ESO

power responsive

Annual Report 2022

A roundup of developments in demand side flexibility markets in GB

Contents

Foreword

Claire Dykta
Head of Markets, ESO

Power Responsive 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.

2022 was another challenging year for the UK, with consumers facing an ongoing cost-of-living crisis, driven partly by increased energy bills due to the illegal Russian invasion of Ukraine. This highlights the need for further investment in renewable energy sources, technologies, and capabilities, to move away from a dependence on fossil fuels. Demand side flexibility will be a key enabler for clean energy, enabling the ESO to fulfil its commitment to operate a zero-carbon power system, by leveraging flexible demand side assets.

With consumers facing risks to gas supply and the ongoing cost-of-living crisis, there has been an increase in public interest for sustainable energy sources in homes which has driven the continued adoption of domestic heat pumps, batteries, and electric vehicles. To leverage the additional flexible volume that comes from domestic assets and to ensure security of supply over the winter period, ESO created the Demand Flexibility Service (DFS) which pays business and households to flex their energy consumption during periods of tight margins. We are extremely proud that the service contracted over 350MW of volume and delivered over 3.3GWh of energy, with 1.6 million consumers and businesses participating. This service was a fundamental first step towards the future of a smart flexible power system with domestic and commercial DSF directly participating nationally for the first time. The Demand Flexibility Service has been a huge success and will help pave the way in encouraging consumers to actively participate in the power market which will allow the ESO to proactively manage the challenges that come with decarbonisation.

We are taking major steps to integrate new clean and flexible technologies into our markets and working closely with stakeholders and industry to establish innovative ways to manage the system. Power Responsive is playing a lead role in this area through its wide industry engagement and focused working groups. These working groups are tackling immediate and future pain points such as operational metering standards and have the potential to reduce the current barriers to entry and enable more domestic and commercial assets to provide demand side flexibility in our ancillary services. We are also looking at ways to trial and test aggregated small scale assets entering our balancing mechanism. In the next few weeks, we anticipate announcing a new and innovative trial which should make it possible for aggregated EVs to participate.

Power Responsive continues to be the driving force behind the growth of compelling DSF solutions for the energy industry and consumers. We still have significant hurdles to overcome and with the support and engagement of the demand side community, we can continue to make great progress towards our net zero ambitions. Being collaborative is key to Power Responsive's continued success, and I'd like to thank everyone who has contributed to the programme in what has been another challenging but progressive year. With the continued development and deployment of innovative technologies and policies, together we can create a cleaner, more sustainable, and prosperous future for generations to come.

1.0 Executive summary

Headlines from the 2022 report

1 High energy prices set the scene in 2022

Electricity and gas prices surged to unprecedented levels in 2022, causing the retail market to struggle and precipitating the collapse of several UK energy suppliers. Power prices were around 80% higher than in 2021. While the energy crisis presents a challenge for consumers, many Demand Side Flexibility (DSF) providers have profited from the situation, especially as rising costs have raised awareness of energy efficiency and DSF amongst a wider audience.

2 Batteries continue to boom

Grid connected battery storage assets accounted for 100% of the Dynamic Containment (DC) market in 2022 and deliver large shares of several other essential system services. The importance of batteries to stable system operation is reflected in the near 2 GW of installed capacity at the end of 2022. As well as dominating DC and Dynamic Firm Frequency Response (FFR) markets and are increasingly prevalent in the much larger Capacity Market (CM) and Balancing Mechanism (BM). 2022 presented an opportunity for DSF providers to bid into a growing number of services including new frequency response services. The average size of battery assets reached almost 50 MW in 2022, mostly limited by connection regulations at distribution level.

Over 1.6 million households and business have participated in the new Demand Flexibility Service during 2022.

3 2022 was the year of domestic flexibility

With the introduction of the Demand Flexibility Service (DFS) last year, the Electricity System Operator (ESO) addressed the need to unlock the potential of domestic flexibility. For the first time, end consumers could directly participate in an ESO service by shifting their demand to different times of day. 1.6 million households and businesses and 31 energy suppliers were involved in DFS events in 2022.

4 Dynamic Regulation and Dynamic Moderation services launch

The ESO introduced Dynamic Moderation (DM) and Dynamic Regulation (DR) in 2022. Together with Dynamic Containment (DC), these new services offer a wide range of opportunities for DSF assets with different technical capabilities. After the launch of DM and DR, the ESO began a process of gradually procuring less Dynamic FFR which will continue throughout 2023.

5 FFR and DC are still the most valuable services for DSF providers

In 2022, the ESO services FFR and DC were the primary sources of revenue for a majority of DSF providers. Over 1 GW of dynamic FFR contracts were awarded in some months, at prices that averaged over £18/MWh over the year. DC was worth over £100/MW/hr during limited periods, and consistently awarded contracts to over 1 GW of DSF assets across the two service types. However, with DC now reaching saturation and new services launched, 2023 is likely to see more diverse commercial models deployed. More details are provided in the Market Metrics section of this report.

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 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 2023/24 focus areas

Power Responsive will continue to champion increased DSF participation in markets in 2023/24 by focusing on three 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) and supporting the development of the DFS.
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.

2.2 Stakeholder commitments

Power Responsive maintains its commitment to providing stakeholder value through continuous engagement and has delivered upon the following commitments in 2022/23:

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
callum.wright@nationalgrideso.com

Callum has been in the industry for over 10 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. Joining 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 7 years' experience in the electricity industry starting out in network management for the National Grid Transmission business before moving to the Electricity System Operator 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
vanessa.jones@nationalgrideso.com

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.

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 powerresponsive@nationalgrideso.com

3.0

State of the industry

3.1 Policy, regulatory and market development

3.1.1 Government

The energy crisis has dominated the narrative of public-facing energy policy announcements in 2022. Gas and electricity prices rose to all-time highs, prompting successive increases in the consumer price cap mechanism and the introduction of an Energy Price Guarantee in October. Elsewhere, the government has continued to roll out funding and support for the fledgling long-duration storage sector.

During the window that sets the Q1 electricity price cap, the electricity prices on the spot market reached 363.71 £/MWh, with the Forward Delivery prices hitting even greater heights at 511 £/MWh. The Default Tariff cap on electricity prices set by Ofgem for January to March 2023 was more than three times greater than a year ago. Despite wholesale prices falling slightly towards the end of last year, the government announced a package of support measures for the domestic and non-domestic sector. To protect customers the Energy Price Guarantee was implemented in October 2022 as an additional measure limiting the unit cost of electricity and gas so that an average household will pay on average £2,500 on their energy bill.

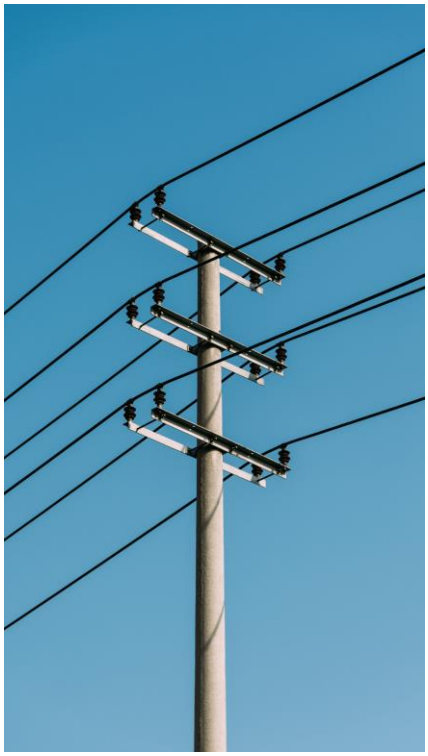
Government continues to work with Ofgem to implement the Smart Systems and Flexibility Plan and the Energy Digitalisation Strategy, both published in 2021. Relevant publications from the government, or on its behalf, in 2022 include the government's response to the call for evidence on Large-scale and Long-duration Electricity Storage (LLES), research on the benefits of long duration electricity storage, a report on delivering a digitalised energy system and a joint response with Ofgem and Innovate UK, a consultation on the interoperability and cyber security of energy smart appliances and remote load control, a consultation related to the government's review of electricity market arrangements, ongoing work on a range of innovation projects as part of the Flexibility Innovation Programme, and continued updates to the Energy Price Guarantee.

The Call for Evidence on LLES examined how to best bring forward new storage technologies with long-term potential within a challenging commercial landscape. The majority of the 66 responses agreed that there are barriers to the deployment of LLES technologies in the UK, such as high upfront costs and a lack of predictable revenue streams. The government's response announced an intention to develop a framework of policy support by 2024 to enable investment in LLES.

Government estimates that long duration storage could reduce the net zero system cost by £13bn to £24bn by 2050, compared to short duration storage alone, with most long-duration storage being in the form of electrolytic hydrogen, assuming a wind dominated electricity system. The government has provided additional funding for the research and development of battery technology and energy storage projects across the UK in 2022, including £32.9 million of UK government funding awarded to projects developing new energy storage technologies and £211 million for battery research and innovation.

In September 2022, the Secretary of State for BEIS commissioned an independent review of the government's approach to achieving its net zero commitment. The review was published in January 2023 and found that the UK's commitment to net zero is creating new opportunities for industry, but that there is a lack of policy clarity, infrastructure bottlenecks, planning system delays, and a lack of investable projects. The review found that businesses in the UK are missing economic opportunities available from the net zero transition due to weaknesses in the investment environment in the UK.

A major government restructure in early 2023 broke up the Department for Business, Energy and Industrial Strategy and split its functions into three new departments. The Department for Energy Security and Net Zero (DESNZ) has taken on the energy policy responsibilities previously held by BEIS.



3.1.2 OFGEM

Ofgem continues to work with Government to implement the Smart Systems and Flexibility Plan, as well as progress policy and regulatory changes aimed at accelerating the roll out of full chain flexibility infrastructure.

Rolling out full chain flexibility means utilising a fully flexible energy system to bring more renewable generation online whilst ensuring costs are kept down for all consumers. Ofgem co-hosted with Government a Smart Systems and Flexibility Forum in March 2022 with a progress update, the priorities for the year ahead, and next steps. Following this forum Ofgem hosted a series of workshops to engage with stakeholders on their priorities for regulatory reform, and to test for unidentified barriers that may be holding back the industry.

In March 2022, Ofgem published a consultation and impact assessment on the regulatory treatment of Customer Load Active System Services (CLASS) as a balancing service during the RIIO-ED2 (Revenue = Incentives + Innovation + Outputs) network price control period. Ofgem decided to continue to allow Distribution Network Operators (DNO) to provide CLASS to the ESO as a balancing service.

The decision on the Access and Forward-Looking Charges Significant Code Review (Access SCR) was published in May 2022. The published decision covered two areas of the original scope of the review: the distribution connection charging boundary, and the definition and choice of access rights. Regarding the former, Ofgem have made the decision to reduce the overall connection charge for those connecting to the distribution network. Notably, this removes the requirement for demand customers to contribute to reinforcements at or above their connection voltage. Generation customers will pay a proportion of reinforcement costs only at their connection voltage, with all other reinforcements will be funded by Distribution Use of System (DUoS) Charges. Changes to access rights will standardise procedures for non-firm connections by introducing clear curtailment limits and end dates for non-firm access arrangements. Both decisions should help reduce the barriers to distributed assets securing connection to the network when they come into force on 1 April 2023.

In November 2022, Ofgem approved a proposal from the ESO to amend the Terms and Conditions related to balancing to include provisions for the Demand Flexibility Service (DFS), a new service to provide grid balancing from Winter 2022/23.

2022 has also seen changes to the price controls mechanisms (RIIO model) for the ESO and the DNOs. RIIO-ED is the specific model for electricity Distribution Network Operators, with RIIO-ED2 being the next price control period from 2023 to 2028.

- After consultation, Ofgem approved most of the amendments proposed by the DNOs and have allocated £22.2bn for further investment plans.
- The DNOs have published a business plan, which outlines the commitments to net zero and DSF.
- In December 2022 Ofgem published the decision to treat CLASS as a balancing service in the RIIO-ED2 price control. This will allow DNOs to offer CLASS to the ESO in a competitive market. The consultation saw almost half of the responses recommending prohibiting CLASS as a balancing service, which highlights the controversy around this decision.

After winter 2022-23, the triad mechanism, which rewarded some distribution connected assets for export or demand reduction during winter peak periods, will be retired. The replacement fixed fee, based on connection capacity, was announced in the decision of the Targeted Charing Review in late 2019 and will take its full effect from next year. While removing a previously lucrative revenue opportunity for DSF, the new fee structure is designed to ensure a fairer distribution of the costs of maintaining the transmission system.

3.1.3 The ESO

The ESO have launched a variety of new services to provide grid flexibility and power response services in 2022.

Dynamic Regulation (DR) was launched by the ESO on 8 April 2022, the first of two new frequency response services which went live in 2022. DR is a pre-fault response service designed to regulate small deviations in grid frequency. On 6 May 2022, Dynamic Moderation (DM) was launched, completing the suite of new fast-response frequency services that also includes DR and Dynamic Containment (DC). DM sits in between DR and DC and is designed to help manage large and sudden differences between demand and generation by responding quickly to changes that push the grid frequency towards the edges of the operational range. On 10 May 2022, the ESO launched an interactive dashboard for DM, DR, and DC, providing visualisation of auction results. The different response characteristics of the three services are shown in figure 1.

The launch of the new services coincides with the phasing out of older services that they are designed to replace. The final Enhanced Frequency Response (EFR) contracts lapsed in 2022, and dynamic Firm Frequency Response (FFR) will be gradually phased out over 2023. Static FFR will continue to be procured for the time being, moving from its currently monthly tender to a daily procurement round. However, it appears that the new services are not yet a complete replacement for dynamic FFR – in its Operability Strategy report published in December 2022, the ESO identified a gap in the frequency response product suite created by the phase-out of dynamic FFR, and identified a potential new service designed to fill it. Provisionally known as Static Recovery, the service would aim to recover frequency to +/-0.5Hz within 60 seconds following large scale losses.

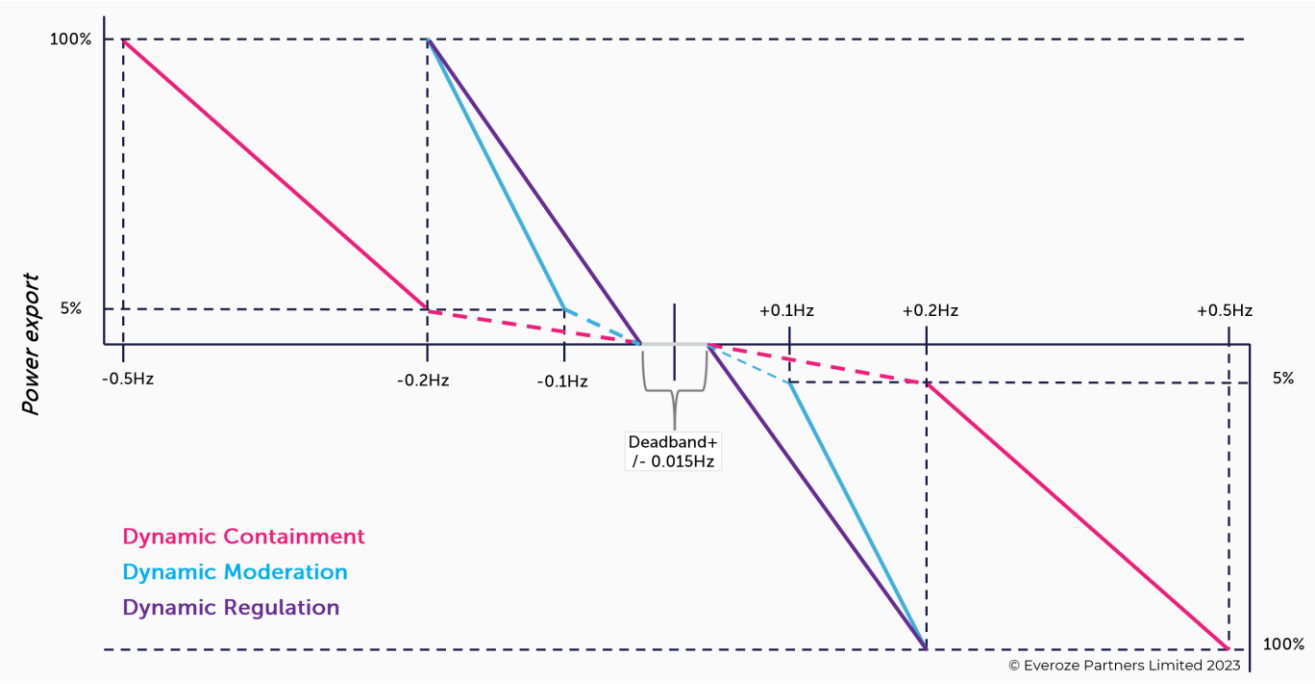


Figure one: *Response characteristics of the three dynamic frequency response products*

On 19 October 2021, the Secretary of State for the Department of Business, Energy, and Industrial Strategy (BEIS) directed the ESO to strengthen the regulatory framework for the restoration of the electricity system through the Electricity System Restoration Standard (ESRS). In the new ESRS, the ESO is required to have adequate capability and arrangements in place to restore 100% of Great Britain's electricity demand within five days. The ESRS should be implemented regionally, with a target of 60% of regional electricity demand restored in the interim within 24 hours. Industry was consulted on the changes to the ESRS at the end of 2021, with the new standard written up over the course of 2022, before being officially implemented on 31 December 2022. The electricity industry has until 31 December 2026, to fully comply with the updated ESRS.

The ESO has launched the Network Option Assessments (NOA) and has created three Pathfinder projects to identify ways to increase system stability, manage system voltage and reduce thermal network constraints. Phase 2 of the Stability Pathfinder projects looked at the most cost-efficient way to increase stability and inertia in Scotland, it started in June 2020 with the tender results published on 6 April 2022.

The ESO's Single Market Platform (SMP) has been rolled out in 2022 as the new, universal access point for ancillary services. The intention is to add functionality via Application Programming Interfaces (API) towards the end of 2023 and into 2024, but for now participants are encouraged to register in preparation for when it becomes a requirement for existing services. The Demand Flexibility Service (DFS) is the first to require SMP registration as a pre-requisite.

Capacity Market (CM) auctions in early 2022 offered long-term contracts to support new build and existing technologies, providing a degree of revenue certainty for investors. Elsewhere, a number of other grid-forming services such as the Enhanced Reactive Power Service (ERPS) and restoration services are being opened up to non-traditional providers. With the quantity of synchronous generation on the grid falling, the ability for battery storage projects and distributed generation to provide these services will be increasingly valuable. However, ensuring the capability for a project to be able to technically deliver these services will often require additional investment decisions in the power electronics procurement phase.

Demand Flexibility Service

In early 2022 the ESO ran a trial of flexible load shifting, termed the Domestic Scarcity Reserve Trial. The trial successfully engaged over 100,000 customers in load shifting and demonstrated that the evening peak of power consumption (4.30-6.30 pm) promised the most in terms of manual load shifting from a baseline of expected demand based on historical usage data. On the back of this trial, the ESO launched the Demand Flexibility Service (DFS) on 4 November 2022. The aim of DFS is to allow the ESO to achieve demand flexibility by asking energy consumers to alter the times at which they perform energy intensive activities. The domestic participants must have half-hour meters (i.e., smart meters) and can only access the service through a single registered DFS participant. In return, consumers who reduce their demand will receive financial incentives from their energy supplier, or an aggregator. Registered DFS providers manage DFS units between 1 MW and 100 MW and can register multiple DFS units, which themselves can be aggregated nationally. No part of any DFS unit can form part of a Balancing Mechanism (BM) Unit except a Supplier Base BM Unit, nor can they be providing any other ESO balancing service or similar to any third party, including having a CM agreement.

The service was initially intended to provide grid flexibility during winter 2022/23. The ESO is currently consulting on operating an evolved service in Winter 2023/24. The ESO published data on the results of the DFS for test and live events. Up until the end of 2022, consumer engagement was higher than expected, with an over delivery on flexibility targets of 35%. The DFS had delivered 780MWh of real demand reduction, yielding £2.8 million of savings for participants. One million households and businesses were involved by mid-December across 26 electricity suppliers.

The evidence of the test and live events suggest DFS has been a success. It may not be a surprise to many in terms of the mechanism, but the speed of its development and the scale of demand reduction that has been achieved in a short time is notable. Stakeholders have been quick to point out that this is not an optimised service, but it marks a significant shift in terms of technology, and engagement of domestic consumers and non-supplier aggregators to ESO flexibility services.

After the success of DFS, the ESO is considering how to build on the momentum for consumer participation in flexibility services. Initially, the next steps are looking towards the coming winter and what modifications may be needed to the current service design, working in collaboration with industry. In parallel the ESO Power Responsive programme is considering what the enduring solutions are for keeping the momentum on demand flexibility, such as looking at removing barriers to entry in the ESO's other markets and the impact of wider market changes, such as wider adoption of half-hourly settlement.

Local Constraint Market

The ESO has recently announced trials of a new demand increase or generation reduction service above the B6 (Anglo-Scottish) boundary, where generation in Scotland often causes transmission system flows to reach the existing connection limits across the border into England. The B6 boundary also represents the interface between Scottish Power Energy Networks (SPEN) Transmission and National Grid Transmission networks. Eligible assets must be distribution connected above the boundary (i.e., on SPEN or Scottish and Southern Electricity Networks (SSEN's) distribution networks), but cannot be BM-registered, stacked with other services, nor subject to an Active Network Management (ANM) or Generation Export Management (GEMS) scheme.

Although the initial documentation on the project outlined a similar 1 MW limit to DFS, a December 2022 update outlined that this service will use the Piclo platform which enables units smaller than 1 MW to participate, as well as non-integer sizes above 1 MW.

The need to act to ease constraints has been growing as the peak southward flows across constrained parts of the network in Scotland increase, largely due to the increase in operational wind generation at northern latitudes. Currently, the BM is the main tool used to manage constraints. This use will continue for near real time adjustment but will now be complemented by a competitive option, assessing whether a proportion of the constraint can be reliably resolved by instructing flexible distributed energy resources hours ahead of time. Constraints can be highly localised so the ESO will work closely with SPEN and SSEN to improve the visibility of potential providers of constraint management services.

As an interim service, designed to endure until more permanent solutions to localised system operations are put in place, the Local Constraint Market (LCM) has been guided by a simpler approach. A day ahead market operating with a light touch on control room practices and systems helps to reduce time to market. The ESO Control room may also be able to utilise Scotland's more northerly assets to reduce southward flows of energy across both B6 and the more northerly B4 boundary.

The service design has drawn on several rounds of stakeholder consultation. Acting on market feedback, the ESO intends to use Applicable Balancing Services Volume Data (ABSVD) adjustment (for qualifying metered and settled assets) and is currently in the process of requesting the service be included in the list of relevant balancing services so that CM participants will be able to fully participate.

Although an ESO service, the new market follows a similar approach to a trial run by SPEN in 2022, termed the Flexibility Demand Shift Trial. The scale of this was significantly smaller than the nationwide Domestic Scarcity Reserve Trial, but still resulted in an average turn up of 1.68 MW per event, that would have otherwise been constrained generation.

Future Energy Scenarios 2022

In the latest Future Energy Scenarios (FES), cross-sector electrification is predicted to lead to increasing peak demands from the mid to late 2020s in all scenarios, before plateauing in the mid-2040s. Demand side flexibility take-up is lower in *System Transformation* and *Falling Short* which have lower levels of consumer engagement. However, they still see over 26% and 19% total peak demand reduction respectively from demand side flexibility.

The main roles for DSF in the FES are described as:

- Balancing daily variations in supply and demand
- Reserve for unplanned outages/forecast error
- Reducing network constraints

The Industrial & Commercial sectors are expected to offer greater demand flexibility in the future, especially from new loads such as electrolysers.

3.1.4 Distribution Network Operators

Distribution Network Operators (DNOs) are incentivised to directly procure flexibility services within its network areas by the RIIO price control framework, which set the priorities and incentives for each of the six GB DNOs. Although the same mechanisms apply nationwide, there is a distinct variation in the nature and extent of the services that are procured across the country.

The Electricity Networks Association (ENA) act as the trade association for energy networks in GB and are particularly active in promoting the role of DNOs in accessing flexibility on local-level networks through the Open Networks programme. Their flexibility figures dataset (discussed in the Market Metrics section) reveals that 2022 was another record year for DSO service procurement. However, there is still work to be done. The Open Networks 2022 in Review highlighted two key challenges for network companies; the first being the need for standardisation of products across DNOs and alignment of technical requirements and procurement processes. The second challenge is in reforming the regulatory framework to deal with conflicting dispatch requirements between DNO and ESO.

Another challenge for DNOs and the DSF sector is the grid connection process. Connection constraints are common at the distribution and transmission level, and firm grid offers are now increasingly rare. Non-firm connection offers, helpfully being standardised as a result of the Access SCR, increasingly require intertripping schemes to be installed for both transmission and distribution circuit constraint scenarios. Once network upgrades have been completed, many of these intertripping schemes will not be required, but they underly a general trend towards grid offer restrictions based on network saturation, and an ever-increasing need for flexible response at all levels of the power system.

3.2 Technologies and providers

Distributed generation

The quantity of distributed or embedded generation on the grid is increasing in volume.

- Thermal generation at the distribution level is focused on longer duration ancillary markets, principally the BM, STOR, static FFR, CM and some DSO services.
- Distributed renewables provided few ancillary services but remain active in the BM and in small volumes in the CM; generation reduction markets like the now discontinued ODFM and the new LCM are the most attractive flexibility services for standalone solar or wind projects.
- Co-location of storage with wind or solar projects faces continued barriers around metering, grid connections and full market access, but these challenges are in the process of being addressed.

Distributed Storage

Whilst other technologies are frequently discussed, none are currently making any significant inroads into the market share of large-scale lithium-ion and existing pumped hydro schemes in the distributed storage market in GB.

- Li-ion batteries dominated the GB storage market, with new grid-connected Li-ion battery projects growing significantly in scale. A significant number of 500 MW+ projects are now consented, and the total GB pipeline is approaching 90 GWh. Constraints on the distribution network are increasingly leading to many projects connecting directly to the transmission network.
- Rising commodity prices for lithium may bring other technologies to the market, although in the UK there are currently no serious commercial competitors to Li-ion at all scales.
- Supply chain issues and cost increases for both batteries and power electronics may slow down the roll out of new Li-ion battery projects in 2023.

Frequency response services - in particular DC Low (DCL) - have been very lucrative markets in 2022 for battery storage assets. However, market saturation has led to falling prices towards the end of 2022. Volume caps on ancillary services and increased battery capacity have increased competition.

Domestic flexibility

Challenges in 2022

While the launch of the DFS was welcomed by many stakeholders and widely considered an important milestone in enabling domestic flexibility, the primary challenges remain raising customer awareness and creating solid investment cases to convince end consumers to invest in flexibility. Legislation and regulation that lags behind the evolution of new markets and technologies have been slowing down the transition.

Despite these hurdles, there is a huge growth projected for the sector. The Future Energy Scenarios estimate that the majority of flexibility will originate from the end consumer by 2050. The ESO expects to see a vast increase in visibility and accessibility of previously inaccessible demand flexibility volume. Across Europe, the domestic flexibility market has already experienced a boom of residential flex systems in 2022. And while undesirable for numerous reasons, high energy prices continuing into 2023 will help firm up the fundamental business case for demand reduction and flexibility.

Digital Transformation

The digital transformation requires new software solutions with a system architecture that serves customers. Energy suppliers play an important role in the roll out of domestic flexibility propositions and are under pressure to live up to the demands of domestic customers. Real-time information exchange and effective engagement of customers are two primary challenges. In response, there have been calls to scale up consumer flex propositions with automated responses instead of manual responses, although such propositions have significant work to do in building consumer confidence before they can be widely rolled out.

Electric Vehicles

The growing flex potential of EVs will be important for DSF in the long run, as highlighted in the latest update of the ESO's Future Energy Scenarios. By 2050, the storage capacity of EVs participating in Vehicle-to-Grid charging (V2G) is expected to match up with battery storage (20 GW installed capacity). Achieving this level of V2G will require continued regulatory support.

4.0 Market metrics

4.1 Dynamic Containment

During 2022, DC has matured into a market which consistently delivers hundreds of MW of rapid frequency response to protect against sudden demand or generation loss. The DC auction products have experienced volatile auction clearing prices, which occasionally broke £100/MW/hr for DCL in 2022.

While Dynamic Markets (DC, DM and DR) attract the same providers, fluid participation across the markets - i.e. liquidity in Dynamic Regulation High (DMH) for example might be linked to levels of participation in Dynamic Regulation High (DRH) or Dynamic Containment High (DCH) - makes it hard to draw any conclusions on volumes and prices in the charts shown in sections 4.1- 4.3.

Service description

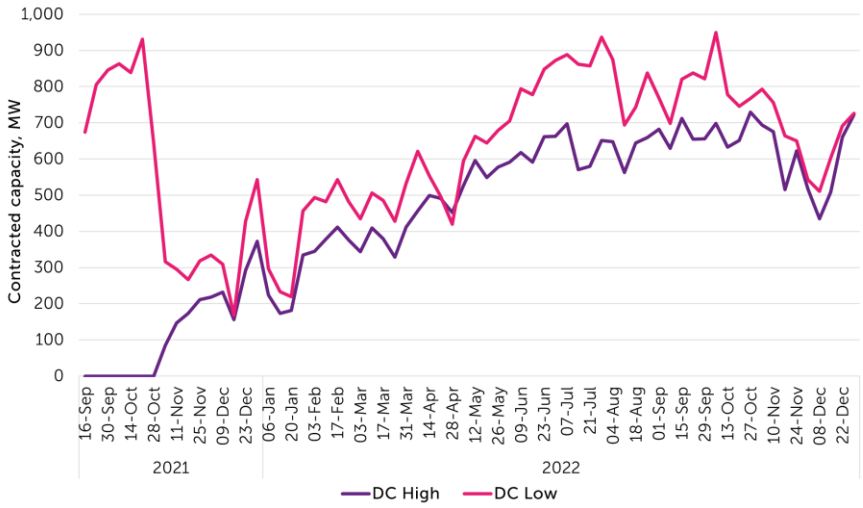
Dynamic Containment is a frequency response product designed to keep the transmission network within safe operating limits of frequency after a system fault. Key features of the service are:

- **Rapid frequency containment**: DC is rapid response service designed to maintain the nominal frequency of 50 Hz within operational limits of +/- 0.2 Hz.
- **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

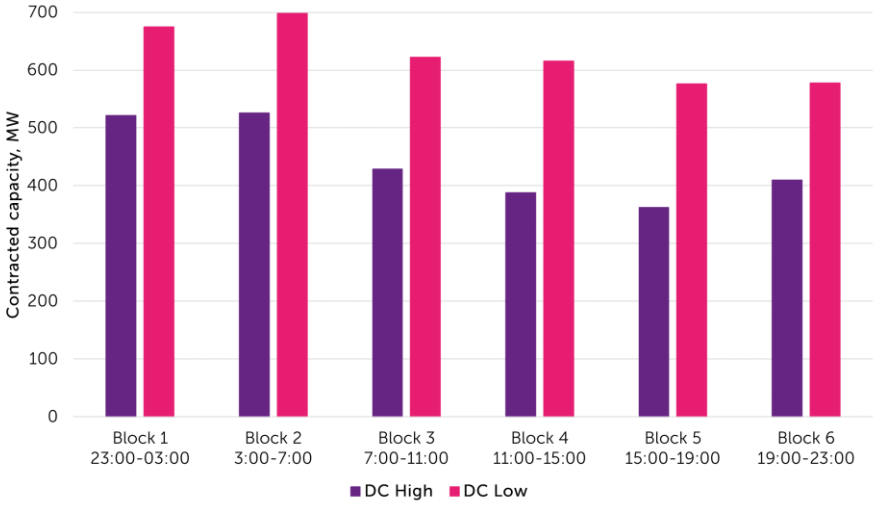
Over the course of 2022 DC developed into one of the most important services for battery storage assets. Over the first half of the year, contracted volumes of DC grew steadily. Dynamic Containment Low (DCL) reached close to 1 GW during some windows over the summer and early autumn as more assets able to deliver the service came online. Since its launch in November 2021, the high-frequency response variant of DC has shown strong growth, quickly catching up with DCL. Contracted volumes of Dynamic Containment High (DCH) averaged above 500 MW from May through to September. A fall in contracted capacity for both services in the final months of 2022 can be attributed to a fall in the ESO's requirements over the winter period.

Chart 1: The contracted capacity of DCL and DCH grew over the first half of 2022
Weekly average contracted capacity of DCL and DCH, MW



EFA-block procurement throughout 2022 allowed the ESO to accurately procure the capacity required at different times of the day. Chart 2 shows the average capacity per EFA block from 16 September 2021 to the end of 2022, revealing a trend for higher volumes overnight and into the morning (blocks 1, 2 and 3) than during the day. The same trend is common to DCL and DCH.

Chart 2: DC volumes peak overnight and into the morning
Average contracted capacity of DCL and DCH per EFA block, 16/09/2021 to 31/12/2022, MW

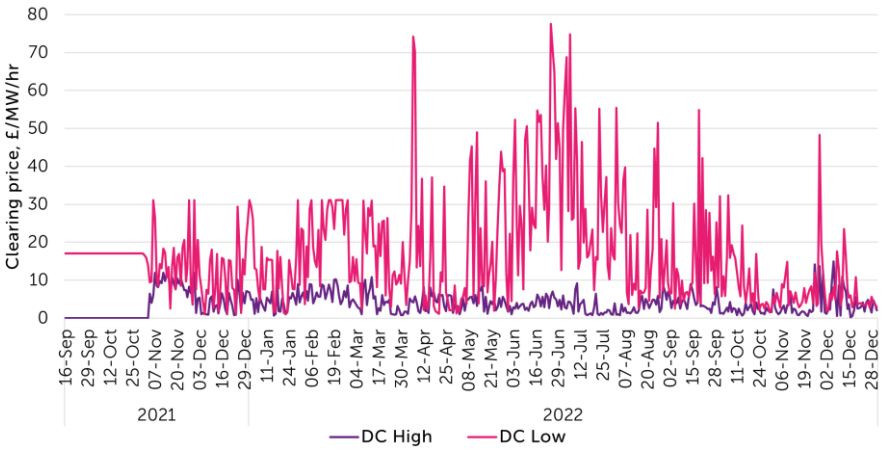


4.1.1 Prices

Since the move to pay-as-clear EFA block auctions in November 2021, low and high DC prices have been volatile (shown in Chart 3). In the DCL market, daily average prices fluctuated between low single digits and around £30/MW/hr over the first three months of the year. A price spike in early April, which saw peak prices break £100/MW/hr in some EFA blocks was short-lived, but prices began to climb again throughout the late spring and early summer. However, the falling price trend visible from July was not without sizeable fluctuations either, as evidenced by notable price spikes in September (£55/MW/hr average on the 19th) and November (£48/MW/hr on the 28th).

Prices were lower in the DCH auctions, with a less notable seasonal trend, but were still relatively volatile. Daily average prices generally ranged between £1 and £10/MW/hr. Surges in prices over short periods later in the year led to a maximum daily average price of £16/MW/hr on September 19th, and several days where prices remained over £12/MW/hr in late November and early December 2022.

Chart 3: DC prices remain volatile
Daily average auction clearing price of DCL and DCH, £/MW/hr



4.2 Dynamic Moderation

Dynamic Moderation (DM) and Dynamic Regulation (DR) were launched in May 2022 and for the first eight months were not yet fully competitive and liquid markets. DM went live on 6 May 2022 as a new service to help manage sudden large imbalances between supply and demand on the transmission system. Take-up of DM was initially slow, especially for the high-frequency variant, which delivered an average weekly volume of just under 50 MW in December. Prices are higher for DMH than for DML.

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

On the first full day of operation, an average of approximately 40 MW of capacity was contracted for both high and low DM. However, between May and August, the weekly contracted capacity fell below 10 MW (shown in Chart 4). However, the price cap for DM services was - among other factors - driven by increasing wholesale prices in late 2022. A higher price cap made bidding into the respective service provision more lucrative -with volumes growing to over 50 MW in November for both service types. In December, the high and low service variants then diverged, with the low-frequency service falling to near zero and the high-frequency variant spiking to around 70 MW in December.

The pattern of contracted capacity across the average day differs from that of DC, with the peak sitting across EFA blocks 3 and 4 between 7 am and 3 pm (shown in Chart 5). The mid-day surge is evident for high and low DM, although the peak is more evident for DMH, which averages over 15 MW for the 11 am-3 pm period.

Chart 4: DML and DMH volumes have diverged since spiking in November
Weekly average contracted capacity of DML and DMH, MW

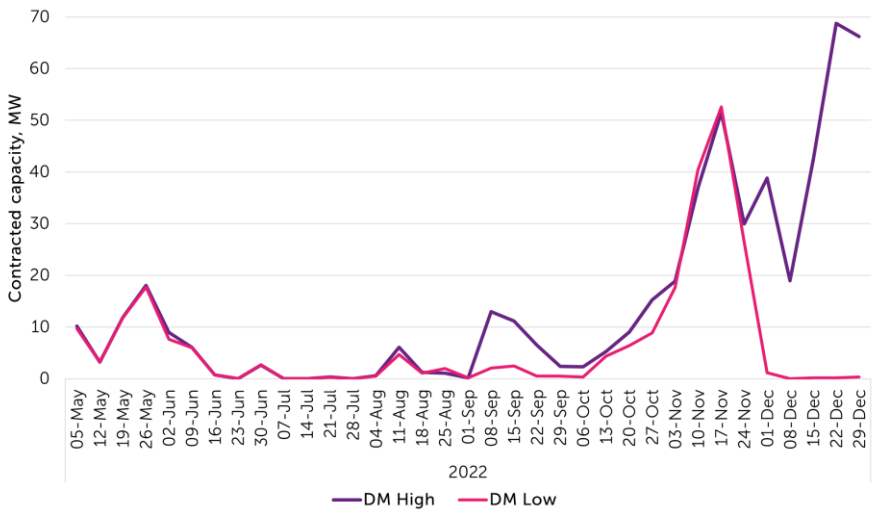
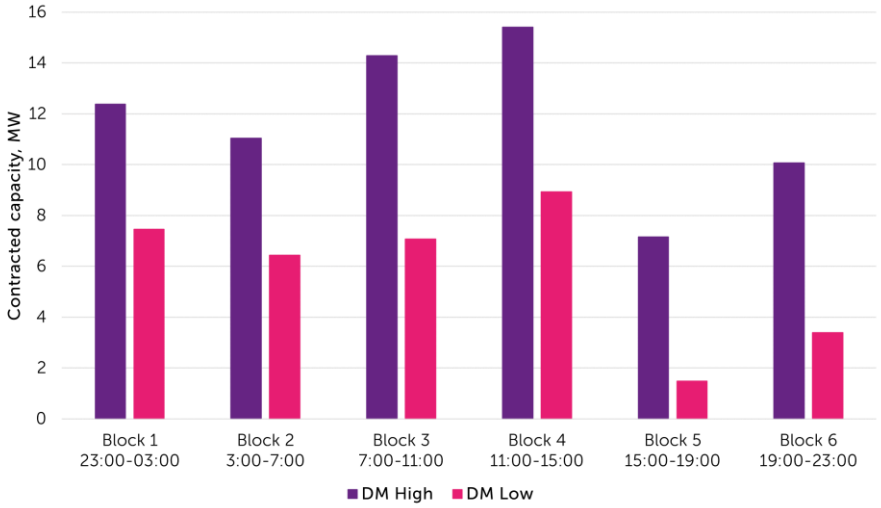


Chart 5: DM volumes peak in the middle of the day
Average contracted capacity of DML and DMH per EFA block, 05/05/2022 to 31/12/2022, MW



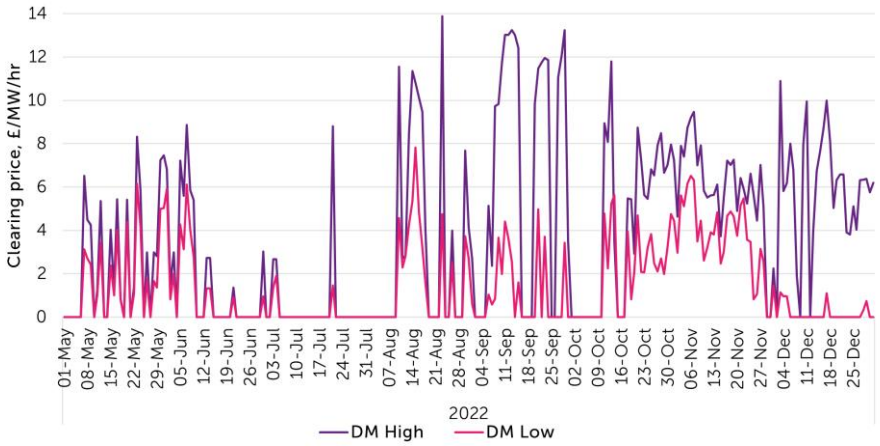
4.2.2 Prices

The irregularity of DM prices, shown in Chart 6, reveals the high incidence of days when no providers were awarded contracts to provide the service, and so a zero price was recorded. When auctions successfully cleared, DML prices were typically 25-75% of DMH prices, a reversal of the high-low price trend seen in DC, where prices are higher for the low-frequency service. Occasions of clearing prices of 0 £/MW/ per hour are a result of zero contracted volume, e.g. for DML in December. The reason for that can be two-fold – either no offered bids were submitted or the ESO set the required volume to zero.

For all providers of the Dynamic Services (DC, DM and DR) the utilisation price of the response energy component is set to 0 £/MWh. The clearing price is the price paid for service delivery, whereas the utilisation price is what the assets are charged for importing or exporting energy. That effectively means that battery assets can charge the battery at zero cost. This can lead to instances when it is more lucrative for battery assets to deliver response energy at the High Frequency Service (charge) than the Low Frequency (discharge), see Chart 4 or Chart 7.

For successful DMH auctions, daily average prices peaked around £14/MW/hr in August, and generally ranged between £3 and £12/MWh depending on the time of year and EFA block. DML daily average prices peaked at just under £8/MW/hr, and typically sat in the £2-£6/MW/hr range over the course of 2022.

Chart 6: DMH prices consistently exceed DML prices when auctions successfully clear
Daily average auction clearing price of DML and DMH, £/MW/hr



4.3 Dynamic Regulation

Launched on the 8th of April, DR is a pre-fault service designed to slowly correct small imbalances in supply and demand, effectively regulating frequency around the target 50 Hz. Initial uptake was strong; however, contracted volumes have varied widely over the year in response to supply and demand effects. The high-frequency response service variant has tended to deliver more capacity than the low-frequency version, while prices have been relatively closely matched across the two forms of DR.

Service Description

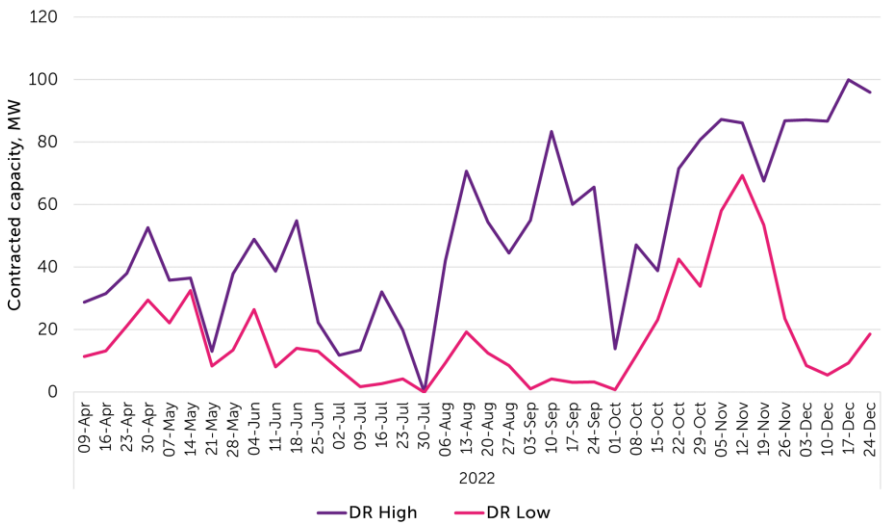
Dynamic Regulation is a pre-fault service designed to keep the frequency within the operational limits. DC, DM and DR can be stacked with the BM. The key features are:

- **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

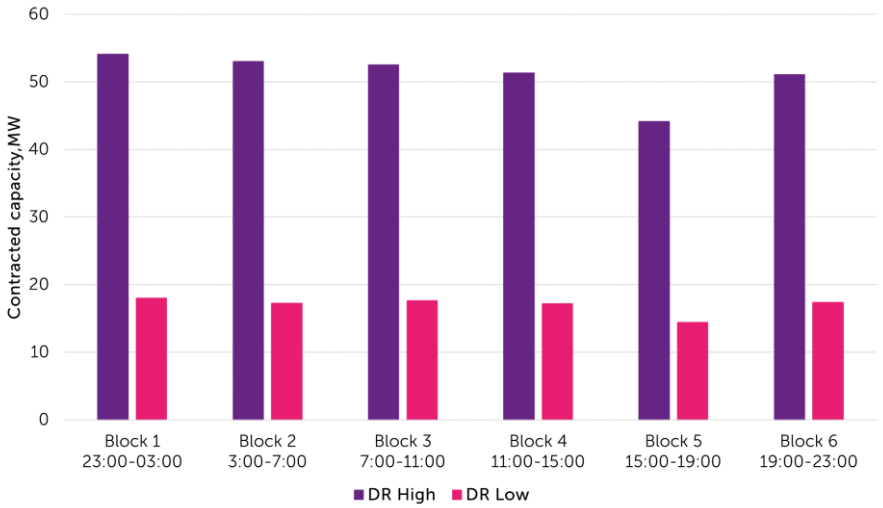
Since DR launched in early April, weekly average volumes have varied between zero and 100 MW across both service types (Chart 7). While significantly smaller than DC, DR is the second largest of the new dynamic frequency response products. As with DM, the high-frequency response service generally clears at higher volumes - due to battery assets effectively charging for free as explained in 4.2.2 above - topping out (again on a weekly average basis) at 100 MW in mid-December. DR Low (DRL) auctions generally delivered less than 30 MW on average over the year before a short-lived surge in November to just under 70 MW of capacity.

Chart 7: Weekly average Dynamic Regulation high-frequency volumes hit a maximum of 100 MW in 2022.
Weekly average contracted capacity of DML and DMH, MW



DR auctions showed little variation in cleared volumes across the day in 2022 (shown in Chart 8). The lowest capacity was in EFA Block 5 for both service variants, averaging 44 MW for DRH and 14 MW for DRL. Block 1 cleared with the largest average volumes, although the difference between smallest and largest is relatively minor, with 54 MW for DRH and 18 MW for DRL in Block 1.

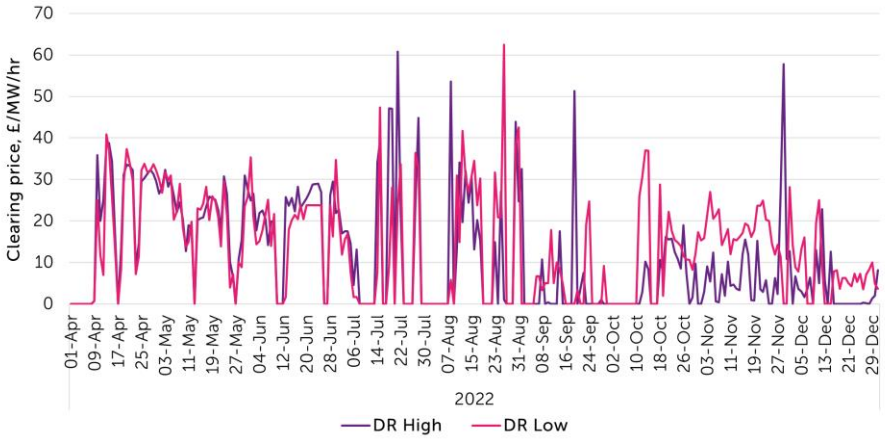
Chart 8: DR volumes remain steady across each EFA block
Average contracted capacity of DRL and DRH per EFA block, 09/04/2022 to 31/12/2022, MW



4.3.2 Prices

Unlike cleared volumes, cleared prices show a strong correlation for both forms of Dynamic Regulation (shown in Chart 9). Prices are high relative to DC and DM, likely reflecting the high-utilisation nature of a regulatory service with a narrow dead band. When capacity was successfully procured, daily average prices typically ranged between £15 and £30/MW/hr from the launch of the service in April to late June. Over July and August prices were spikier, and there were several periods where auctions returned no capacity. Prices peaked at over £60/MW/hr for DRH and DRL during this period. More consistent capacities from October to the end of year coincided with a divergence of prices between services. With the exception of a price spike in late November, DRH average prices remained below £20/MW/hr over from October to December while DRL prices were higher, but still typically below £30/MW/hr.

Chart 9: DMH prices consistently exceed DML prices when auctions successfully clear
Daily average auction clearing price of DML and DMH, £/MW/hr



4.4 Firm Frequency Response

The ESO plans to phase out dynamic FFR in 2023. FFR remained a key market for DSF providers of all forms in 2022. Dynamic FFR has procured over 1 GW of capacity in more than half of the months of 2022, and volumes of static FFR are setting new capacity records. Prices for both services also increased in 2022.

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:

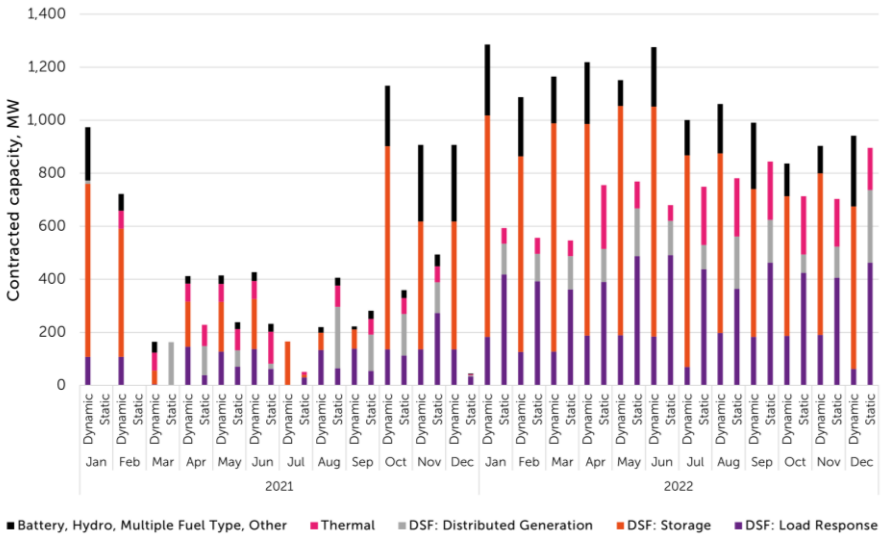
- **Quick response, short duration:** FFR is a frequency response service that requires a quick response (between 10 and 30 seconds) and short duration (20 seconds to 30 minutes).
- **In-build optionality:** Several different forms of FFR exist, each with different technical requirements. For monthly FFR tenders these include static and dynamic services. For weekly FFR tenders the two options are Low Frequency Static (LFS) and Dynamic low high (DLH). Static services provide a fixed response to a defined frequency deviation while dynamic delivers a response proportional to the system frequency deviation.
- **Monthly tenders:** The monthly tenders award contracts based on price and alignment to ESO requirements. Successful providers are paid on an availability basis.
- **Weekly auction:** The FFR auction trial procures capacity for the week ahead through a pay-as-clear auction against the ESO's requirements. The availability-based clearing price can vary with each 4-hour EFA block.

4.4.1 Volumes and technologies

FFR volumes surged upwards in 2022, despite plans to phase out the service in early 2023. Dynamic FFR volumes were over 1 GW for each of the first six months of the year, topping out at 1,285 MW in January before dropping slightly in the latter half of the year, (shown in Chart 10). Distribution connected storage and load response make up the vast majority of dynamic contracts, as has been the case in previous years. The remaining volume comprises a mix of transmission connected storage, hydro power, multiple fuel type units and other technologies. No gas, diesel, biofuel or distributed generation secured dynamic FFR contracts in 2022.

There was a significant increase in static FFR contracts in 2022, especially notable considering some months in early 2021 delivered no static volume at all. Over 500 MW of bids were accepted in each month of 2022, reaching almost 1 GW by the end of the year. Load response is responsible for the best part of the increase in volumes, with more traditional static FFR technologies such as distributed generation and large-scale thermal generation also successfully bidding for static FFR contracts.

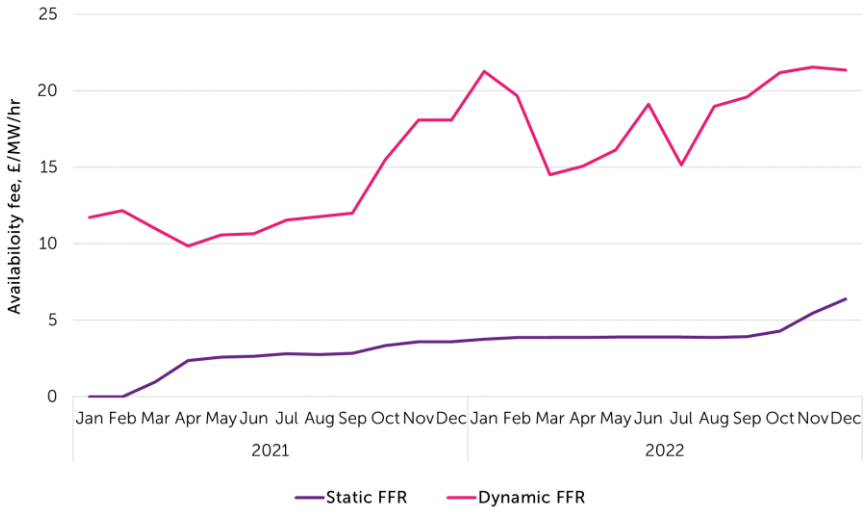
Chart 10: Dynamic FFR returns to 2020 levels and load response pushes the static market up to record levels in 2022
Dynamic and static FFR capacity, monthly market, by technology, MW



4.4.2 Prices

Prices for dynamic FFR in 2022 proved that the surge which occurred in late 2021 was not a one-off event (Chart 11). Average prices secured by dynamic FFR providers varied in the £14-22/MW/hr range over the year, a level that no doubt contributed to the high volumes delivered each month. In the static market, the trend was for a gradual price increase from January through to September which accelerated in the final few months of 2022. Static prices are still well below dynamic levels but broke the £5/MW/hr mark for the first time in over four years in 2022.

Chart 11: Prices for dynamic and static FFR hit new heights in 2022
Monthly average dynamic and static FFR availability fees, accepted tenders, £/MW/hr



4.5 Demand Flexibility Service

The ESO's new service designed specifically for domestic flexibility kicked off in 2022 with a series of test events designed to trial the new service and give the ESO and providers confidence ahead of live events. The 16 test events and 2 live events which took place before mid-February delivered 312 MW of demand reduction from a diverse range of domestic, industrial and commercial energy users. Each earned a guaranteed acceptance price of £3,000/MWh or more for reducing their demand on the grid during periods when supply was tight. Live events procured volumes through pay-as-bid tenders.

Service Description

DFS is a demand reduction service provided by registered suppliers or aggregators. A notification that the service might be required is provided 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 CM.
- **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 2023.** On-boarding test events are being run throughout the period with a Guaranteed Acceptance Price to encourage participation.

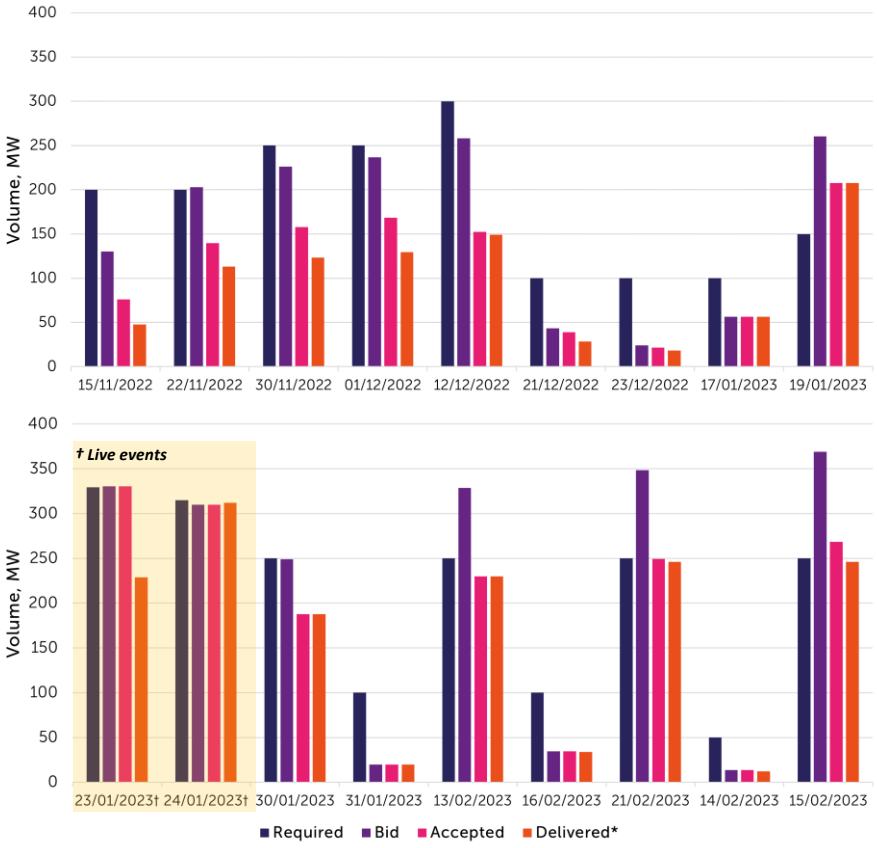
4.5.1 Volumes

The 20 events that occurred between the launch of the service in November 22 - March 2023) delivered* between 12 and 312 MW of demand reduction to the grid. Almost 50 MW was delivered in the very first test event, against a requirement of 200 MW (shown in Chart 12), indicating strong uptake from the start for what is a novel and unfamiliar service. The test events operated under competitive auction arrangements which required providers to submit bids against a pre-defined system requirement. Most, but not all of the bids were accepted for the events that occurred in 2022. From 2023, a different trend emerged as bids exceeded the requirement for the first time. In some cases, the ESO accepted considerably more bids than required. More often than not the volume delivered ended up being less than originally accepted, suggesting slight over-procurement on the part of the ESO as an effective way of managing delivery reliability for a consumer-focused service.

Just two 'live' events have been run to date, on the 23rd and 24th of January 2023. Both set a requirement of over 300MW and delivered the majority of that. 219 MW was delivered on the 23rd against a 330 MW requirement, and perhaps due to having an extra day's warning, providers were able to deliver 312 MW on the 24th, just a few MW shy of the 315 MW requirement.

**Delivered capacity refers to 'D0' capacity, which is an updated forecast of available capacity provided by each provider on the day of the event. Actual delivered volumes may differ from the D0 forecast.*

Chart 12: DFS events have delivered up to 312 MW of demand reduction.
Volumes of DSF services required, bid, accepted and delivered*, MW



4.5.2 Prices

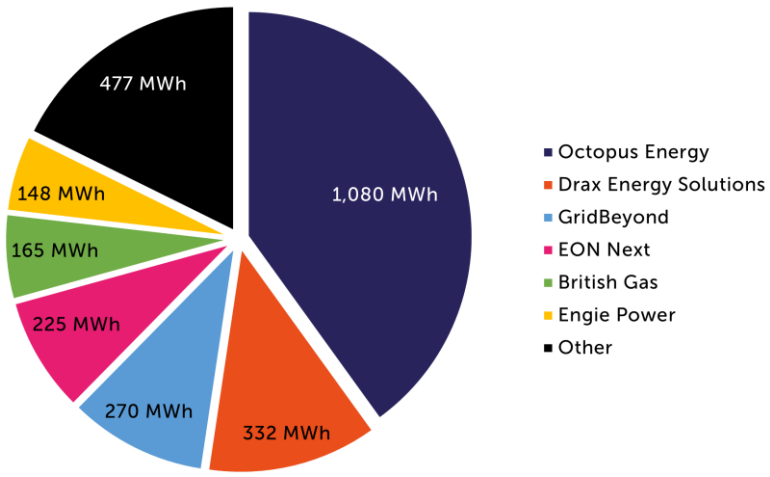
Different pricing patterns have emerged in the live and test events. Unsuccessful bids from the DFS test events were rejected largely based on price. £3,000/MWh appeared to be the cut-off – of the 116 rejected bids in the test events that have occurred to date, 98 submitted bid prices of over £3,000/MWh, ranging from £3,150/MWh to £6,000/MWh. 18 bids at £3,000/MWh were also rejected, although a closer analysis of the data suggests that this was due to errors in the bid submission. In accepted bid prices for test events there was no variation. All 547 successful bids received a price of £3000/MWh.

For the two live events that ran in January 2023 price does not appear to have been a factor in the selection of successful bidders. Just four bids were rejected, all apparently because of errors in submission. The 165 accepted bids ranged in price from £2,799 - £6,500/MWh, although the single provider with bids accepted at £6,000/MWh was not able to successfully deliver any demand reduction during the event, meaning they were not paid.

4.5.3 Providers

DFS providers are primarily domestic and industrial/commercial energy suppliers who deliver demand reduction by incentivising (or directly acting) to reduce their customer's demand during service windows. DFS events so far have been dominated by a small number of suppliers who have been early adopters of the new opportunity the service presents (shown in Chart 13). Octopus Energy delivered the largest volume at just over 1 GWh across the 18 events, followed by Drax Energy Solutions with 332 MWh and GridBeyond at 270 MWh. EON Next, British Gas, and Engie Power followed closely behind with 225 MWh, 165 MWh and 148 MWh respectively. 17 other providers contributed the remaining 477 MWh of demand reduction delivered.

Chart 13: DFS events were dominated by a relatively small number of energy suppliers
Demand reduction delivered* during DFS test events to date, 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 providers deliver additional electricity or increase their demand to help balance overall supply and demand.

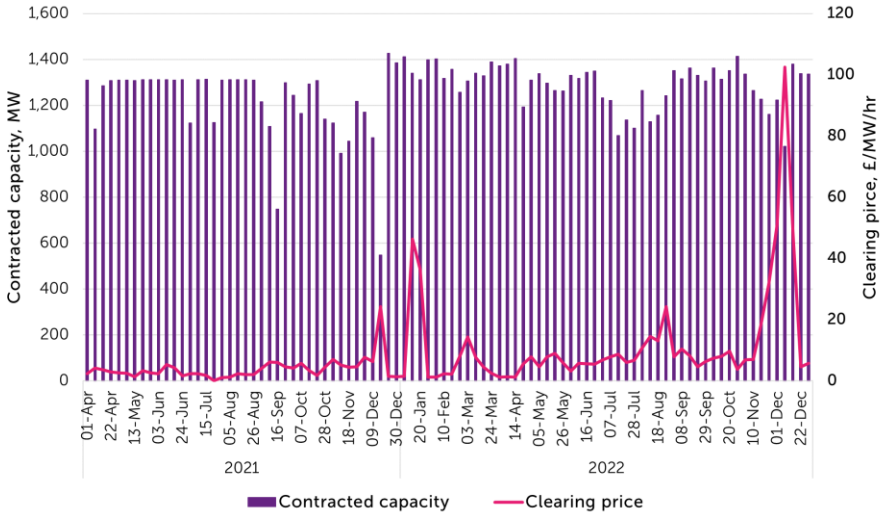
- **Slow response, long duration:** STOR requires a slower response (within 20 minutes) and longer duration (a minimum of 2 hours) than frequency response services.
- **Capability to recover and respond again:** Participating assets must be able to respond for a second time after their initial response, 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, re-launched in April 2021, continued to deliver over 1 GW of reserve services throughout 2022 (Chart 14). Weekly average volumes peaked at just over 1,400 MW and showed remarkable consistency over the year, with only a small reduction noticeable in July and early August. In most auctions, over 2 GW of providers placed bids.

Prices were markedly less consistent during the early and late months of the year. Rarely breaking £5/MW/hr in 2021, weekly average prices surged to over £45/MW/hr in January before falling back to more historically typical levels of below £10/MW/hr. However, several periods of higher average prices in the spring and summer point to a general increase in the value of STOR services to providers, something that was reinforced by a record price increase in December, when a handful of the daily auctions cleared at well over £100/MW/hr.

Chart 14: Spikes in January and December suggest a general inflationary trend in STOR clearing prices
STOR weekly average contracted volume and clearing price, MW and £/MW/hr

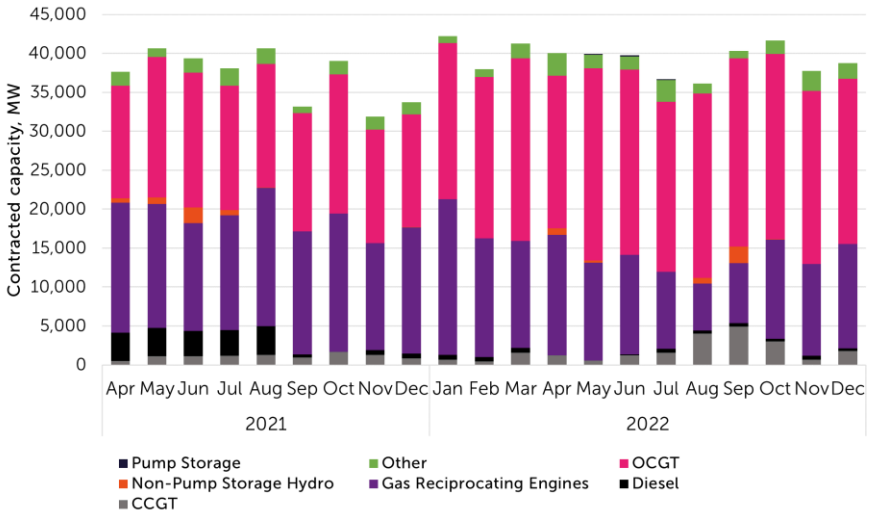


4.6.2 Technologies

As was the case in 2021, STOR remains a market dominated by traditional thermal forms of generation (shown in Chart 15). Open-Cycle Gas Turbines (OCGT) and gas reciprocating engines provide the majority of capacity, with OCGTs taking a bigger share than in 2021, a total of over 20 GW each month. The fall in the size of contracts awarded to diesel generators which began in late 2021 has been maintained through 2022.

Most non-thermal DSF assets fall into the 'other' category of STOR technologies, along with some other non-DSF assets. The size of STOR contracts awarded to this group increased slightly in 2022 compared to the previous year, although there are no discernible seasonal trends.

Chart 15: Thermal generation technologies continue to dominate STOR
STOR total contracted volume per month by technology type, MW



4.7 DSO Services

The number of flexibility services procured directly by GB Distribution Network Operators increased again in 2022 to a record 1.9 GW. While location-specific and highly variable in value, DSO services are an increasingly attractive option for DSF providers located in the right area of the distribution network.

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 100kW 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.

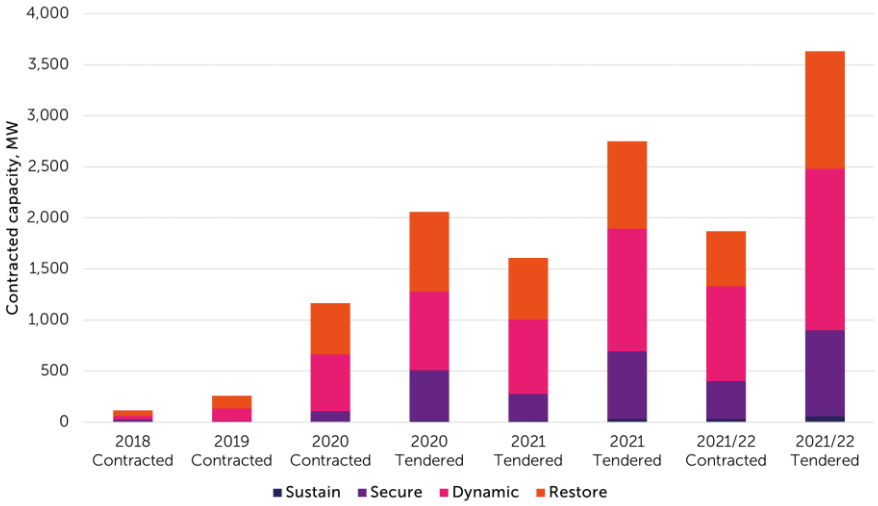
In 2022 the Energy Networks Association, the industry body for the electricity and gas network operators in the UK and Ireland, changed the way in which they reported on the flexibility services procured by GB Distribution Network Operators. Rather than providing figures for each calendar year, they 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 volumes of flexibility services procured by the UK's six Distribution Network Operators continue to increase. In 2021/22, a record 3.6 GW of services were put out to tender, 1.9 GW of which were contracted to a range of DSF providers across the country (Chart 16). Dynamic services still make up the majority of contracted services, although there has been a substantial increase in Secure-type services, up from 263 MW to 375 MW. There has also been a noticeable increase in the passive Sustain-type services tendered and contracted, although at only 28 MW this form of service still lags behind the others.

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.

Chart 16: The quantity of contracted DSO services continues to rise
Volumes of DSO services contracted and tendered by service type, 2018 to 2021/22, MW



4.8 The Capacity Market

The long-standing CM had a bumper year in 2022, with the T-1 and T-4 auctions held in early 2022 delivering record-high clearing prices and increased total capacities. The £75/kW/yr clearing price in the T-1 auction is particularly notable, as is the 1 GW of battery storage projects awarded long-term contracts on the T-4 auction.

Service Description

The CM 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.

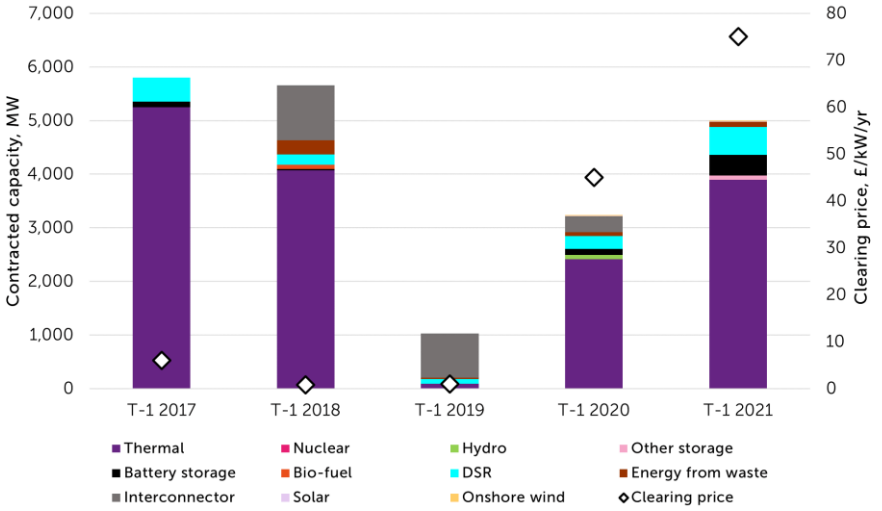
Under normal operation, two CM auctions are held each year. The T-1 is for delivery commencing at the start of the next delivery year, and the T-4 for delivery in four years' time. Auctions are pay-as-clear, with contracts of up to 15 years available in T-4 auctions for some new build assets.

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 of renewable energy subsidies are not eligible.

Any system stress events are preceded by a CM Notice (CMN), which provides a warning at least four hours in advance that there may be a generation shortfall approaching.

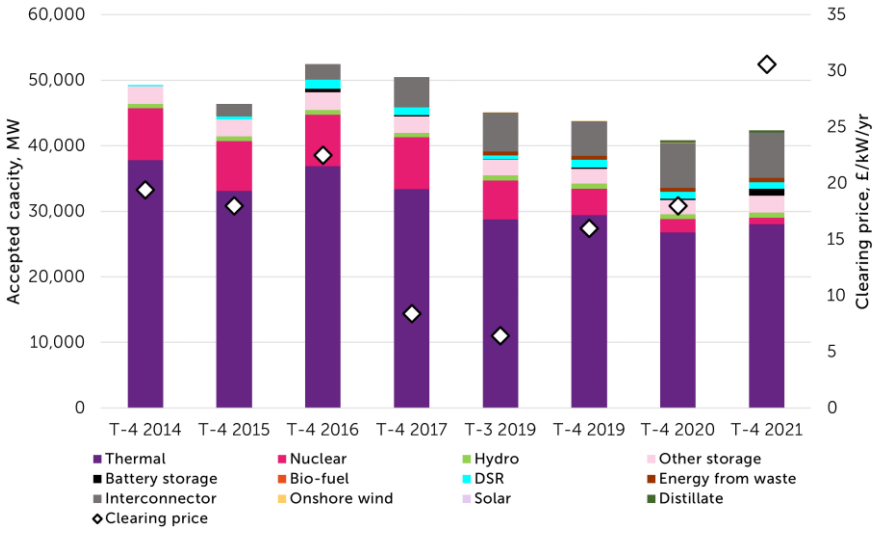
In the 2021 T-1 auction (held in early 2022), prices and capacity rose sharply for the second year in a row. The cleared capacity of just under 5 GW may not have quite topped the 2017 and 2018 auctions, but the auction clearing price of £75/kW/yr is a record high, an increase of £30/kW/yr on the previous auction, (shown in Chart 17). A large proportion of the increased capacity is delivered by thermal generators; however, other technologies also increased their market share, including battery storage (385 MW) and DSR (516 MW).

Chart 17: The 2021 T-1 auctions deliver a record high price
Clearing price and accepted capacity by technology of T-1 Capacity Market auction, MW and £/kW/yr



The T-4 auction cleared at a price of £30.59/kW/yr, another record (Chart 18). As with the T-1, the 2021 T-4 auction was actually held in early 2022. The T-4 is held 4-years ahead of delivery and offers contracts of up to 15 years for new-build assets. Contracts were awarded to over 42 GW of assets of various different technologies. In addition to the 28 GW of thermal technologies, over 1 GW of (derated) battery storage projects won contracts for the first time, as well as another 1 GW of demand side response.

Chart 18: Over 1GW of battery storage projects were awarded T-4 contract at record high prices
Clearing price and accepted capacity by technology of T-4 Capacity Market auction, MW and £/kW/yr



4.9 The Balancing Mechanism

In 2022 the opportunity presented by the BM was capitalised on by more DSF assets than ever before. As other high-value markets become increasingly competitive, DSF providers able to navigate the hurdles of BMU registration and trading competence are making use of their asset's capabilities in this large and volatile market.

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.

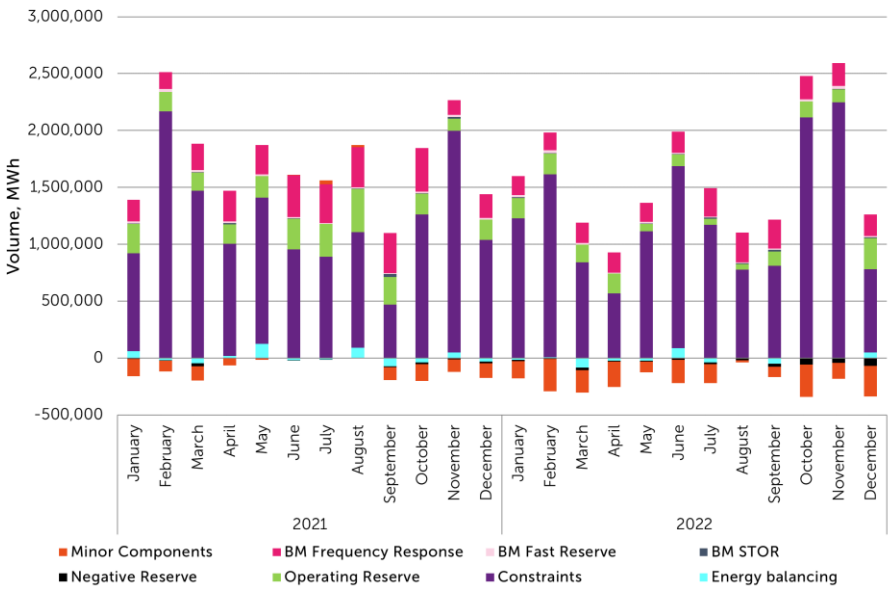
Participants in the BM submit bids and offers to reduce or increase their generation or consumption within each 30-minute settlement period. The ESO calls on these providers as needed, paying the bid or offer price for the volume dispatched.

4.9.1 Volumes

The quantity of energy dispatched through the BM reveals its huge scale compared to other markets for DSF assets. In 2022, monthly dispatched BM volumes ranged from 1 TWh to over 2.5 TWh (including negative dispatch, i.e. energy consumption or reduction in generation; shown in Chart 19). As was the case in 2021, most actions are taken for constraint management purposes. What is notable in 2022 is the increase in negative dispatch volumes, primarily minor components, hinting at the increasing need and ability to control over-supply on the grid.

Chart 19: Monthly BM volumes ranged from 1 TWh to over 2.5 TWh over the course of 2022

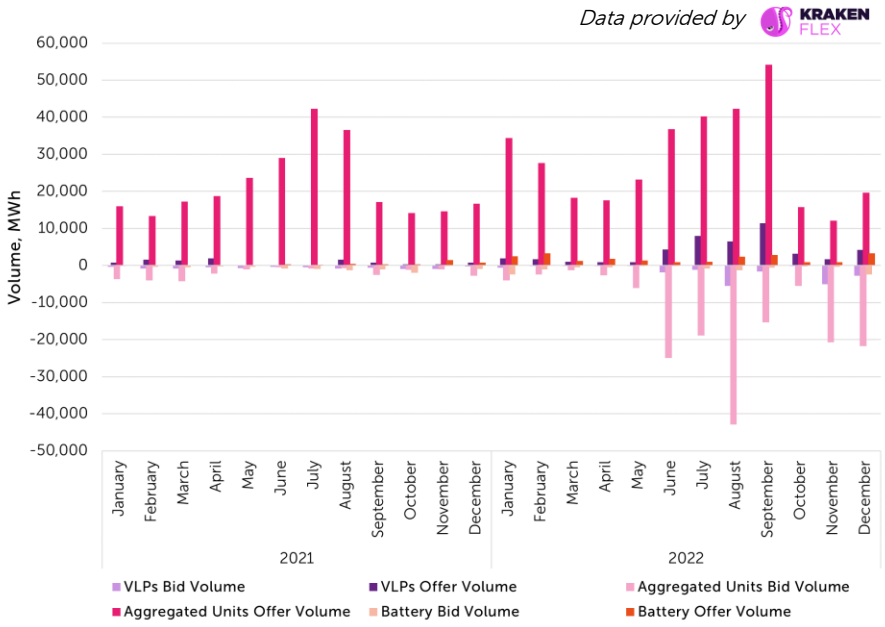
Balancing Mechanism volumes by type of instruction, MWh



Conventional, large-scale thermal generators deliver the vast majority of these actions. 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 new routes into the market for non-traditional asset classes. For batteries assets at least, it does not appear that the number of active providers is the only reason DSF technologies are not more prevalent in the BM. More battery projects capable of providing BM services are online than ever before, and as DC starts to reach full capacity, these assets are looking to markets such as the BM for alternative revenue sources. Backing up this trend, Chart 20 shows a notable increase in BM activity for batteries, with total offer volumes increasing from around 4,000 MWh in 2021 to over 20,000 MWh in 2022. However, some battery operators claim that their assets can do more and are often overlooked in favour of traditional assets by the system operators. While the ESO is reportedly improving their tools to allow more efficient dispatch of smaller BM units, implementation may take some time.

In addition to the increased BM activity from batteries, Chart 20 indicates that the dispatched volumes of all DSF-friendly BMU unit types increased in 2022. Most notable in the surge is accepted bids to consume electricity (or reduce generation) from aggerated units, which hit almost 50 GWh in August 2022.

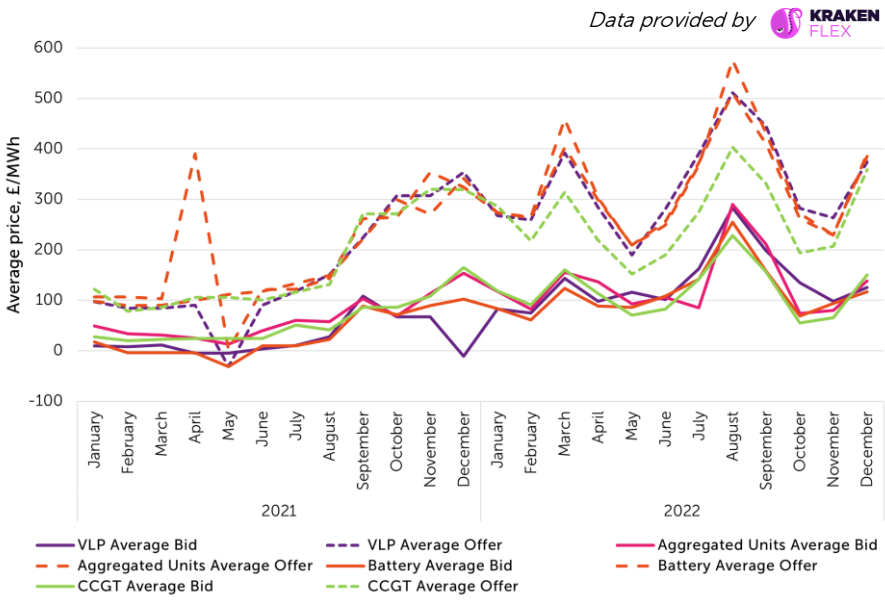
Chart 20: Dispatch of all DSF-friendly BMU types increased in 2022
Balancing Mechanism dispatch volumes by BMU type for aggregated battery and secondary BMUs, MWh



4.9.2 Prices

Average accepted bid and offer prices indicate the long-run value of the BM. The upward trend in prices in 2022 is underpinned by the significant increase in wholesale energy costs seen over the last 12 months. The effects of this cost increase are evident across all the four BMU types shown in Chart 21 which are strongly correlated for both bid and offer prices. However, monthly average prices hide the true nature of BM volatility, which has been especially high throughout 2022. DSF assets, typically quick to respond and often capable of importing and exporting power, are well placed to respond to the extreme price events that are a frequent occurrence in a volatile market. With average monthly offer prices nearing £600/MWh for aggregated units in August 2022, for the more than 40 GWh of dispatched volume, there is significant value available in the BM for DSF providers who know how to capture it.

Chart 21: Average BM bid and offer prices have increased in 2022
Monthly average accepted bid and offer prices by BMU type, £/MWh

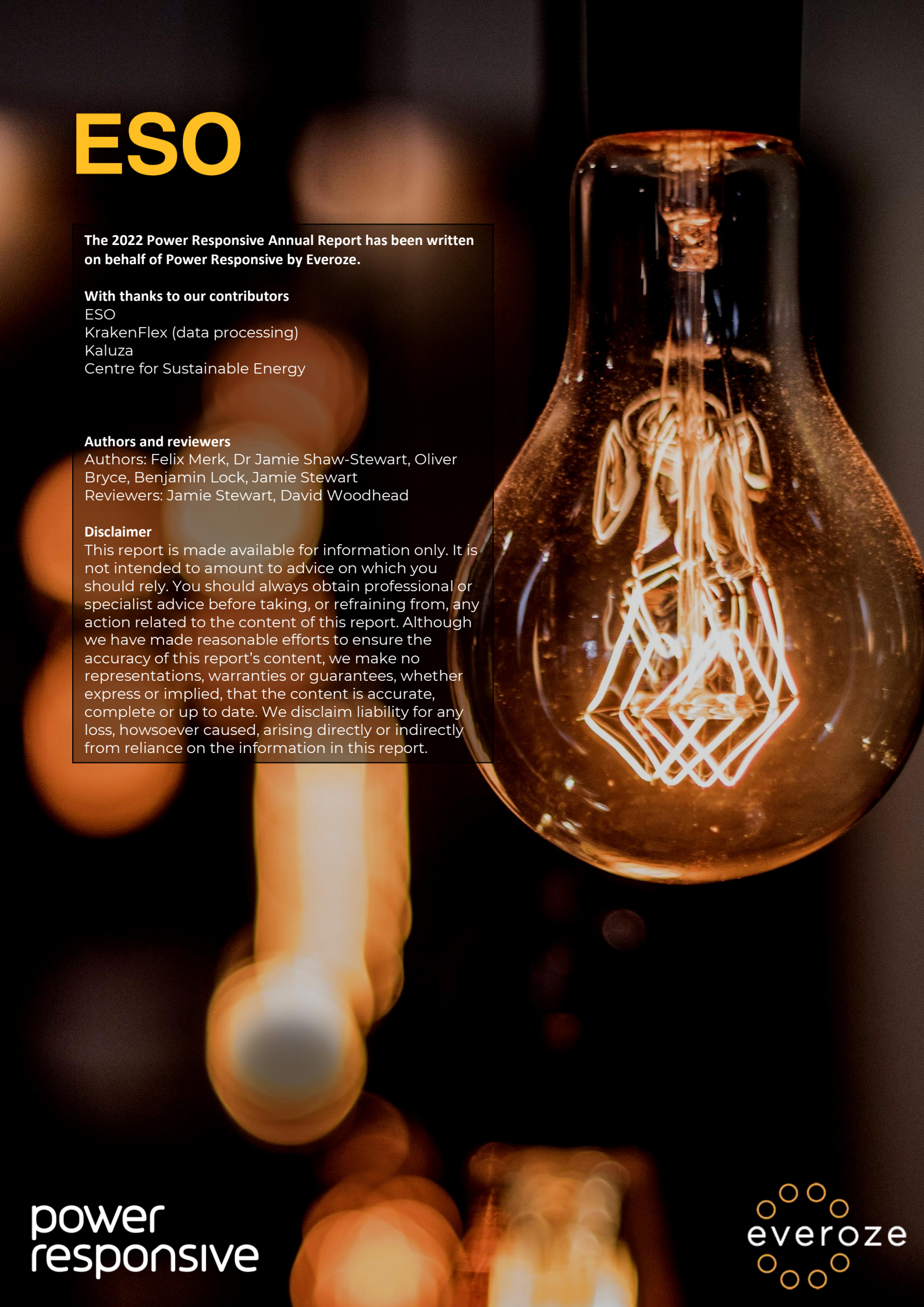


5.0

Appendix A – glossary

Access SCR	Access and Forward-looking Charges Significant Code Review
API	Application Programming Interface
BEIS	Department for Business, Energy, and Industrial Strategy (UK)
BM	Balancing Mechanism
BMU	Balancing Mechanism Unit
CCGT	Combined Cycle Gas Turbine
CCS	Combined Charging System
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	Simple Market Platform
SPEN	Scottish Power Energy Networks
STOR	Short Term Operating Reserve
UK	United Kingdom
V2X	Vehicle to Everything

.



ESO

The 2022 Power Responsive Annual Report has been written on behalf of Power Responsive by Everoze.

With thanks to our contributors
ESO
KrakenFlex (data processing)
Kaluza
Centre for Sustainable Energy

Authors and reviewers
Authors: Felix Merk, Dr Jamie Shaw-Stewart, Oliver Bryce, Benjamin Lock, Jamie Stewart
Reviewers: Jamie Stewart, David Woodhead

Disclaimer
This report is made available for information only. It is not intended to amount to advice on which you should rely. You should always obtain professional or specialist advice before taking, or refraining from, any action related to the content of this report. Although we have made reasonable efforts to ensure the accuracy of this report's content, we make no representations, warranties or guarantees, whether express or implied, that the content is accurate, complete or up to date. We disclaim liability for any loss, howsoever caused, arising directly or indirectly from reliance on the information in this report.

power responsive

everoze