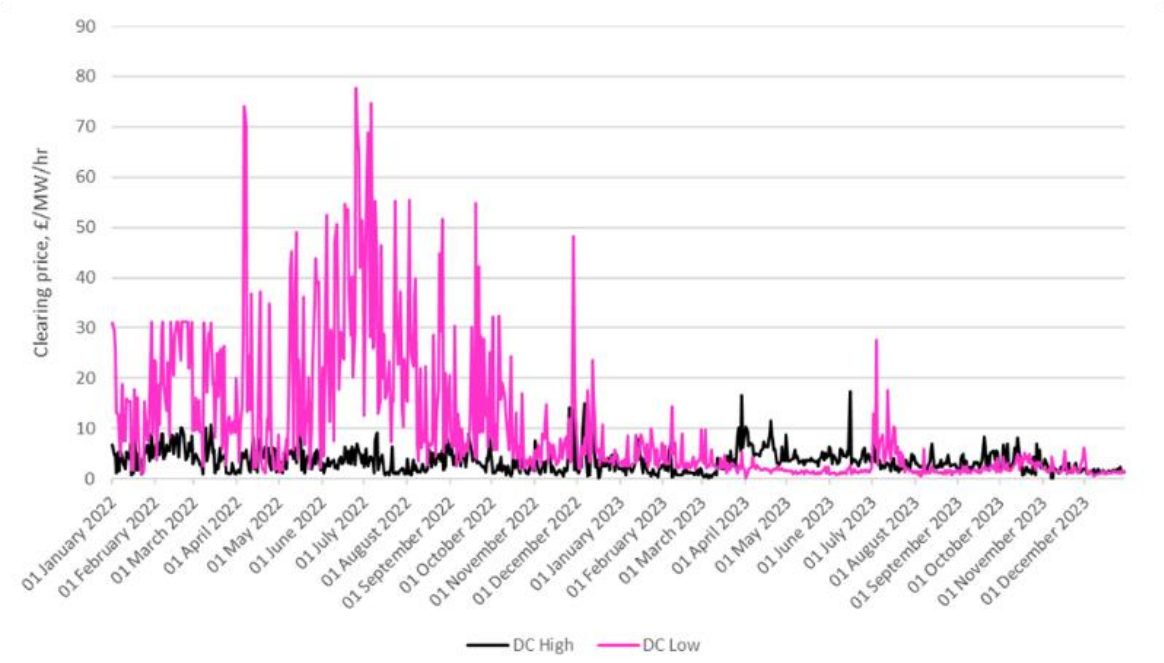


4.1.1 Prices

2023 saw a significant drop in DCL auction clearing prices compared to 2022, while DCH prices remained more stable (see Figure 4). Daily average DCL prices in July 2022 reached over £70/MW/hr but in 2023 the highest daily average price was £28/MW/hr (on 4th of July), and average prices consistently sat below £10/MW/hr for the most of 2023. Average DCH prices also sat below £10/MW/hr for much of the year, but this was a similar trend seen in 2022.

Although the introduction of the Enduring Auction Capability (EAC) allowed for negative prices in the DCH market, a negative average daily clearing price was only seen on one day (7th November 2023) at £-1.48/MW/hr. While it appears that the introduction of the EAC has reduced clearing prices for both services, data gathered over a longer period is needed to confidently establish a trend.

Figure 4- Daily average auction clearing price of DCH and DCL, £/MW/hr



4.2 Dynamic Moderation

Dynamic Moderation went live in May 2022 as a service to help manage sudden large imbalances between supply and demand on the transmission system. In 2023, contracted volumes of Dynamic Moderation High (DMH) and Dynamic Moderation Low (DML) continued to increase. Auction clearing prices for DMH reduced from 2022 and occasionally went negative in November and December 2023. Although volatile, DML prices through 2023 remained similar to 2022.

Service Description

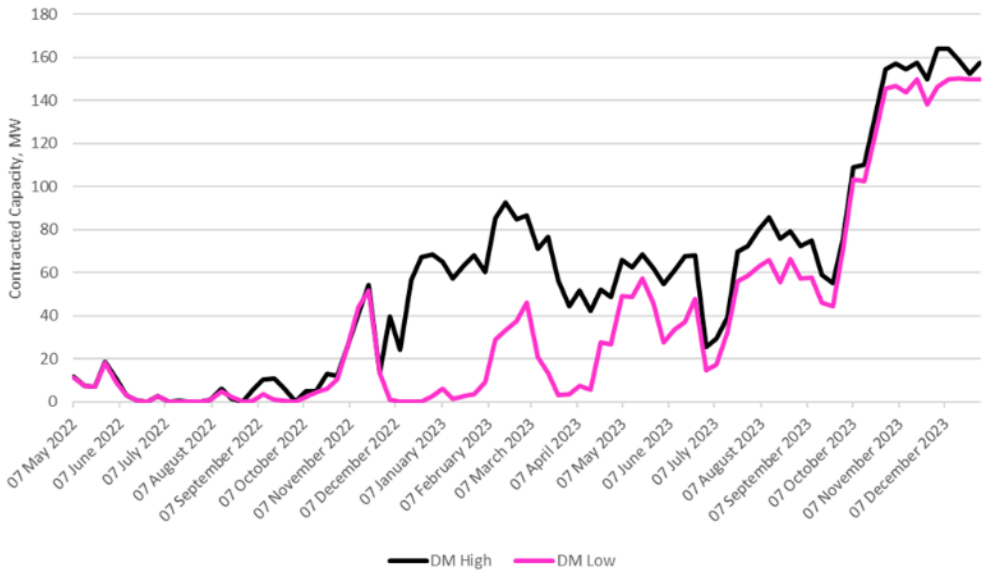
Dynamic Moderation is a pre-fault service designed to keep the frequency within the operational limits. DC, DM and DR can be stacked with the BM. The key features are:

- **Delivery range:** +/- 0.015 - 0.2 Hz with a 5% output +/- 0.1Hz (knee point) and a linear increase to 100% output at +/- 0.2 Hz
- **Speed of response:** The service requires full response in under 1 second, with output sustained for 30 minutes
- **Export and import:** DM is split into two services, one responding to high-frequency events (where there is more generation than demand) and the other to low-frequency events (when there is less generation than demand). The high-frequency service was introduced in April 2022. Both can be provided from the same asset. There is a unit cap of 50 MW per asset**.**
- **Performance metering:** the metering frequency for DM is 20Hz.
- **Intra-day auctions:** Pay-as-clear auctions run each day for each EFA block. There are six EFA blocks throughout the day, each lasting four hours in duration. Payment is based on an availability fee (£/MW/hr).

4.2.1 Volumes

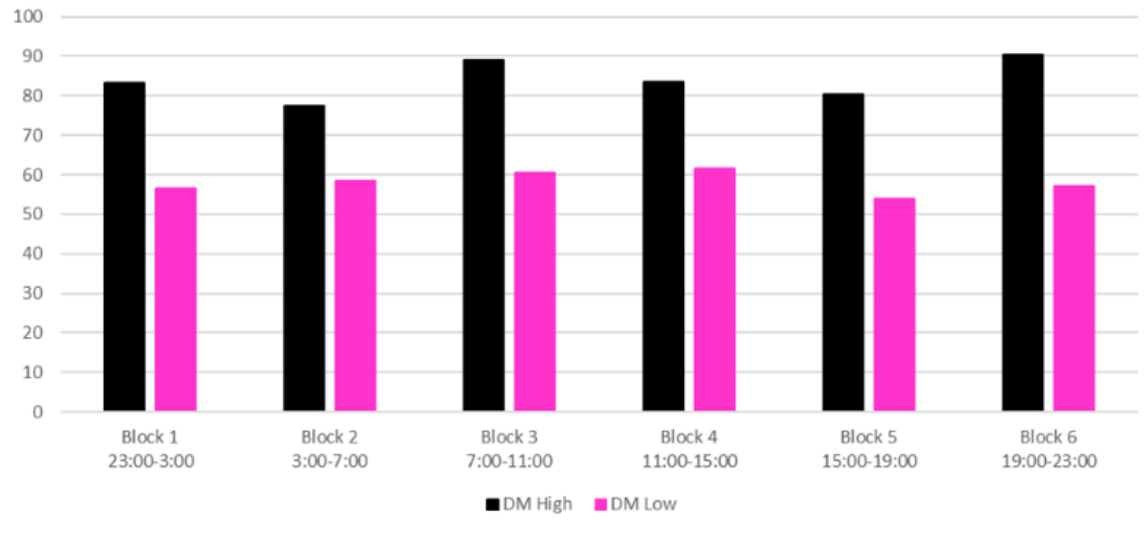
2023 saw volumes of DMH and DML increase compared to 2022, with a notable jump observed in October 2023, where volumes more than doubled from around 60 MW to over 150 MW for both services (See Figure 5). Apart from a period in December 2022 and January 2023, where DML volumes remained very low, the volumes of both services roughly track each other.

Figure 5 - DM Weekly average contracted capacity of DMH and DML, MW



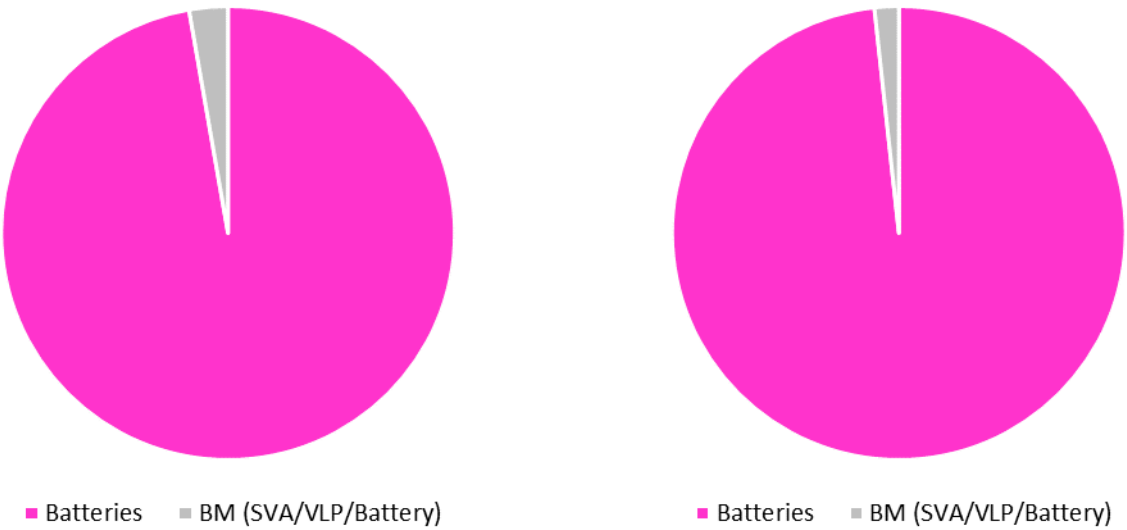
As shown in Figure 6, the highest contracted volumes for DMH were in blocks 1, 3, 4 and 6, with the midday peak being less prominent than observed in 2022. The reduction in variation across EFA blocks is due to requirements, which are the same across each EFA block for DM, being more consistently met in 2023 than in the previous year. The highest contracted volumes for DML were across the middle of the day in blocks 3 and 4.

Figure 6 - Average contracted capacity of DMH and DML per EFA block, 1/1/2023 to 31/12/2023, MW



Since the EAC began in November 2023, the ESO has recorded the technology type of assets contracted to deliver DM services through the EAC. As shown in Figure 7, batteries made up 97% (DCH) and 98% (DCL) of executed quantities from when the EAC began in November 2023 to the end of 2023. For DMH and DML the remaining 3% and 2% of executed quantities respectively, was comprised of BM (SVA/VLP/Battery).

Figure 7- Breakdown of 'technology type' for 'executed quantities' (MW) of DMH (left) and DML (right) between 4/11/2023 to 31/12/2023

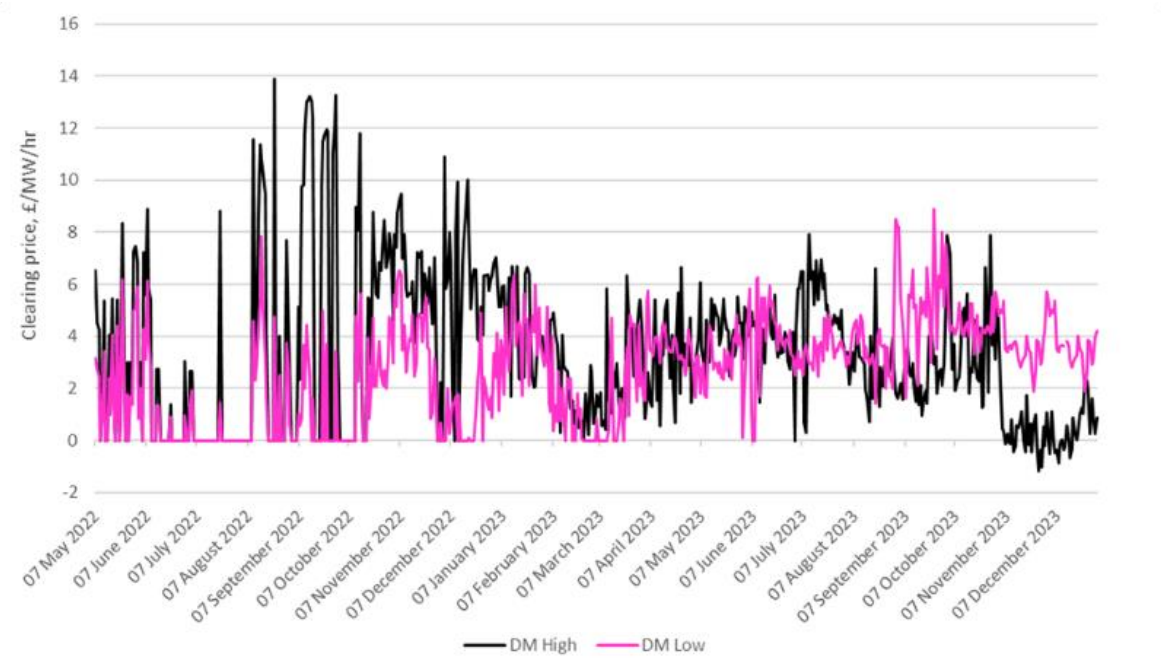


4.2.2 Prices

In 2023, average auction clearing prices for DMH reduced from the £14/MW/hr occasionally seen in 2022 to peaks of £8/MW/hr and more stable values of around £4/MW/hr from April to November 2023 (See Figure 8). The introduction of the EAC in early November 2023 is clearly visible in the DMH data, where auction clearing prices drop significantly and are often negative with a low of £-1.16/MW/hr (on the 26th of November).

DML prices in 2023 peaked just below £9/MW/hr (on 24th September 2023) and were typically around £4/MW/hr for the majority of 2023. An exception to this was at the end of February and in the first half of March, when clearing prices were commonly zero - meaning providers did not receive payment for service delivery in those periods.

Figure 8 - Daily average auction clearing price of DMH and DML, £/MW/hr



4.3 Dynamic Regulation

Launched in April 2022, Dynamic Regulation is a pre-fault service designed to slowly correct small imbalances in supply and demand, effectively regulating frequency to the target 50 Hz. Through 2023, contracted volumes of Dynamic Regulation High (DRH) and Dynamic Regulation Low (DRL) significantly increased with both services tripling contracted volumes across 2023. To counteract the phase out of Dynamic Firm Frequency Response (dFFR), increasing volumes of DR were procured from July 2023, which explains the increases observed. Volatility in daily average auction clearing prices reduced significantly compared to 2022, with reductions seen across both services. Clearing prices for DRL remained higher than those for DRH, with negative DRH clearing prices commonly seen since the launch of the EAC in early November.

Service Description

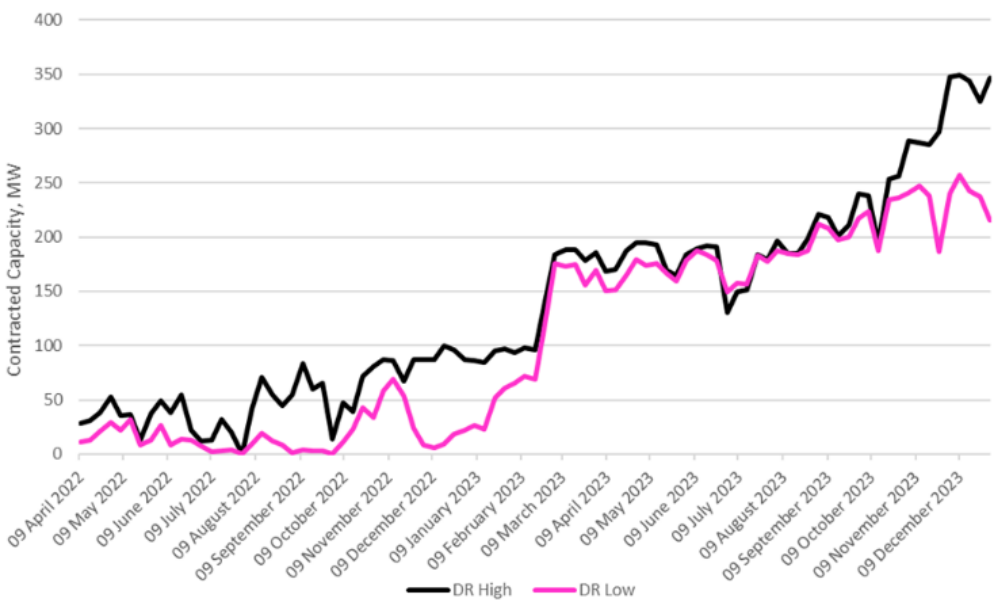
Dynamic Regulation is a pre-fault service designed to keep the frequency within the operational limits. DC, DM and DR can be stacked with the BM. The key features are:

- **Delivery range:** +/- 0.015 - 0.2 Hz with a linear range of 100% at +/- 0.2 Hz
- **Speed of response:** The service requires full response in under 10 seconds, with the output sustained for 60 minutes
- **Export and import:** DR is split into two services, one responding to high-frequency events and the other to low-frequency events. The high-frequency service was introduced in April 2022. Both can be provided from the same asset. There is a unit cap of 50 MW per asset**.**
- **Performance metering:** Metering frequency for DR is 2Hz, there was a transition phase, allowing 1Hz for the first 6 months.
- **Intra-day auctions:** Pay-as-clear auctions run each day for each EFA block. There are six EFA blocks throughout the day, each lasting four hours in duration. Payment is based on an availability fee (£/MW/hr).

4.3.1 Volumes and technologies

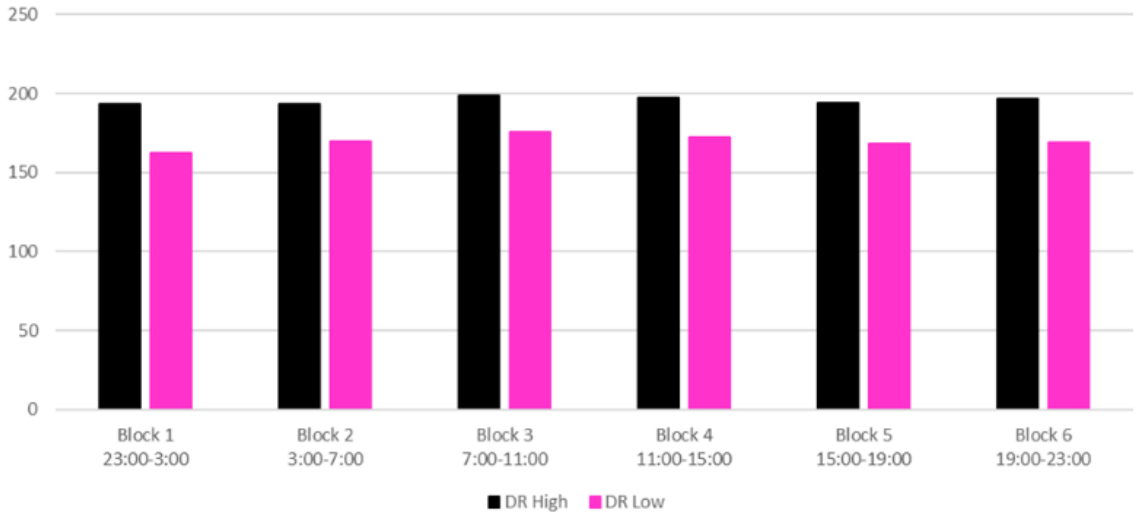
Volumes of DRH and DRL increased consistently throughout 2023, with DRH increasing from around 100 MW contracted capacity at the start of 2023, to over 300 MW by the end of the year (see Figure 9). The contracted capacity of DRL increased tenfold from around 20 MW at the start of 2023, to over 200 MW by the end of the year. This was driven by the ESO gradually increasing the DR cap through 2023 as Dynamic Fast Frequency Response was phased out. Where 2022 saw several points where no capacity was contracted, this was not evident in 2023.

Figure 9 - Weekly average contracted capacity of DRH and DRL, MW



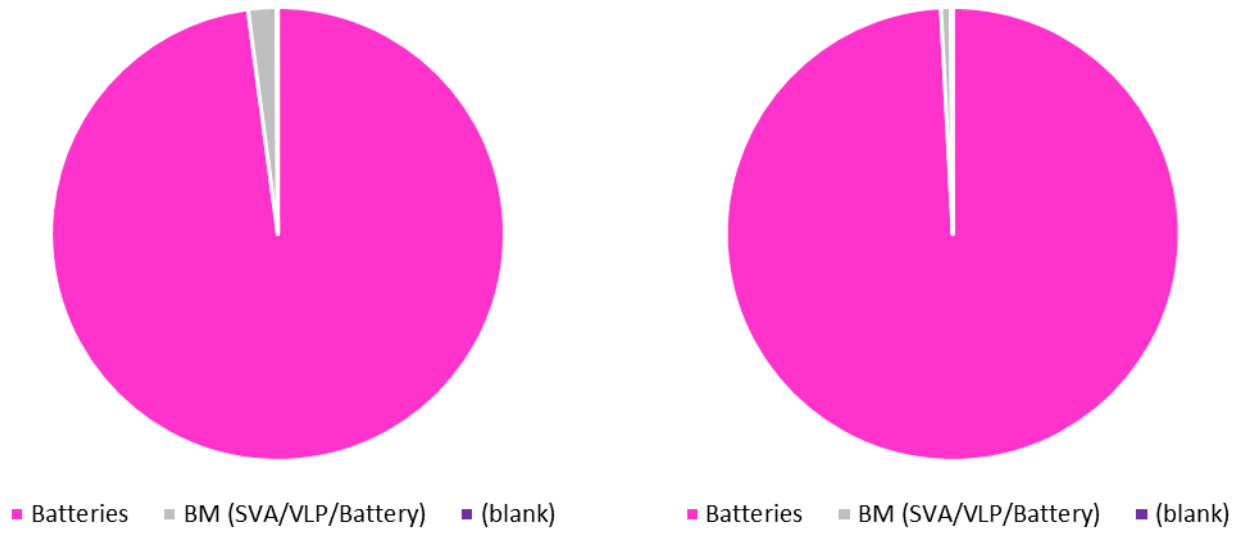
As shown in Figure 10 below, the contracted volumes for both DRH and DRL are relatively consistent across the 6 different EFA blocks, with no obvious trends. Across all EFA blocks DRH consistently contracted higher volumes than DRL.

Figure 10 - Average contracted capacity of DRH and DRL per EFA block, 1/1/2023 to 31/12/2023, MW



Since the EAC began in November 2023, the ESO has recorded the technology type of assets contracted to deliver DR services through the EAC. As shown in Figure 11, batteries made up 98% (DRH) and 99% (DRL) of executed quantities from when the EAC began in November 2023 to the end of 2023. For DRH, the asset class 'BM (SVA/VLP/Battery)' comprised 2% of executed quantities and under 1% for DRL. For both DRH and DRL the technology type of the remaining quantities (<1%) was not recorded (blank).

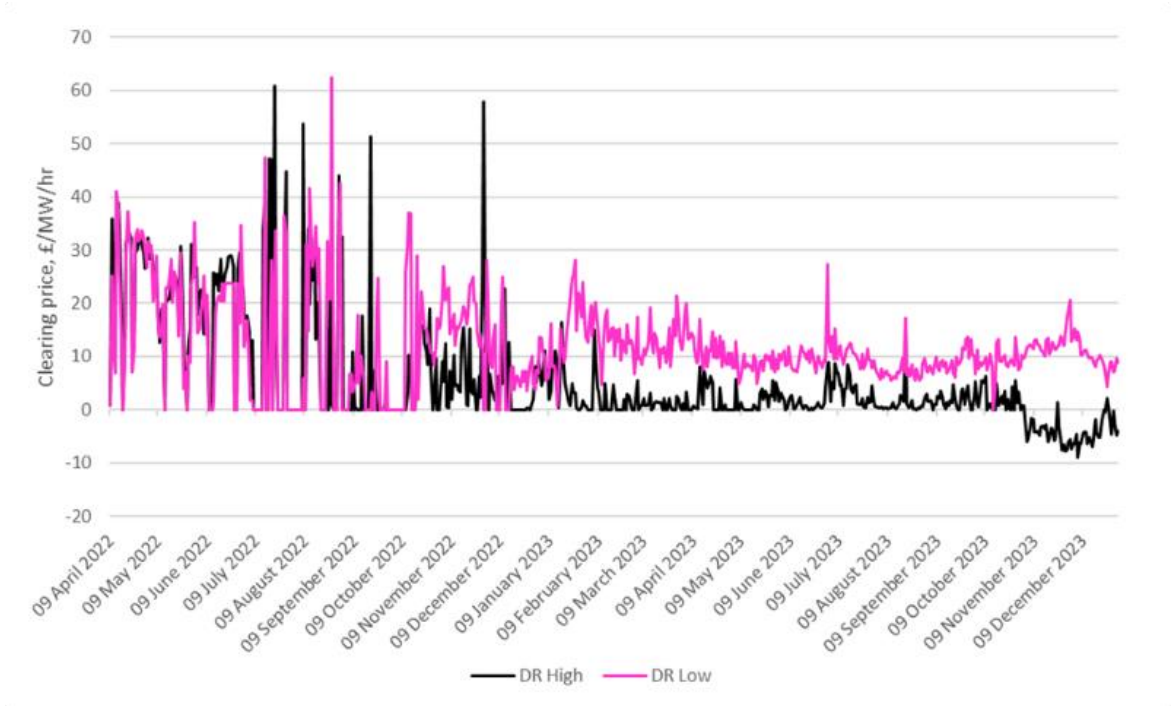
Figure 11 - Breakdown of 'technology type' for 'executed quantities' (MW) of DRH (left) and DRL (right) between 4/11/2023 to 31/12/2023



4.3.2 Prices

In 2022, DRH and DRL prices were relatively strongly correlated. In 2023, daily average clearing prices for DRL were consistently higher than those for DRH (see Figure 12). DRH prices peaked in January at £17/MW/hr but averaged just over £1/MW/hr across the year. In 2023, DRL prices saw a peak of £27/MW/hr in July and averaged just over £10/MW/hr across the year. Notably, from the 3rd of November 2023, when the EAC was introduced, DRH prices became negative on most days, with a low of £-9/MW/hr seen on the 9th of December. DRL prices were the highest of all the Dynamic Response Services.

Figure 12 - Daily average auction clearing price of DRH and DRL, £/MW/hr



4.4 Firm frequency response

Of all the frequency response markets, the biggest changes in 2023 were made to Firm Frequency Response (FFR). Static FFR (sFFR) moved to day-ahead procurement in April (from month-ahead), and the managed phase out of Dynamic FFR (dFFR) finally concluded, with November 2023 being the final delivery month. Availability fees for dFFR reduced, as might be expected as the service was phased out, while availability fees for sFFR remained stable.

Service Description

FFR is a frequency response product designed to be adaptable to providers with different capabilities. Multiple different forms of the service exist with different procurement routes. FFR's key features include:

- **Quick response, short duration:** FFR is a frequency response service that requires a quick response (between 10 and 30 seconds) and short duration (20 seconds to 30 minutes).
- **Monthly tenders:** The monthly tenders award contracts based on price and alignment to ESO requirements. Successful providers are paid on an availability basis. Monthly procurement of Dynamic FFR continued until the final tender in October 2023 for delivery in November 2023.
- **Day ahead:** In April 2023 the procurement of Static FFR moved to a day-ahead auction.

4.4.1 Volumes and technologies

Volumes of accepted capacity for dFFR reduced significantly in 2023, with the ESO reducing the volume cap from July, which saw monthly volumes reduce to 138 MW in November when the market closed (see Figure 13).

sFFR volumes, now reported in a different format, and hence shown separately in Figure 14, remained stable since the launch of the day-ahead procurement and monthly volumes averaged 1400MW. From April 2023, the sFFR service was dominated by 'diesel' and 'load response', which both had a similar share, and batteries making up a very small proportion of the market.

In dFFR, 'DSF Storage' dominated the market, with a significant reduction in 'DSF Load Response' in comparison to 2022. Batteries continued to contribute to the dFFR market, with almost 20% market share of accepted contracts in 2023.

Figure 13 – Dynamic and static FFR capacity, monthly market, by technology, MW

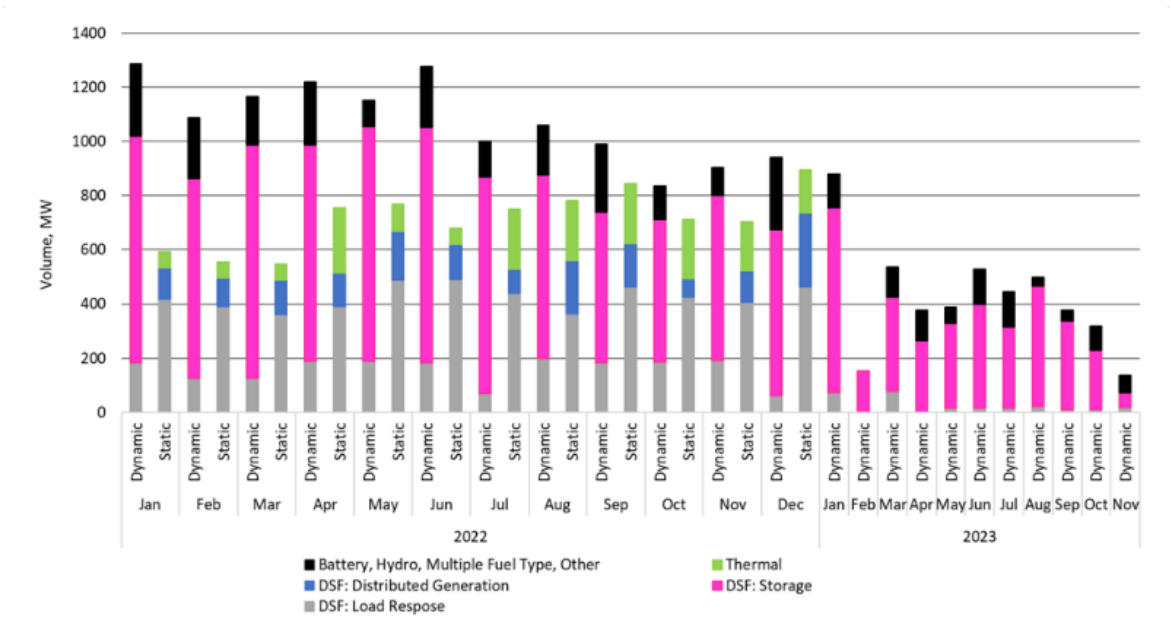
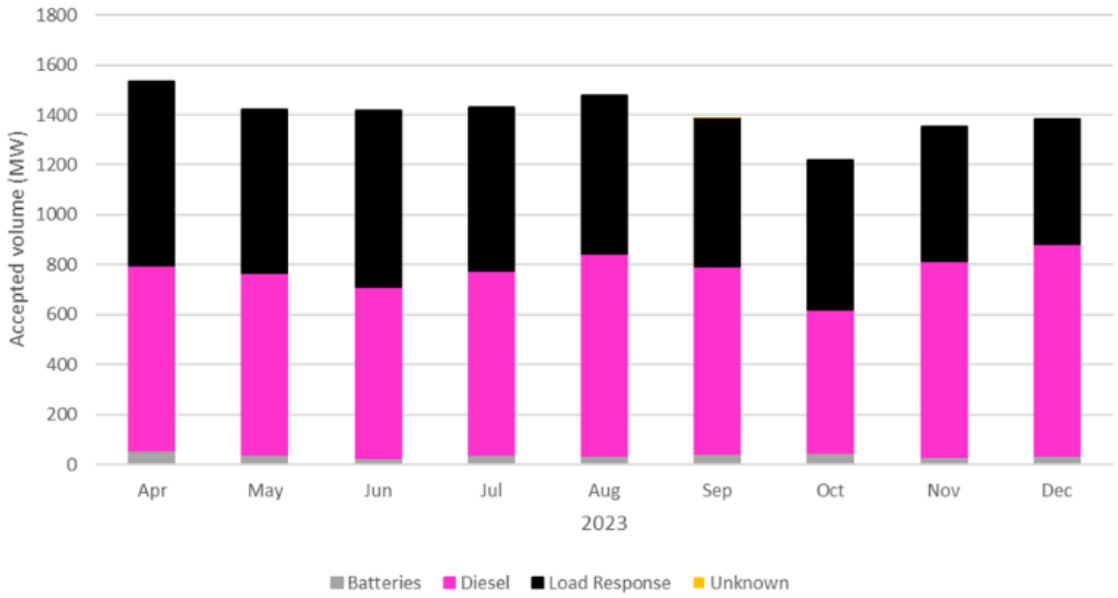


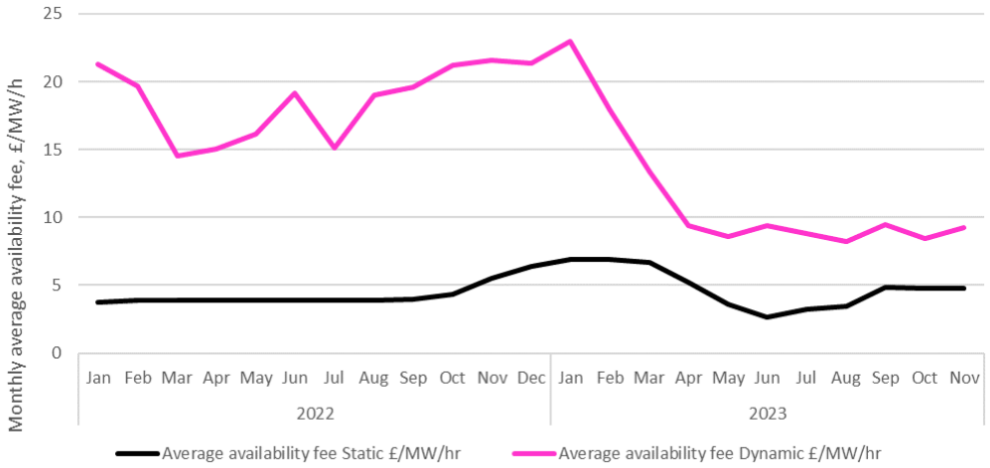
Figure 14 – Static FFR daily average approved volume, by technology, by month, MW



4.4.2 Prices

In 2023, prices for dFFR reduced significantly from a peak of £23/MW/h in January 2023 to under £10/MW/hr in November, the last delivery month of the service (see Figure 15). Prices for sFFR were largely stable at around £5/MW/hr. Although sFFR moved to day-ahead procurement (from monthly) in April 2023, it did not appear to have a significant impact on the availability fees secured.

Figure 15 - Monthly average dynamic and static FFR availability fees for accepted tenders, £/MW/h



4.5 Demand Flexibility Service

The ESO's Demand Flexibility Service 2.0 launched on the 30th of October 2023 and ran until the 31st of March 2024. It introduced two new within-day windows as well as day-ahead test notifications, to ask consumer households and businesses to change their electricity usages at shorter notice than last year. Test events were used to build confidence amongst service providers and the ESO ahead of live events.

By the end of March 2024, 3.6GWh of energy demand had been delivered. Until the event on the 2nd of February, all service providers delivering demand reduction in test events received £3,000/MWh. After that date, the procurement mechanism was altered to remove the guaranteed acceptance price of £3000/MWh to allow for a competitive bidding process – subject to a volume threshold being met. By the end of March 2024, 14 test events and 2 live events had been delivered. A peak of over 400 MW of demand reduction was settled (per settlement period) on the 17th of January 2024, which was significantly above the peaks of 300MW seen in the previous year and was delivered by a mix of 2.6 million domestic, industrial and commercial participants.

Service Description

DFS is a demand reduction service provided by registered suppliers or aggregators. A notification that the service might be required is provided on the day or one day ahead to registered participants, who then have the opportunity to place a bid specifying the demand reduction they can deliver and their price for each 30-minute block. Key features are as follows:

- **Registered providers must aggregate to bid in integer units of between 1 and 100 MW.** The aggregated assets cannot participate in other ancillary or DNO services, including the Capacity Market.
- **All assets require half-hourly metering.** This means that domestic smart-meters are ideal assets to be aggregated.
- **Response must last for the whole block that is bid.** The registered provider must provide the half-hourly data to evidence the demand reduction within two weeks of the event.
- **Tender submissions are Pay-as-bid.** After the initial day-ahead bid, once accepted the registered provider must contact assets to confirm participation before making a final in-day volume update
- **The current service runs until March 2024.** On-boarding test events are being run throughout the period with a Guaranteed Acceptance Price to encourage participation.

4.5.1 Volumes and prices

Live events were on 29th November 2023 and 1st December 2023. All other events noted in Figure 16 below were Test Events. The largest volumes of required demand reduction were during the live tests, where the ESO published a requirement of 550 MW per 30-minute settlement period on that day. The lowest volume of required demand reduction was 50 MW on the 1st of March. Until January 2024, the volumes of procured demand reduction were in most cases significantly lower than what was initially noted as required by the ESO. This reflects the ESO's way of ensuring that there is always enough service provision. The volumes of settled energy demand are in most cases even lower again, highlighting that some service providers did not deliver what they had signed up to, and therefore were not paid. From February, volumes bid were significantly higher than volumes required, procured and settled. Of the 16 live and test events described here, four had three 30-minute settlement periods, eight had two settlement periods and four had 1 settlement period.
The lowest bid received during this competitive test events was £150/MWh and averaged at £1,110.90/MWh. Across the 2 days of live events, 224 bids were accepted across the different service providers and 30-minute settlement periods. Accepted bids for live events ranged from £3,000/MWh to £6,000/MWh, with an average of £4,153/MWh.

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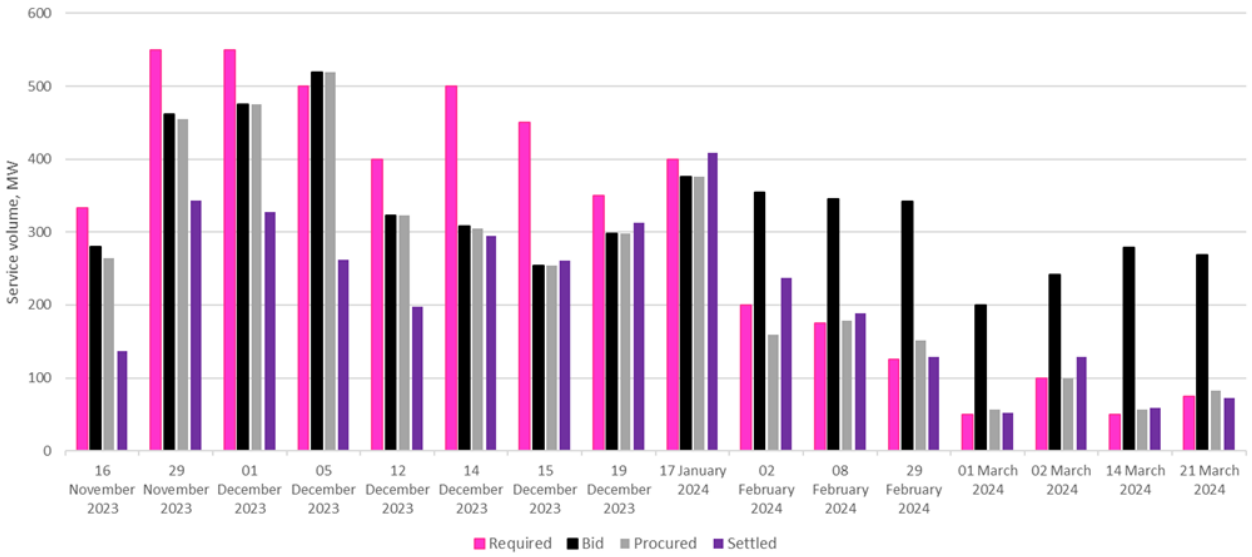
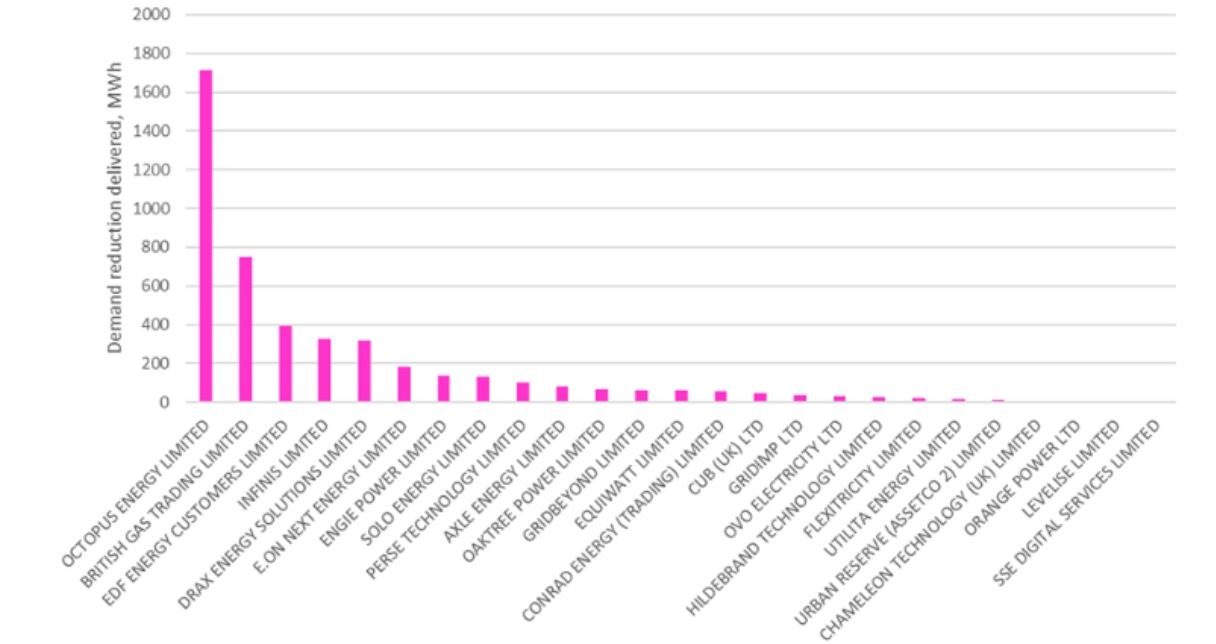
Figure 16 - DFS required, bid, procured, settled, MW per Settlement Period (2023-24 events)



5.3 Providers

DFS service providers are primarily domestic and industrial/commercial energy suppliers who deliver demand reduction by incentivizing (or directly acting) to reduce their customer's demand during service windows. In 2023/24 there were a total of 25 service providers, but delivery was dominated by a small number of suppliers who delivered a significant proportion of the demand reduction across the service (see Figure 17). Like in last year's DFS, Octopus Energy delivered the largest volume at just over 1.7 GWh across the 16 events. This was followed by British Gas with 749 MWh and EDF at 394 MWh. Infinis, Drax, EON and Engie were next, with 330 MWh, 320 MWh, 184 MWh and 138 MWh respectively. 18 other providers contributed the remaining 766 MWh of demand reduction delivered.

Figure 17 - Demand reduction delivered, by provider, MWh



4.6 Short Term Operating Reserve

The day-ahead version of Short Term Operating Reserve (STOR) continued to offer up contracts to over 1 GW of mostly thermal generation each month of 2022. A spike in the auction clearing price in December and a general upward trend over the year have benefitted providers; however, new reserve services announced by the ESO may disrupt the STOR market when they go live.

Service Description

STOR is used by the system operator to manage inaccuracies in forecasting generation and demand. STOR is a post fault service and providers deliver additional electricity or increase their demand to help balance overall supply and demand.

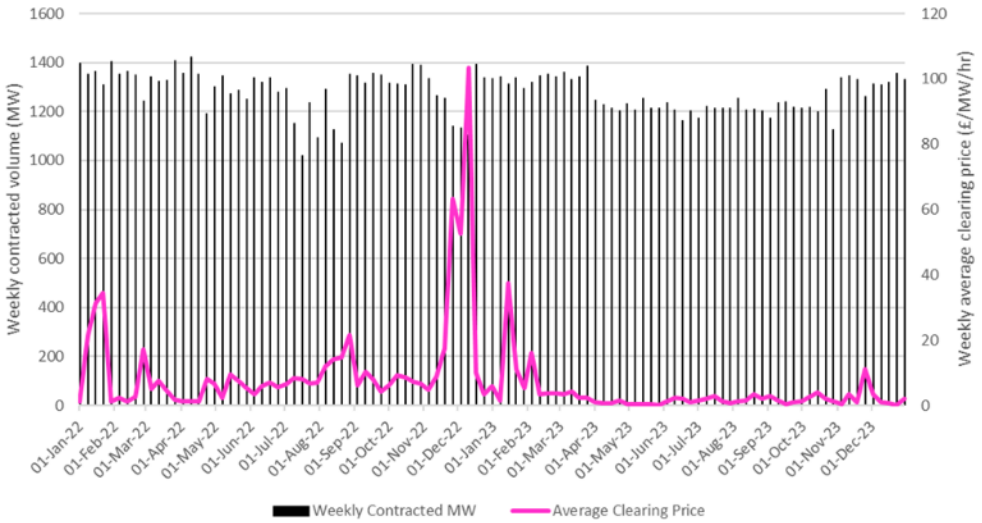
- **Slow response, long duration:** STOR requires a slower response (within 20 minutes) and longer duration (a minimum of 2 hours) than frequency response services.
- **Capability to recover and respond again:** Participating assets must be able to respond for a second time after their initial response, with recovery within 20 hours.
- **Prequalification is mandatory:** All prospective providers must prequalify ahead of an auction by showing compliance with the Platform for Ancillary Services or by being active in the Balancing Mechanism.
- **Day-ahead tenders:** STOR procures capacity for the day-ahead through pay-as-clear auctions.
- **Larger volume requirement:** STOR units must be able to deliver at least 3 MW of generation or steady demand reduction. This can be aggregated from more than one site.
- **Stackability:** Outside of STOR contracted availability windows other services can be provided, as long as ability to deliver STOR is not affected. It is not possible to provide other services at the same time as providing STOR.

4.6.1 Volumes and prices

The day-ahead STOR market continued to procure over 1 GW of reserve services throughout 2023, at similar volumes to those seen in 2022 (see Figure 18). Daily average contracted volumes were relatively consistent through the year and were generally above 1300 MW from January 2023 to March 2023, before falling to nearer 1200 MW until the end of October when volumes increased again to nearer 1300 MW in line with the published procurement requirement.

STOR clearing prices in 2023 were lower and more stable than those seen in 2022. 2023 prices spiked in January 2023 when the weekly average clearing price peaked at £38/MW/hr. This compares to a spike of £103/MW/hr in December 2022. Throughout the majority of 2023 clearing prices were below £5/MW/hr and averaged at £3/MW/hr for the whole of 2023. This compares to an average clearing price of £11/MW/hr in 2022. This trend signals that the value of the STOR market for providers has reduced back to levels more typically seen pre-2022.

Figure 18 - STOR weekly average of contracted volume per day and Weekly Average Clearing price, MW and £/MW/hr

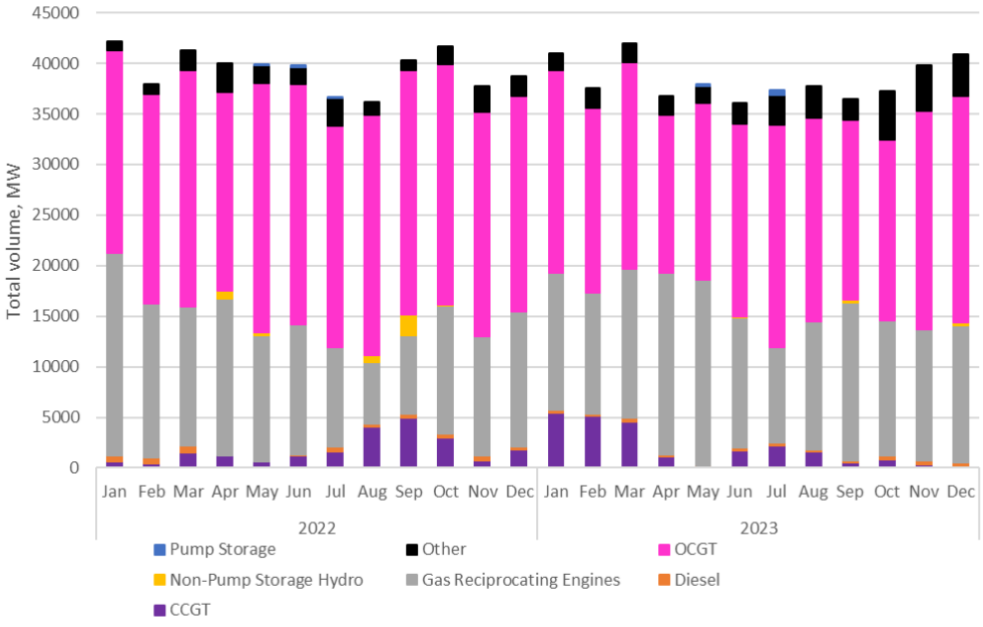


4.6.2 Technologies

In 2023, the STOR market continued to be dominated by thermal forms of generation (see Figure 19). Gas Reciprocating Engines and Open Cycle Gas Turbines (OCGT) continued to be the two most prevalent technology types, again delivering over 30 GW per month between them. Diesel generation also retained the same share of the market as seen in 2022. Pumped Storage entered the market in only 2 months of the year in 2023. Volumes of Combined Cycle Gas Turbine (CCGT) were more volatile, with higher volumes seen in the first three months of 2023 (peaking at 5445 MW in January) before falling again to only 48 MW in May and then staying below 2500 MW for the rest of 2023.

As in 2022, most non-thermal DSF assets fall into the 'Other' category of STOR technologies, alongside some other non-DSF assets. In 2023, contracted volumes of this 'Other' asset type increased, and in the last 3 months of 2023 topped 4000 MW.

Figure 19 - STOR total contracted volume per month by technology type, MW



4.7 DSO Services

The total volume of flexibility services procured directly by GB Distribution Network Operators in 2023 was the same as in 2022. This was despite DNOs tendering for a record volume. This shows that while the DNOs have more ambition to deliver flexibility services, the volumes delivered remained the same, likely due to constraints on the volumes offered by service providers. Although aggregated contracted volumes remained static in 2023, DSO services remain an attractive option for DSF providers located in the parts of the Distribution Network where services are available. In some areas, the DNO tendered for an uncapped volume of flexibility across Secure, Dynamic and Restore services

Service Description

DSO services are procured by the six Distribution Network Operators that operate in GB. They are designed to manage the particular challenges faced by the lower voltage networks and are necessarily locational – procuring services in certain areas of the grid where they are most needed. A range of different types of service come under the banner of DSO services.

- **Partially standardised services:** The Open Networks project have defined four primary service types, each with a 100 kW minimum threshold. Uptake of the standard service forms is growing, but is not universal, and many competitions are for services that do not follow the standardised service definition exactly. The four Open Networks service types are:
  - **Sustain**: a scheduled constraint management service (usually requiring a 30-minute minimum duration)
  - **Secure**: a closer to real time constraint management service (usually requiring a 30-minute minimum duration)
  - **Dynamic**: a post-fault service (usually requiring a 30-minute minimum duration)
  - **Restore**: a service to help restore the network to normal operation after a fault (usually requiring a 3-hour minimum duration)
- **Location is key:** DSO services are locational, meaning only assets in a given geographic area (and therefore connected to a specific part of the network) can deliver services.
- **Centralised procurement**: Procurement is coordinated across the Piclo Flex and Flexible Power platforms, which communicate the timing, location and technical details of upcoming tenders, as well as providing DSF asset operators with the information they need to bid for services.
- **Differences between procedures remain**: The procurement process differs slightly between DNOs, but generally follows a process of qualification, testing and delivery, only including a competitive element in the currently rare case of an oversubscribed competition.

In 2022, the Energy Networks Association (the industry body for the electricity and gas network operators in the UK and Ireland) changed the way in which they reported on the flexibility services procured by GB Distribution Network Operators. Rather than providing figures for each calendar year, they now report according to the regulatory year running from April to March. For this reason, figures in the charts below switch from the calendar year to the regulatory year from April 2021 to March 2022, labelled 2021/22 for simplicity.

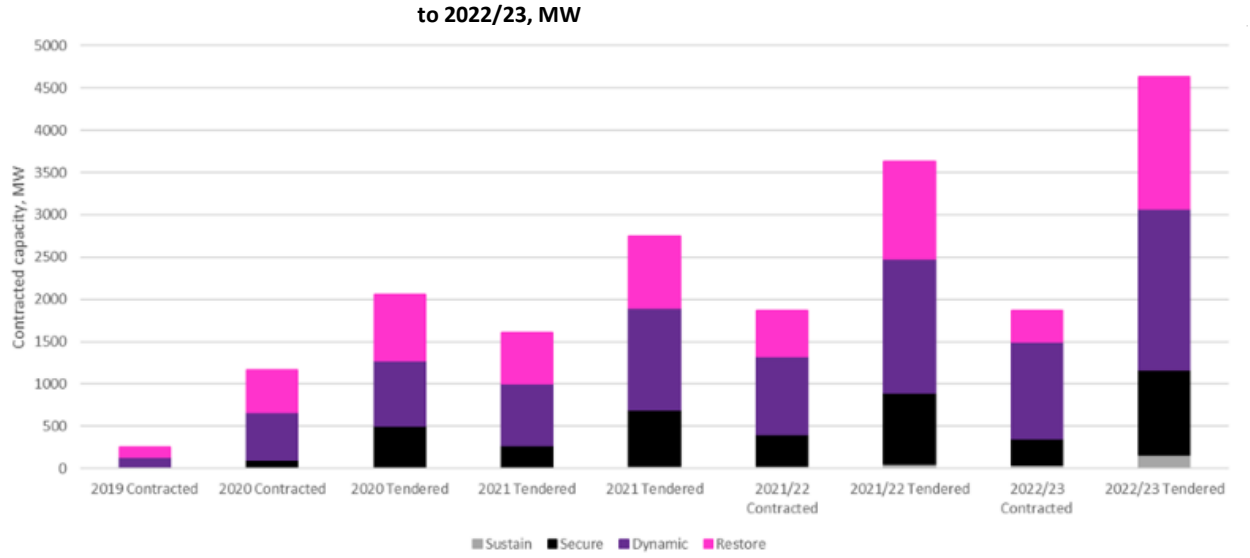
4.7.1 Volumes

The total volume of contracted DSO services in 2023 was 1.9 GW, the same value contracted in 2022 (see Figure 20). This was despite the volume of capacity tendered increasing from 3.6 GW to 4.6 GW. This highlights that constraints in the service delivery of DSO services is limiting an increase in contracted delivery.

In 2023, Dynamic services (post-fault constraint management) continued to dominate the DSO market with 1140 MW of contracted capacity. This compared to 376 MW contracted for Restore services (black-start restoration), 317 MW for Secure services

(pre-fault constraint management) and 38 MW for Sustain services (scheduled constraint management). Compared to 2022, volumes contracted for Sustain, Secure and Restore decreased in 2023, but an increase in Dynamic services (926 MW in 2022, to 1139 MW in 2023) meant that total volumes contracted across all services in 2023 were almost the same as those in 2022 (1867 MW in 2022, 1871 MW in 2023). As in previous years, no capacity was contracted for Reactive Power services despite over 10 MW being tendered. By July 2022, the ENA indicated that over 3 GW of services had already been put out to tender in the April 2022 – March 2023 period and over 1 GW contracted, indicating that the latest year will again be a record year for DSO services.

Figure 20 - Volumes of DSO services contracted and tendered by service type, 2018 to 2022/23, MW



Technology-wise, DNOs are typically agnostic when it comes to sourcing flexibility services, but there is a range of different technologies being contracted, such that different services have different major technology types. In 2022/23, storage was the exclusive source of contracted Sustain services, although UKPN were the only DNO to contract any Sustain services. Storage was also the largest single supplier of Dynamic services by power in MW (35%) closely followed by fossil fuels (28% - including diesel generators and gas turbines). For Secure services, hydro was the largest single technology type by power (MW), although this was exclusively contracted by SSEN. Storage and "Other" was also large components of Secure services too. Storage and "Other" also dominated Restore. NGED have not been transparent about what the "Other" technologies are, but since wind isn't categorised, it is assumed that it could include wind power, or possibly hybrid sites (e.g. renewables/batteries with supplementary fossil-fuel generation capacity).

4.8 The Capacity Market

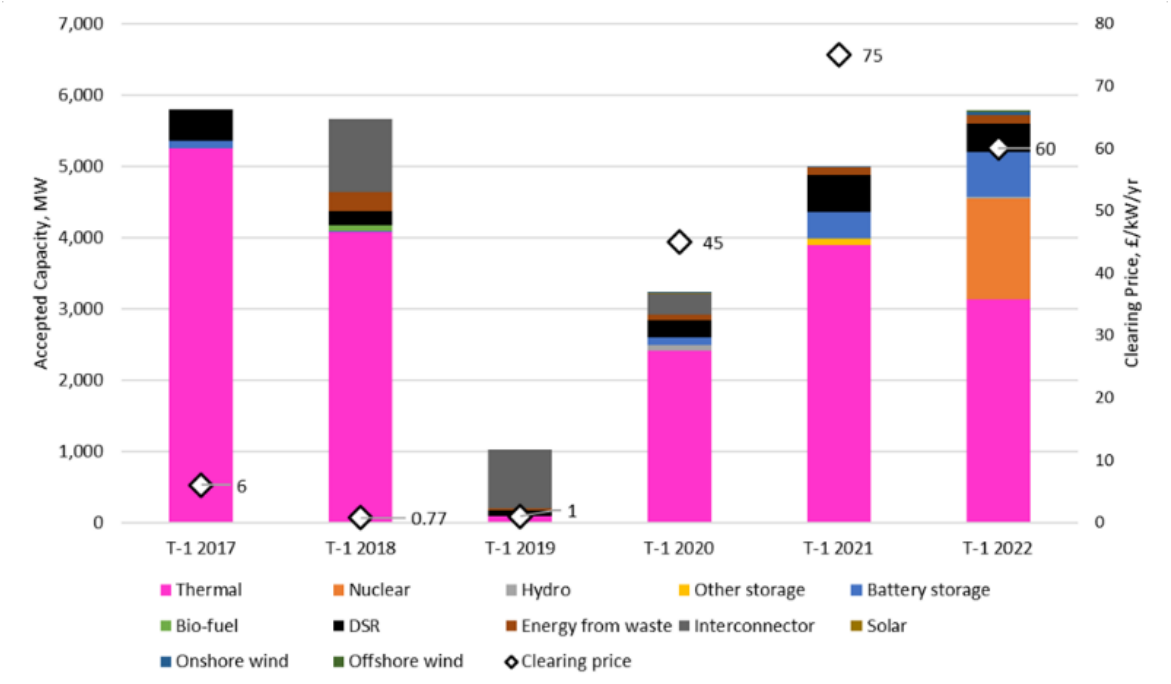
The 2022 Capacity Market auctions (held in early 2023) had another strong year, with both T-1 and T-4 auctions seeing increased accepted capacities compared to the previous year. Auction clearing prices for the 2022 T-1 auction fell slightly to £60/kW/yr. In the 2022 T-4 auction, clearing prices doubled relative to the previous auction, with a historic high of £63/kW/yr in the 2022 auction. Of note in the 2022 T-1 auction, is the significant volume of Nuclear (1.4 GW) and the increasing volume of Batteries (621 MW). Proportions of technologies acquiring contracts in the 2022 T-4 auction remained similar to those seen in the previous year

Service Description

The Capacity Market seeks to ensure sufficient generation capacity in GB to meet demand during peak periods. This is achieved through participants being available to generate or reduce demand during system stress events.
Under normal operation, two Capacity Market auctions are held each year. The T-1 is for delivery commencing at the start of the next delivery year, and the T-4 for delivery in four years' time. Auctions are pay-as-clear, with contracts of up to 15 years available in T-4 auctions for some new build assets.
The minimum capacity limit is 1 MW, although each technology is given a de-rating assumption linked to the likelihood of it being available during system stress events. Generators receiving renewable energy subsidies are not eligible.
Any system stress events are preceded by a Capacity Market Notice, which provides a warning at least four hours in advance that there may be a generation shortfall approaching.

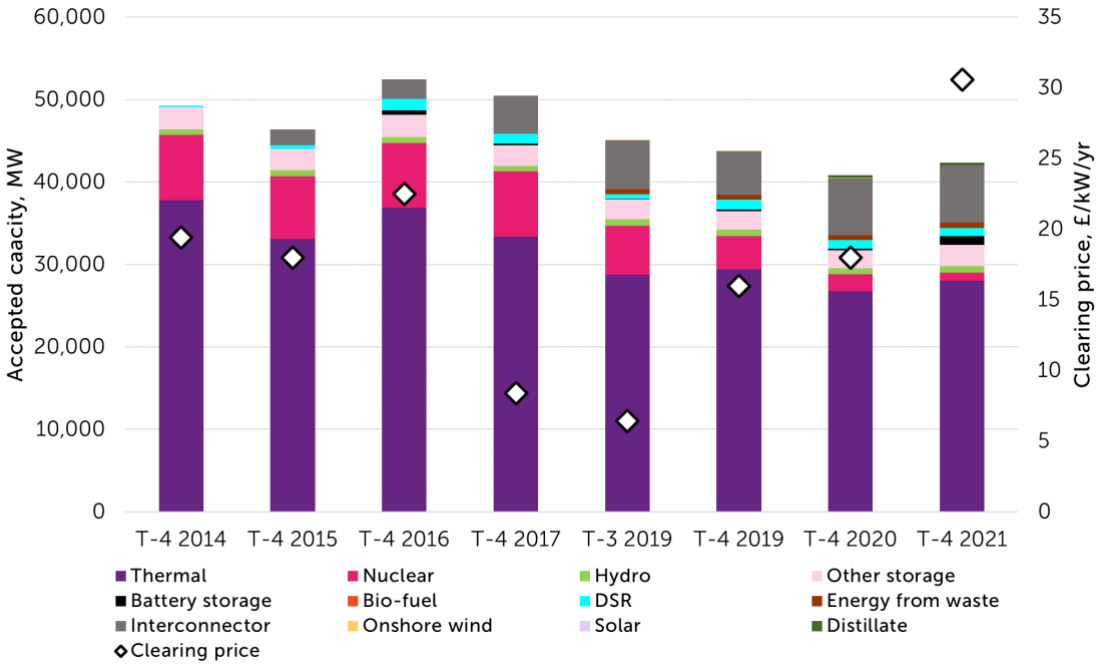
In the 2022 T-1 auction (held in early 2023), volumes of accepted capacity increased to 5.8 GW, which compared to the 5 GW seen in the 2021 auction (See Figure 21). Notable increases were seen in the volume of Nuclear winning contracts (1412 MW) in 2022, largely displacing thermal, where no nuclear had been previously contracted in the last five years. The volume of Battery Storage continued to increase with 621 MW contracted, compared to the 385 MW seen in the previous year's auction. Also of note is the inclusion of Offshore wind in the Capacity Market for the first time (32 MW) and the tripling of capacity awarded to Onshore Wind (33 MW in the 2022, auction compared to 12 MW in 2021). The auction clearing price in the 2022 auction decreased to £60/kW/yr after the high of £75/kW/yr in 2021.

Figure 21 - Clearing price and accepted capacity by technology of T-1 Capacity Market auctions, MW and £/kW/yr



The 2022 T-4 auction was also held in early 2023. As shown in Figure 22**Error! Reference source not found.**, accepted volumes increased slightly but were similar to those seen in the previous year (43 GW in 2022 vs 42.4 GW in the 2021). The proportion of technology types winning contracts in the 2022 auction was also similar to those seen in the 2021 auction, with only minor adjustments, such as the volume of 'Other storage' decreasing from 2528 MW in the 2021 auction to 1790 MW in the 2022 auction. Battery storage also increased from 1094 MW in the 2021 auction to 1284 MW in 2022. As with the 2022 T-1 auction, Offshore Wind won capacity contracts for the first time in the T-4 auction, with 48 MW awarded. Clearing prices in the 2022 T-4 auction more than doubled compared to 2021, reaching £63/kW/yr and were higher than the £60/kW/yr cleared in the 2022 T-1 auction.

Figure 22 - Clearing price and accepted capacity by technology of T-4 Capacity Market auctions, MW and £/kW/yr



4.9 The Balancing Mechanism

In 2023 the Balancing Mechanism (BM) remained a large yet volatile market for flexible assets of all types. Over the course of the year the ESO made several changes to the BM to allow greater participation of DSF assets of different scales. The most significant was the launch of the first stages of the Open Balancing Platform in December 2023, which aims to support the bulk dispatch of battery storage and small Balancing Mechanism Units. Less stringent operational metering standards came into place in February 2024 to allow 300MW of aggregated assets access to the BM. However, as shown in the section below, even before these interventions went live, volumes of DSF assets such as batteries have been increasing.

Service Description

The BM is the ESO's primary tool for balancing electricity supply and demand close to real time. The interface between the BM and tendered ancillary services is complex. Some services are dispatched through the BM, while others are not. Most services targeted by DSF providers sit outside the BM.

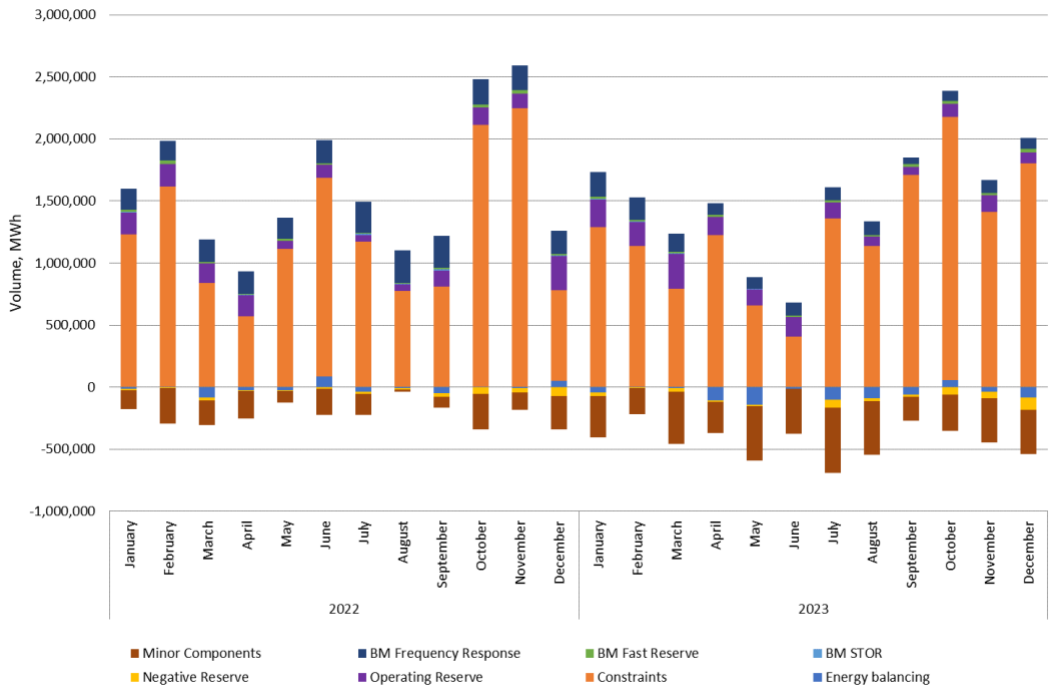
Regulatory changes have opened up access to the BM to DSF providers, including a reduction in the threshold of participation from 100 MW to 1 MW; introduction of the Virtual Lead Party (VLP) route for aggregators; and the release of an Application Programming Interface (API) improving data and access for providers. National Grid ESO have also improved dispatch systems to allow more efficient dispatch of smaller units.

Participants in the BM submit bids and offers to reduce or increase their generation or consumption within each 30-minute settlement period. The ESO calls on these providers as needed, paying the bid or offer price for the volume dispatched.

4.9.1 Volumes

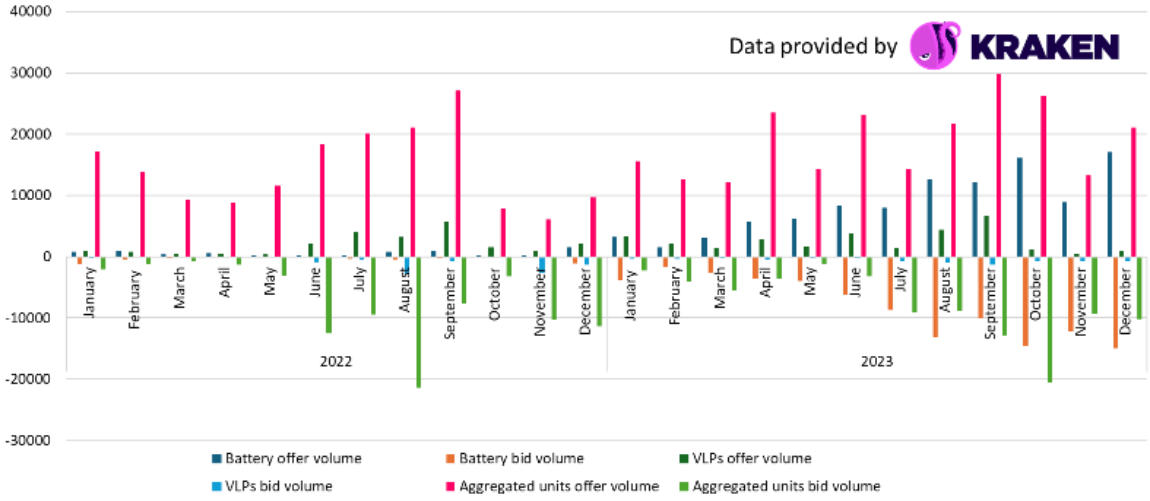
Average monthly volumes of capacity secured through the BM in 2023 remained at similar levels to those in 2022, with notable volatility between months (see Figure 23). In 2023, the greatest volumes procured were in October (2.4 TWh) and the smallest volumes procured in a month were in June (0.684 TWh). As in previous years, most BM instructions are taken to manage constraints on the grid. The volumes of Minor Components, Energy Balancing and Negative Reserve used to control over-supply increased again in 2023. Volumes of BM Frequency Response decreased in 2023 compared to the previous year, likely due to increasing volumes of frequency response services procured through DM, DC and DR.

Figure 23 - Balancing Mechanism volumes by type of instruction, MWh



Conventional, large-scale thermal generators still deliver the vast majority of actions in the BM. DSF technologies deliver only a small fraction of the total market volumes even though dedicated BMU classes for aggregated units, batteries and Virtual Lead Parties (VLP) have created routes into the market for non-traditional asset classes. Figure 24 shows the breakdown of volumes both offered and bid by different DSF asset types in the BM. Volumes of Aggregated units and VLPs were similar to those in 2022, but volumes of Batteries increased significantly. For example, Battery offer volumes in 2023 increased to 103,066 MWh compared to 7,110 MWh the year before and Battery bid volumes increased in magnitude from -4,573 MWh to -95,034 MWh. This reflects the significant increase in the number of grid connected battery storage assets on the GB grid and the growing contribution they are making to balancing supply with demand.

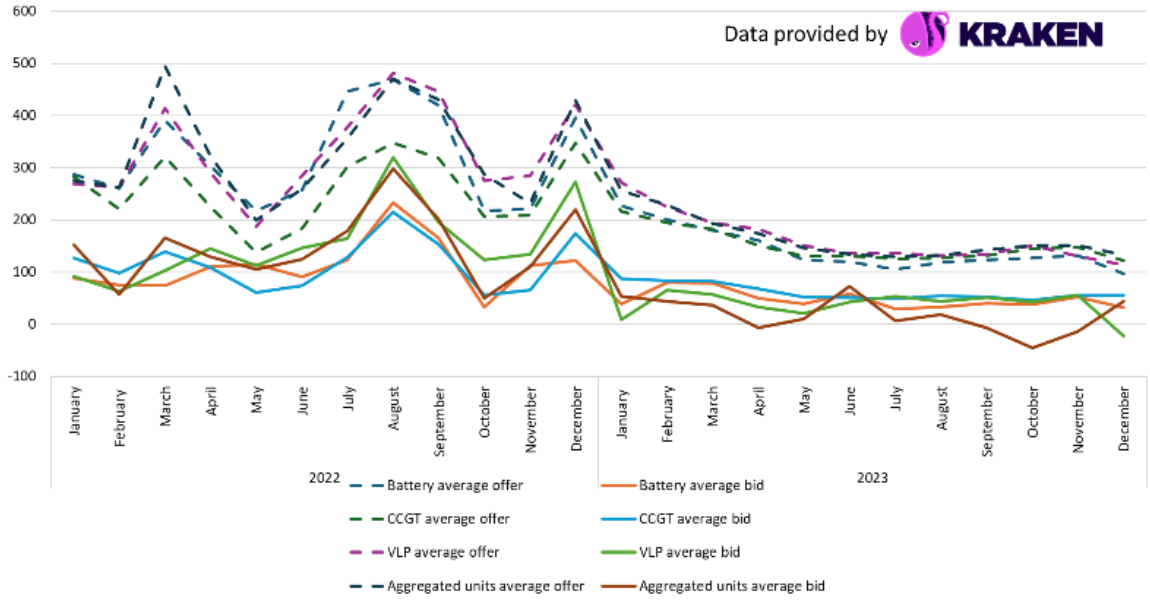
Figure 24 - Balancing Mechanism dispatch volumes by BMU type for aggregated battery and secondary BMUs, MWh



4.9.2 Prices

Average accepted bid and offer prices indicate the long-run value of the BM. After the extreme volatility seen in prices in 2022, average BM prices in 2023 stabilised and generally trended downwards (see Figure 25). This reflects the stabilisation of prices seen across wholesale energy markets in 2023. Average offer prices decreased from over £240/MWh at the start of the year to nearer £120/MWh by the end of the year. Average bid prices decreased from over £110 MWh at the start of the year to just over £25/MWh by the end of the year. No significant trends between the offer and bid prices were observed across the different DSF technologies.

Figure 25 – Monthly average accepted bid and offer prices by BMU type, £/MWh



5.0

Appendix A – glossary

API	Application Programming Interface
DESNZ	Department for Business, Energy, and Industrial Strategy (UK)
BM	Balancing Mechanism
BMU	Balancing Mechanism Unit
CCGT	Combined Cycle Gas Turbine
CCS	Carbon Capture and Storage
CM	Capacity Market
DC	Dynamic Containment
DCH	Dynamic Containment High
DCL	Dynamic Containment Low
DFS	Demand Flexibility Service
DM	Dynamic Moderation
DNO	Distribution Network Operator
DR	Dynamic Regulation
DSO	Distribution System Operation
DSF	Demand Side Flexibility
ED	Electricity Distribution
EFA	Electricity Forward Agreement
EFR	Enhanced Frequency Response
ENA	Energy Networks Association
ERPS	Enhanced Reactive Power Service
ESO	Electricity System Operator
ESRS	Electricity System Restoration Standard
FFR	Firm Frequency Response
FSO	Future System Operator
GB	Great Britain
GW	Gigawatt
LLES	Large-scale and Long-duration Electricity Storage
MPAN	Meter Point Administration Number
MW	Megawatt
NG	National Grid
NIS	Network and Information Systems
NOA	Network Option Assessment
ODFM	Optional Downward Flexibility Management
PV	Photovoltaic
RIIO	Revenue= Incentives + Innovation + Outputs
SMP	Single Markets Platform
STOR	Short Term Operating Reserve
UK	United Kingdom
V2X	Vehicle to Everything

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Appendix B – Data sources

DM/DC/DR

Data from 'DC, DR & DM Results Summary Master Data 2021-2023' (data to 2nd November 2023)

https://www.nationalgrideso.com/data-portal/dynamic-containment-data

'EAC ESO Results Summary 2023-2024' (data from 3rd November - 31st December 2023)

https://www.nationalgrideso.com/data-portal/eac-auction-results

Static FFR

'Static Firm Frequency Response Auction Results' (data from April 2023 - 31st December 2023)

https://www.nationalgrideso.com/data-portal/static-firm-frequency-response-auction-results

Dynamic & Static FFR

Data from collated monthly reports for each month with file names titled 'Post Tender Report TR166 October 2023 EXT'

https://www.nationalgrideso.com/data-portal/firm-frequency-response-post-tender-reports

*Static data only reported here until April 2023.

DFS

Data from 'DFS Utilisation Report Summary' and 'DFS Utilisation Report'

https://www.nationalgrideso.com/data-portal/demand-flexibility-service

STOR

Data from 'STOR DA Auction Results'

https://www.nationalgrideso.com/data-portal/short-term-operating-reserve-stor-day-ahead-auction-results

BM

Data collated monthly volumetric data (by instruction type) from 'Monthly Balancing Services Summary (MBSS) Dec-2023'

https://www.nationalgrideso.com/data-portal/mbss

*Kraken provided monthly data for volumes by BMU type and average accepted bid and offer prices.

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ESO

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