Electricity System Operator

Markets Roadmap to 2025

nationalgridESO

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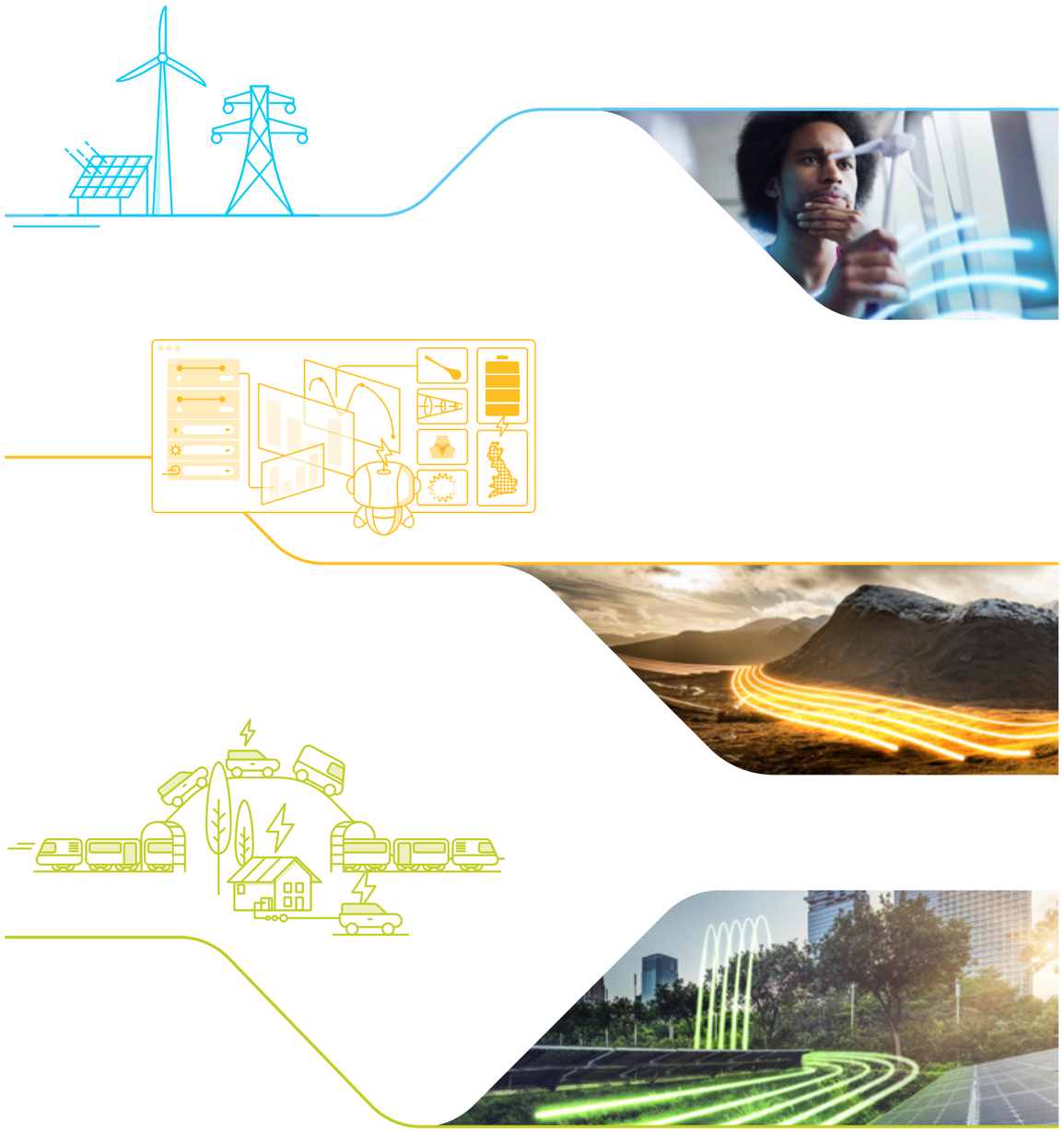

Foreword

We are delighted to publish National Grid ESO's Markets Roadmap to 2025. The period to 2025 represents a crucial time for our business as we reform market arrangements that will enable the system to operate carbon free and deliver competition everywhere.

Kayte O'Neill
Head of Markets, National Grid ESO

The ESO has a unique role in the development of market arrangements, from developing reforms across balancing markets to running the Delivery Body function within Electricity Market Reform. With the importance of these roles, comes the need for openness and transparency of our plans and decisions in order to deliver reliable markets that are good value for consumers. We recognise that we can't do this alone. We will continue to build trust and partnerships with you, our stakeholder, to jointly remove unnecessary market barriers and deliver greater value.

This publication sets out an overview of our transformational plans from today to 2025 for those markets in which we play a key role. We present our ambition to transform these markets and the principles underpinning their design. We also provide detail on each of our markets, setting out current and future market values and areas for development. Alongside this, we discuss how these markets interact with others in the wider electricity sector.

In addition, we are committing to regular updates on our plans as part of a more extensive engagement process to be launched during 2021.

Our markets journey to date

The need to decarbonise the power sector is driving a fundamental shift in how stakeholders use and interact with the electricity system. These changes require enhanced market arrangements to deliver efficient market outcomes and consequently good value for consumers.

Recognising the need for change we initiated a project back in the summer of 2017, where we first communicated our intent to reform many of our market arrangements. This was in the form of our System Needs and Product Strategy, often referred to as 'SNAPS'. SNAPS laid out a plan for extensive reform across areas such as inertia, frequency response, reserve, voltage and black start. This work provided the foundation of our approach to transforming our balancing services markets which continues today. The principles we established for reform back in 2017 remain largely unchanged with a focus on standardising market arrangements, rationalising the volume of products and simplifying our processes and contracts to facilitate market access for an ever-growing number of providers.

Whilst our SNAPS publication was successful in outlining our forward intent and vision, it has also highlighted the complexity of making such material reforms in an operational and dynamic environment. We have made considerable progress towards the visions laid out in SNAPS; opening up markets to more participants and introducing new products and services in record time. However, the changing energy landscape and continually evolving system needs coupled with the complexity of delivering high quality market reform has resulted in changes to our reform roadmaps. We recognise the impact this has had on market participants and their business planning.

As we move forward, we recognise there is a stronger emphasis on the delivery of our plans and on transparency of the risks that complex programmes of work will naturally have. We are also benefiting from the knowledge and experience gained from delivering important and transformational programmes of work such as facilitating easier access to the Balancing Mechanism and our new Dynamic Containment frequency response product which went live in the autumn of 2020. These projects, among others, have further reinforced the importance and value of collaboration with our stakeholders to reach mutually beneficial outcomes and best enable the realisation of our 2025 ambitions.

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Ambition, principles and process

Ambition, principles and process

We are committed to providing transparency and clarity around our plans to transform our markets as we move towards 2025. Here we share our ambition and the key principles that underpin our design decisions for ESO markets along with our process for developing market arrangements.

Our ambition is to design market arrangements that facilitate security of supply at the lowest sustainable cost for customers, while enabling the transition to net-zero.

Any market design must promote and achieve this ambition both now and, in the future, and therefore the following design principles will underpin our approach.

We will design markets that are individually and collectively:

Competitive and Accessible	• Highly competitive and liquid, balancing short- and long-term value and sustainability • Accessible to all market participants that can technically deliver the service, irrespective of technology type
Transparent	• Clear and transparent, where requirements are understood, and outcomes are explainable / auditable • Underpinned by accurate and timely information that supports decision making, removes information asymmetry to enable confidence in a level playing field
Fair	• Operating under standard contracts, frameworks, technical requirements and pre-qualification processes that are proportionate, fair and durable • Designed from the outset to support a clear and transparent performance monitoring regime
Coherent	• Coherent with each other and consistent in approach across • Complementary, allowing the market participant to choose where (into which market(s)) to bid and enabling value / revenue stacking where product offerings can technically stack

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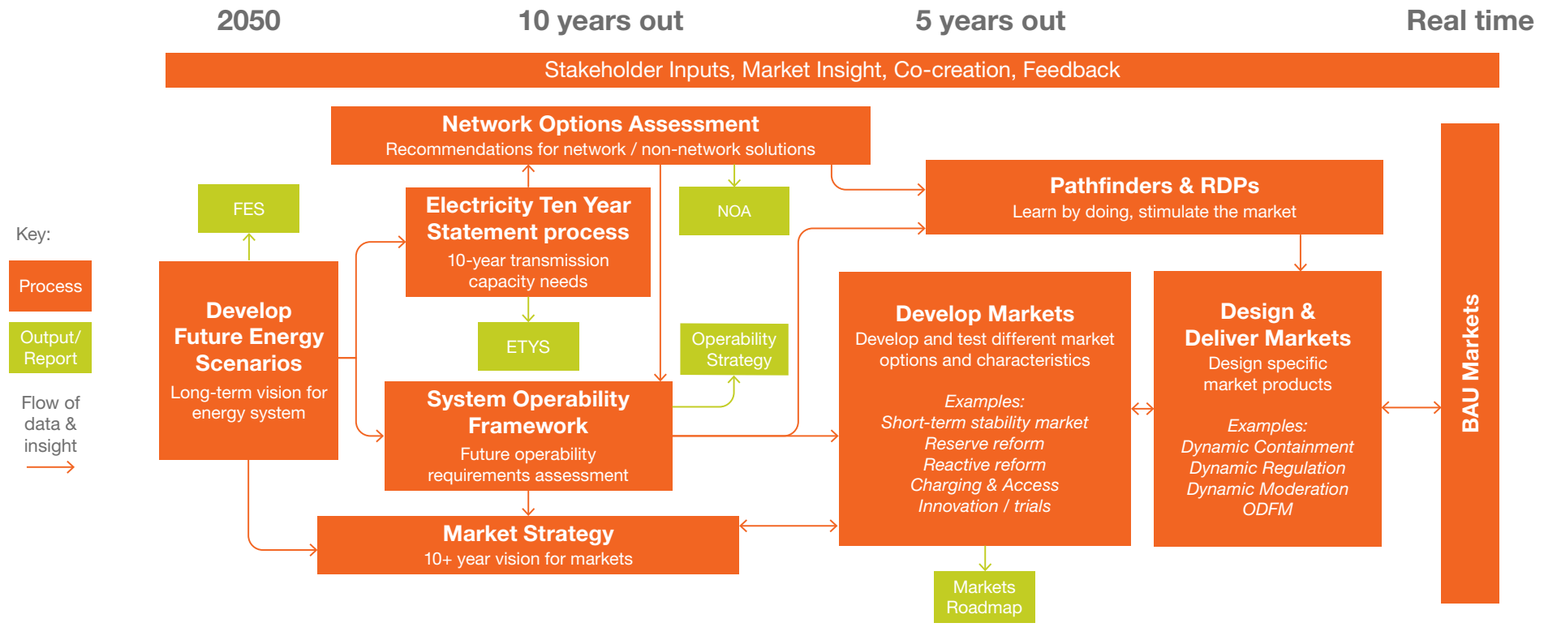
Ambition, principles and process

Process for developing markets

Here we provide an overview of the process for delivering market reforms. This process is designed to show the flow of a specific change we would make in the market. As part of bringing the process to life we have illustrated how different ESO publications interact with our process and the expectations that stakeholders can expect throughout out process.



What can stakeholders expect to understand?	2050	10 years out	5 years out	Real time
	• Long-term future market scenarios • High-level consumer impact • **Outcomes will be very uncertain**	• Clear 10-year vision for markets • High-level set of options to get to this vision • **The 10-year vision will be clear, the means to get there still uncertain at this stage**	• 5-year roadmap for markets • Consumer and stakeholder impacts • Opportunities to participate in trials • **Objectives for 5-year market reforms will be clear, with indicative delivery dates for objectives. Detailed product designs still unclear at this stage**	• Communicate transparent requirements of our products • **Clear and concrete product design and delivery plan**

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Ambition, principles and process

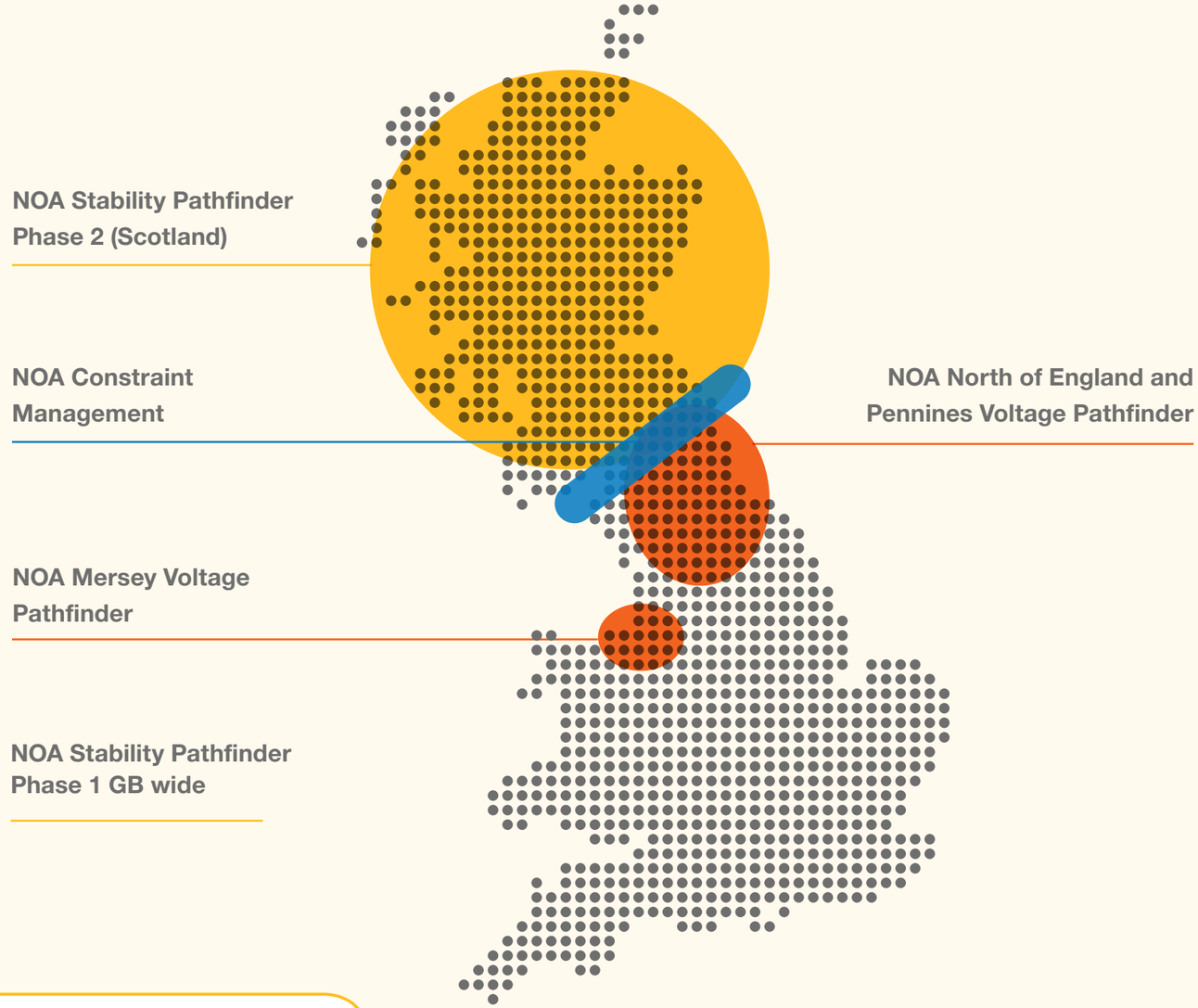
Case Study:
A focus on our pathfinder projects

Historically many of the systems operational needs were provided as either a by-product of the technology of the generation plant or as a condition of its connection arrangements given the generation capacity of the asset. The changing energy mix means as the system needs change, the options for how we provide solutions against these needs require transformation as well.

We therefore developed a pathfinder approach to investigate how commercial services from participants could deliver against certain system needs that have not historically been open for commercial opportunities.

The pathfinder approach is a new process that is very much ‘learning by doing’ and engaging solution providers in an ongoing conversation in order to attract competitive and innovative service proposals, leading to contracts for the services we need.

A map showing our key Pathfinder Projects is shown in the figure right.



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A focus on 2025

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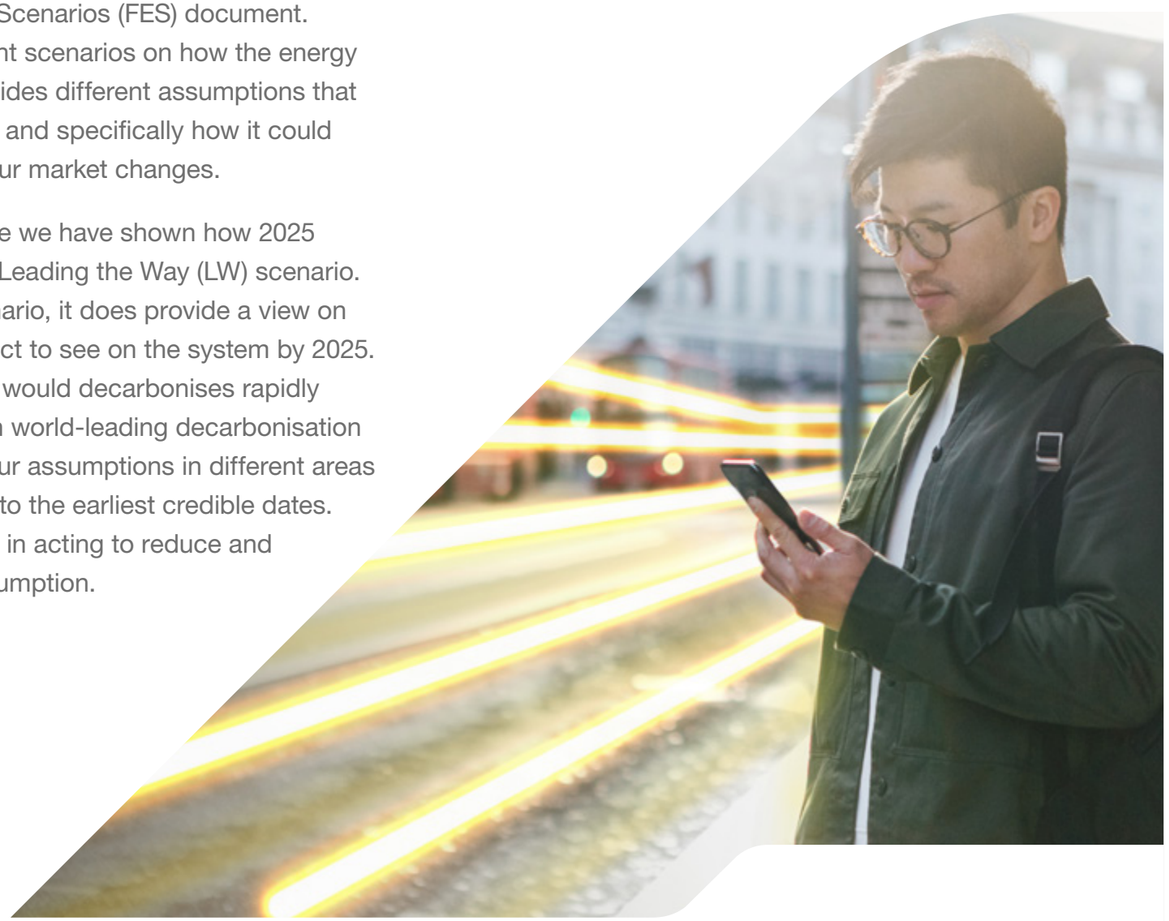
A focus on 2025

Our mission is to enable the transformation to a sustainable energy system and ensure the delivery of reliable, affordable energy for all consumers. By 2025 success would be an electricity system that can operate carbon free, with competition everywhere and the ESO acting as a trusted partner for you. Enabling change in our markets is an extremely important component in achieving this success.

Whilst our market plan is focused on how we achieve this success we will also need to continually review our plan as decisions in the wider energy environment change the view on what the future will look like. Our plans will therefore need to adapt and be fine-tuned to the dynamic nature of the sector. We don't expect the core elements of our plan to change, but it is possible that the delivery of some projects will be modified as the case for change evolves.

One important document that enables us to have a view of the future is our Future Energy Scenarios (FES) document. This document includes different scenarios on how the energy system could develop and provides different assumptions that provide a version of that future, and specifically how it could drive the pace and design for our market changes.

To illustrate a vision of the future we have shown how 2025 could look using the FES 2020 Leading the Way (LW) scenario. Whilst this is an ambitious scenario, it does provide a view on the step change we could expect to see on the system by 2025. The scenario assumes that GB would decarbonises rapidly with high levels of investment in world-leading decarbonisation technologies. In this scenario our assumptions in different areas of decarbonisation are pushed to the earliest credible dates. Consumers are highly engaged in acting to reduce and manage their own energy consumption.



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A focus on 2025

	2020	2025 (LW)	What could this mean for markets?
Supply side			• These new low-carbon sources should provide cost effective power. But they will also change the characteristics of how the system behaves in terms of greater unpredictability. Our markets will therefore need to be efficient for cleaner low carbon technology and smaller decentralised providers. This means that markets will need to attribute more value to speed of service response, and enable decisions for market outcomes closer to real time operation.
Renewable generation (%)	38%	75%	
Offshore wind	9.5GW	24.7GW	
Solar	13GW	19GW	
Interconnector capacity	4.75GW	17.9GW	
Demand side			• Vast amounts of new potential flexibility will connect to the system, from a variety of sources including EVs and batteries. Markets across both transmission and distribution need to be co-ordinated and co-optimise to recognise the whole electricity system value that these assets can deliver. • The nature of the changing energy mix on the system will change how we use the system. This will result in ESO markets needing to evolve in order to work efficiently for the changing profile of demand across different profiles.
BEVs of total cars	0.3%	9%	
Battery storage	1GW	>4GW	
Residential heat pumps	162k	1.86m	
Transmission demand summer Sunday pm	18.8GW	14.5GW	
Transmission peak demand	46.2 GW	38.7GW	

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Markets deep dives

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Markets deep dives

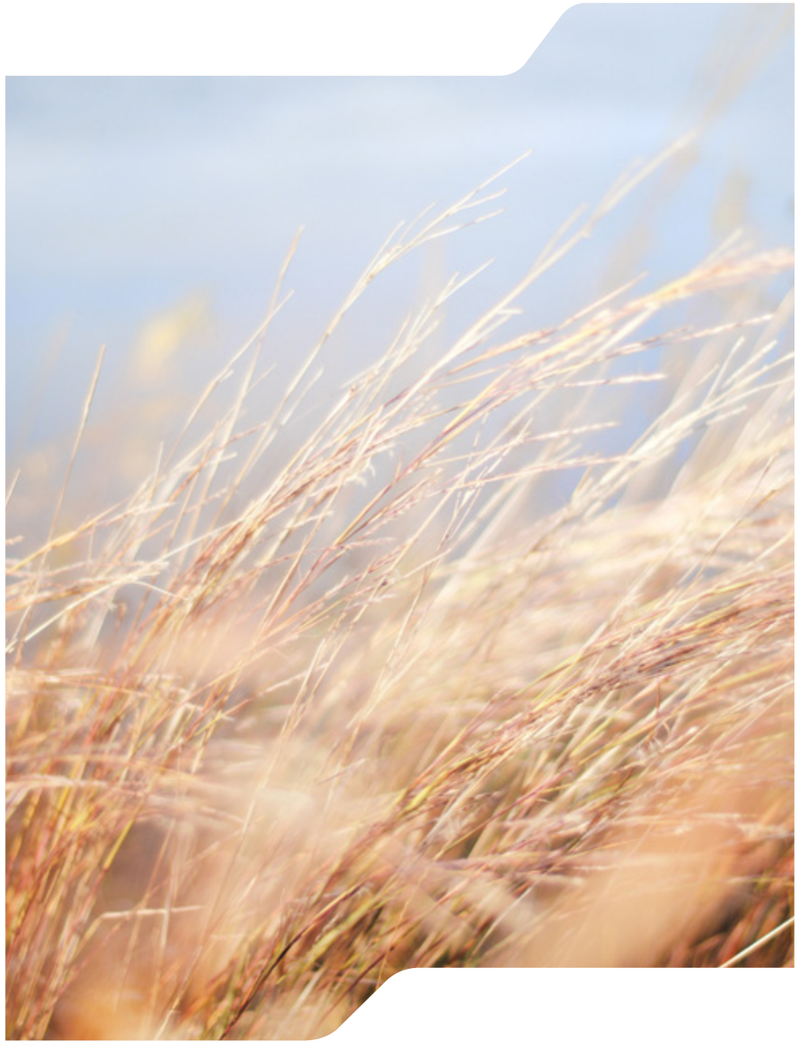
Given the strong case for change, we want to be transparent about our plans. We understand that providing as much clarity on future needs as possible will assist more parties to participate in our markets and drive value for consumers.

In this section we explore our roadmaps from today to 2025 for the markets we own and administer:

- Frequency Response
- Reserve
- Thermal
- Reactive Power
- Restoration
- Stability
- Balancing Mechanism (Bids and Offers)
- Capacity Market

For each market, we set out the following information:

- Our vision for that market in 2025
- The key drivers for reform
- How the operational need is changing
- The value of the market
- How to get involved with upcoming events
- A roadmap of related activity through to 2025



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Frequency Response

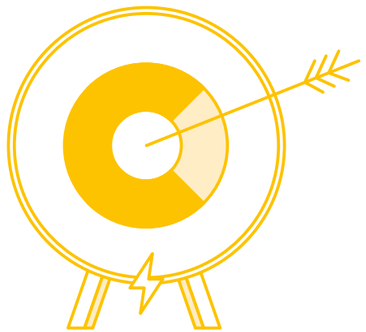
To operate a zero-carbon system we need fast-acting dynamic response products. These products will be procured through deep, liquid and close to real time markets. This is a key enabler to achieve our ambitions for zero-carbon system operation by 2025 and competition everywhere.

We procure Frequency Response services to manage system frequency within Security and Quality of Supply Standard (SQSS) limits around 50Hz. The services support us in managing frequency both on a second by second operational basis (regulation) and in post-fault situations where there is a sudden loss of generation or demand from the system which creates a mismatch between demand and supply. To contain a fall in frequency we require an injection of active power or reduction in demand to correct the deviation. Conversely, to contain high frequency scenarios we require a reduction in active power or increase in demand to return frequency to the normal range.

Key Drivers for Change

- Changing System Conditions
- ESO Ambition: Competition Everywhere
- ESO Ambition: Zero-Carbon Operation
- European Code Compliance

We are increasingly experiencing low inertia conditions on the electricity system which means that the frequency moves more quickly in the immediate moments after a large imbalance. To tackle this, we need faster acting response products that deliver MW proportionally to system need.



ZERO-CARBON OPERATION 2025

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Frequency Response

Operational Need

To manage a system with lower levels of inertia we need faster acting dynamic frequency response products to secure our system in the event of any credible system loss. In 2025 we expect to see credible losses that are larger than today, for example new nuclear, interconnectors and offshore wind. In addition, the number of possible losses will increase. We will be procuring a combination of our new response products Dynamic Containment (DC), Dynamic Moderation (DM) and Dynamic Regulation (DR) to manage these system needs.

Operational Requirement

2020/2021	2025
Today, we buy response to meet our obligations under the SQSS. We meet these obligations through a mixture of response products and by reducing the size of the losses we need to secure. To procure our dynamic Primary/Secondary/High (P/S/H) product we use the Firm Frequency Response (FFR) monthly tender, Weekly Auction Trial and real-time Mandatory frequency response (MFR) via the Balancing Mechanism. Our minimum requirement is currently set at 550MW and we weigh up expectations of prices in closer to real time markets when deciding how to meet this. We expect to buy more DC (up to 1400MW) over the summer months in 2021 with a slightly reduced requirement (up to 1100MW) in winter. This requirement is driven by forecast demand, inertia and loss sizes as well as the FFR and stability pathfinder procurement strategies.	In 2025, we will be guided by the Frequency Risk and Control Report & Methodology (FRCR) which sets out the losses we need to secure and the agreed cost vs. risk framework. By 2025 our requirement will change daily based on system conditions (driven mainly by intermittent generation forecasts) and by security obligations determined by the FRCR. As an example, the FRCR may require us to secure all low cost but high probability losses and these will change each day depending on the generation mix. Our procurement needs will be more transparent. For example, buying more frequency response on days with low inertia but large infeed losses. Or buying less frequency response when our normal largest loss is not active.

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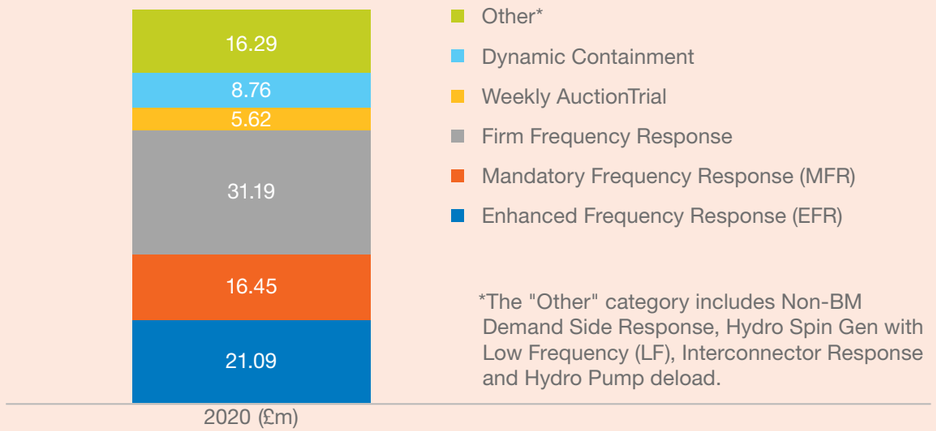
Frequency Response

Value of the Market

In 2020 (from January to December 2020 inclusive) the total value of ESO response markets was almost £100m. By 2025 this picture will look quite different as new response products will have been introduced whilst existing and legacy products, such as EFR, FFR and the Weekly Auction Trial, will have been phased out. Spend on the new products will depend largely on how competitive the markets are by 2025 and the ESO's procurement requirements for zero-carbon system operation which are still being defined.

2020 Response Spend – by product



*The "Other" category includes Non-BM Demand Side Response, Hydro Spin Gen with Low Frequency (LF), Interconnector Response and Hydro Pump deload.

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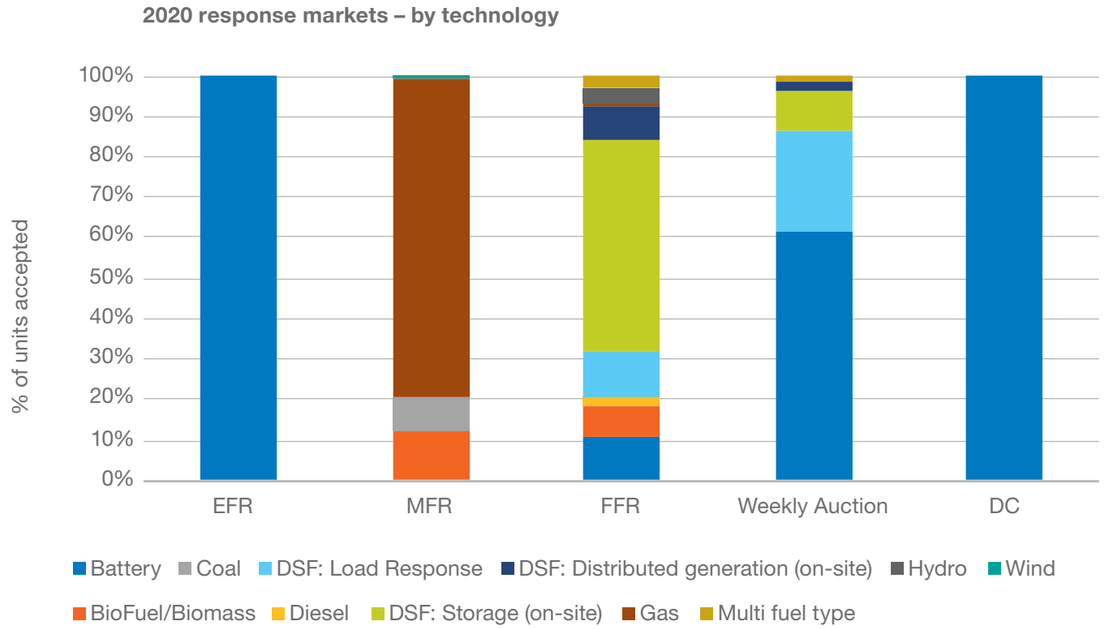
Frequency Response

Market Information

Our frequency response markets are already accessible to the widest range of providers of all our balancing services markets, but we still have some work to do to deliver our ambition of competition everywhere. Our response reform programme will enable greater volumes of zero-carbon generators: wind, solar PV, batteries and interconnectors to participate in response markets.

Market Information - Service Providers

2020	2025
The ESO currently procures response services from a wide range of providers. Batteries and demand side aggregators make up the majority of volume in DC and the Weekly Auction. The FFR market has the broadest range of technology types whilst the MFR market remains dominated by large conventional generators such as CCGT, biomass and coal units.	By 2025 there will be greater volumes of distribution connected generation and aggregated capacity participating in our response markets. Our markets will have been opened up to renewables like wind and solar of all sizes. Emerging flexibility providers such as Vehicle to Grid (V2G) and residential DSR will be looking to ESO response markets for commercial opportunities. We expect that most providers who currently participate in our FFR market will be able to meet the technical requirements for DR but if this is not possible, there will be opportunities in our new reserve product markets.



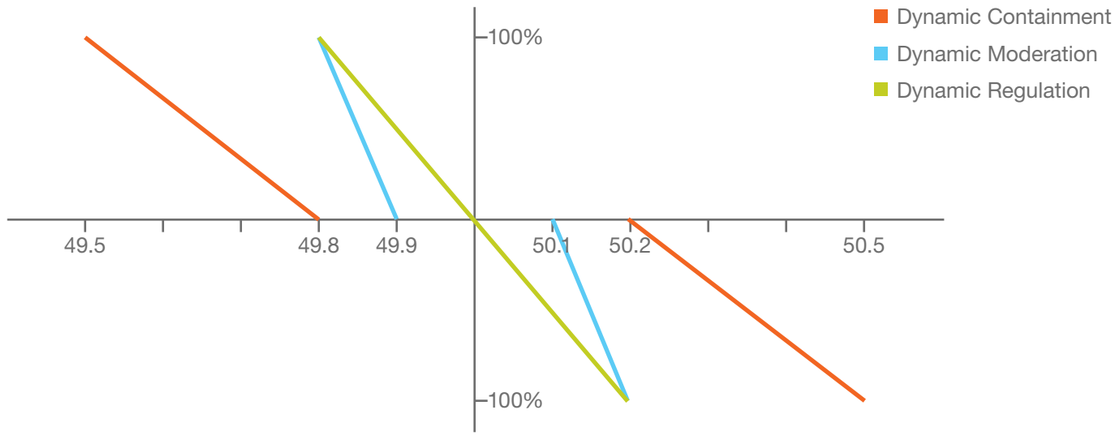
Frequency Response

Our Future Response Product Suite

Our end-state vision for meeting our response need in 2025 is through three products: Dynamic Containment, Dynamic Moderation and Dynamic Regulation.

These products work together to protect the system. The first product to be launched Dynamic Containment (DC) is our post fault product which is designed to 'catch' the frequency before it falls so low that demand is disconnected. The remaining products in our new response product suite support the system in less extreme scenarios. Dynamic Moderation (DM) is expected to be rapidly delivered when frequency begins to move towards the edge of the operational range. We would expect DM to deliver if there is a large imbalance between demand and generation due to an erroneous wind forecast or a large unit rapidly ramping. Dynamic Regulation (DR) continually delivers even during times of normal system operation regulating frequency around 50Hz.

New Response Products[1]



	Dynamic Containment (DC)	Dynamic Moderation (DM)	Dynamic Regulation (DR)
Product Characteristics	Designed to arrest the change in frequency following a sudden imbalance. The aim is to contain frequency within SQSS limits (for unacceptable frequency conditions)	Designed to assist frequency management following large imbalances. The aim to contain frequency within operational limits of +/-0.2Hz	Designed to slowly correct small continuous deviations in frequency. The aim is to continually regulate frequency around the target of 50Hz
How we will buy it	Pay-as-clear Auctions	Pay-as-clear Auctions	Pay-as-clear Auctions
When we will buy it	Day-Ahead	Day-Ahead	Day-Ahead

1 The image above is simplified and does not show "deadband" zones.

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Reserve

Our reserve products need to adapt to be fit for the future electricity system and to complement our new response product suite. We will be launching a new set of products to be procured alongside the new response product suite through deep, liquid and close to real time markets.

Reserve is the capability to deliver upward or downward energy within a specified timescale. It is used to ensure that sufficient upward and downward flexibility is available so that the system can be operated securely. If required, energy delivery is manually instructed within gate closure timescales either to manage energy imbalances or to complement automatic frequency response services. Reserve can be either upward (an increase in generation/decrease in demand) or downward (a decrease in generation/increase in demand). Today, we use a mix of balancing services products like Short Term Operating Reserve (STOR), the Balancing Mechanism (BM) and trading to ensure that we have access to reserve in the necessary timescales.

Key Drivers for Change

- Changing System Conditions
- ESO Ambition: Competition Everywhere
- ESO Ambition: Zero-Carbon Operation
- European Code Compliance

We are increasingly experiencing periods of low demand and low inertia on the Transmission System which require new reserve products to manage. Lower demand requires access to negative energy products (demand turn-up/generation turn-down) products to maintain sufficient foot room.

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Reserve

Operational Need

The need for faster acting reserve services originates from many of the same considerations for faster acting response services; we need to be able to act quickly to restore frequency to 50Hz. In addition to frequency restoration from infeed or outfeed loss events, reserves are required to balance the system due to the uncertainty in upcoming demand and generation, and to react to rapid shifts causing imbalance.

Operational Requirement

2020	2025
1700MW of firm reserve is secured near demand peaks via the STOR product for SQSS largest loss compliance. Other optional commercial products such as Fast Reserve are still accessible for use for rapid reactions to energy imbalance and to complement BM actions. Additional reserves to cover uncertainty in demand and generation are accessed via scheduling decisions, varying across the day, week, and year and according to weather forecast.	In 2025 we will need to secure access to fast, flexible sources of both upwards and downwards reserve energy. This will help us to manage the impact of weather on directly connected renewable generation and shifts in generation and visible demand. We will rebuild our requirement setting approach to account for these uncertainties and other input factors identified at day ahead timescales to best inform our day ahead procurement requirements. This will enable us to schedule and secure appropriate levels of reserve for upcoming conditions. We intend to procure firm access to standardised commercial products to support the BM, currently our primary reserve source.

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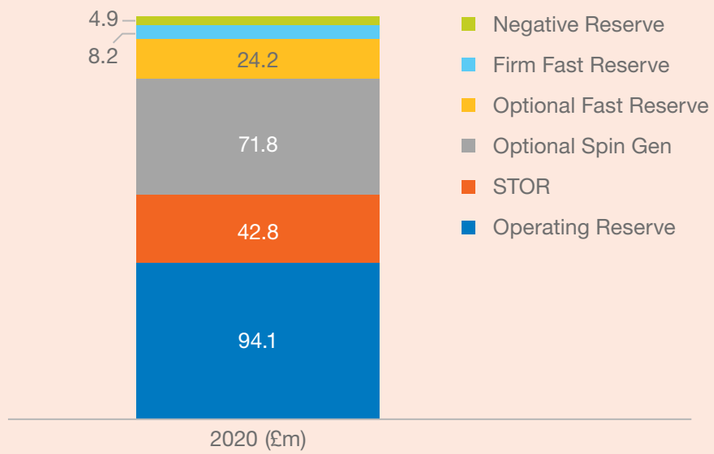
Reserve

Value of the Market

In 2020 (from January 2020 to December 2020 inclusive) the total value of ESO reserve markets was over £240m. Most of the reserve volume was procured directly through the BM. By 2025 this picture will look quite different as new reserve products will have been introduced moving volume and spend from the BM to these new product markets.

2020 Reserve Spend – by product



Reserve

Market Information

The introduction of new reserve products procured closer to real time will provide new opportunities in these markets for all technology types including intermittent generation generators. Reserve products which complement the new response product suite will ensure that procurement decisions can deliver great consumer value with every MW purchased.

Market Information - Service Providers

2020	2025
Our reserve services are still mostly bought via the Balancing Mechanism, in real time. This route, by nature, excludes some parties from participating in the market. The most recent year was not a typical one for reserve procurement as both STOR and Fast Reserve monthly tenders were paused from January 2020 to comply with CEP requirements. In 2020 the majority of our Operating Reserve was provided by large gas stations procured and instructed via the BM.	By 2025 we will be accessing more reserve through standardised products in day-ahead or close to real time procurement rounds. This will increase the participation of smaller providers. We intend to be using new reserve products by 2025 which we will develop in collaboration with industry through 2021.

Day Ahead STOR procurement – from April 2021

We will restart procurement of our STOR service from 1st April 2021 moving to day ahead procurement. In moving to daily procurement of STOR there are no significant changes to the service design. Flexible STOR has been removed. The daily auction for the Committed STOR windows closes at 05:00 for service delivery the following day starting at 05:00. Non-BM Providers can participate in Optional STOR outside of the Committed windows.

The daily auction process requires providers to submit their MW and Availability Price. All availability prices for firm STOR will be settled using a pay-as-clear mechanism. Moving the availability price to pay-as-clear incentivises STOR providers to submit their marginal price and is believed will have a downward pressure on overall balancing costs.

All utilisation prices for instructed STOR will continue to be settled using a pay-as-bid mechanism and submitted closer to real time and not fixed during the auction.

The technical parameters of the assets are captured in the STOR Data Template – these were previously captured at the point of tender submission.

There is more information on the new STOR day-ahead procurement process here.

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Response and Reserve Programmes

Tackling Uncertainties in our Response and Reserve Programmes

Our three end state products show how we want to transform our response markets and our vision for response procurement before 2025. However, there are still some important questions that we are focused on answering regarding the implementation and ultimate end state of the response market. Our reserve strategy is still in the early stages of development too. As part of our approach we are working closely with stakeholders as we move towards the broader implementation of these solutions.

Key questions we are currently still considering include:

- The detailed programme for rolling out DM and DR products;
- Whether a GB-only Replacement Reserve product could be introduced, now that the UK has left the EU and does not currently have access to EU balancing platforms (implemented via projects TERRE and MARI);
- How do we phase out existing products and transfer our procurement targets to the new product suites; and
- Our procurement targets across DM/DR/DC and new reserve products to 2025.

Upcoming events

- Frequency Risk and Control Report submitted to Ofgem (1 April 2021).
- Consultation on new reserve products closes (2 April 2021). Head to nationalgrideso.com/document/187871/download to share your views before the consultation closes.
- The ESO's Optional Downward Flexibility Management (ODFM) service begins for Summer 2021 (30 April 2021). The service is expected to run until 31 October 2021.

Useful links

- Future of Balancing Services – this page will keep you up to date with the latest developments in the response and reserve reform workstreams. Updates are also communicated through the Future of Balancing Service distribution list.
- Dynamic Containment – this page contains all the latest information on the DC implementation programme. This includes consultations on service terms and a regularly updated development document explaining the programme of development activities the team are undertaking in "Wave 1" and "Wave 2" of DC development.
- Operability Strategy Report – this ESO document is published annually and provides an accessible overview of our operational requirements out to 2025. Navigate to p23-26 to learn more about our Frequency response and reserve operational needs and the system changes that are driving them.

Contact

box.futureofbalancingservices@nationalgrideso.com

Response and Reserve – Roadmap[2]

Why

These faster acting, dynamic frequency products will support us in managing the system with a growing proportion of variable generation. These products will be bought at Day Ahead timescales to reduce barriers to entry for intermittent and demand side providers.

As providers move from the existing response markets to DC/DM/DR the MW available through the older services decreases. DC/DM/DR procurement replaces the requirement for slower products.

The recast Electricity Regulation part of the EU's Clean Energy Package (CEP) drives compliance in these areas.

A new package of reserve services will be introduced, developed in conjunction with industry feedback and consultation to complement the new response services and European platforms

Co-optimised auctions for response and reserve will optimise consumer value.

Feedback from stakeholders has been that pre-qualifying and entering assets into ESO balancing services markets and the CM is too onerous. We want to improve access to our markets and reduce administrative burdens on industry.

What

We will continue to improve the **Dynamic Containment** product after the soft launch in October 2020. Wave 1 of improvements focuses on embedding the existing product and includes: early development based on provider feedback, growing the volume and robustly integrating new data flows. Wave 2 of DC work will bring us closer to the enduring solutions and signal the separation of DC-HF procurement.

Dynamic Regulation and Dynamic Moderation are the next products in development as part of our enduring response product suite. Launch dates for DM and DR are not yet confirmed but are expected to be no later than the end of March 2022, industry engagement on these products is due to start at the end of March 2021.

As we increases procurement of the new suite of response products some of the **existing products will be phased out**. The timescales of this are subject to change depending on the speed of roll out of Dynamic Regulation in particular.

Weekly Auction Trial ends. The trial will come to an end in Q3 2021/22. DLH volumes will return to the monthly FFR tenders whilst the static LFS product is phased out.

The ESO will begin procuring **STOR in Day-Ahead timescales** in April 2021.

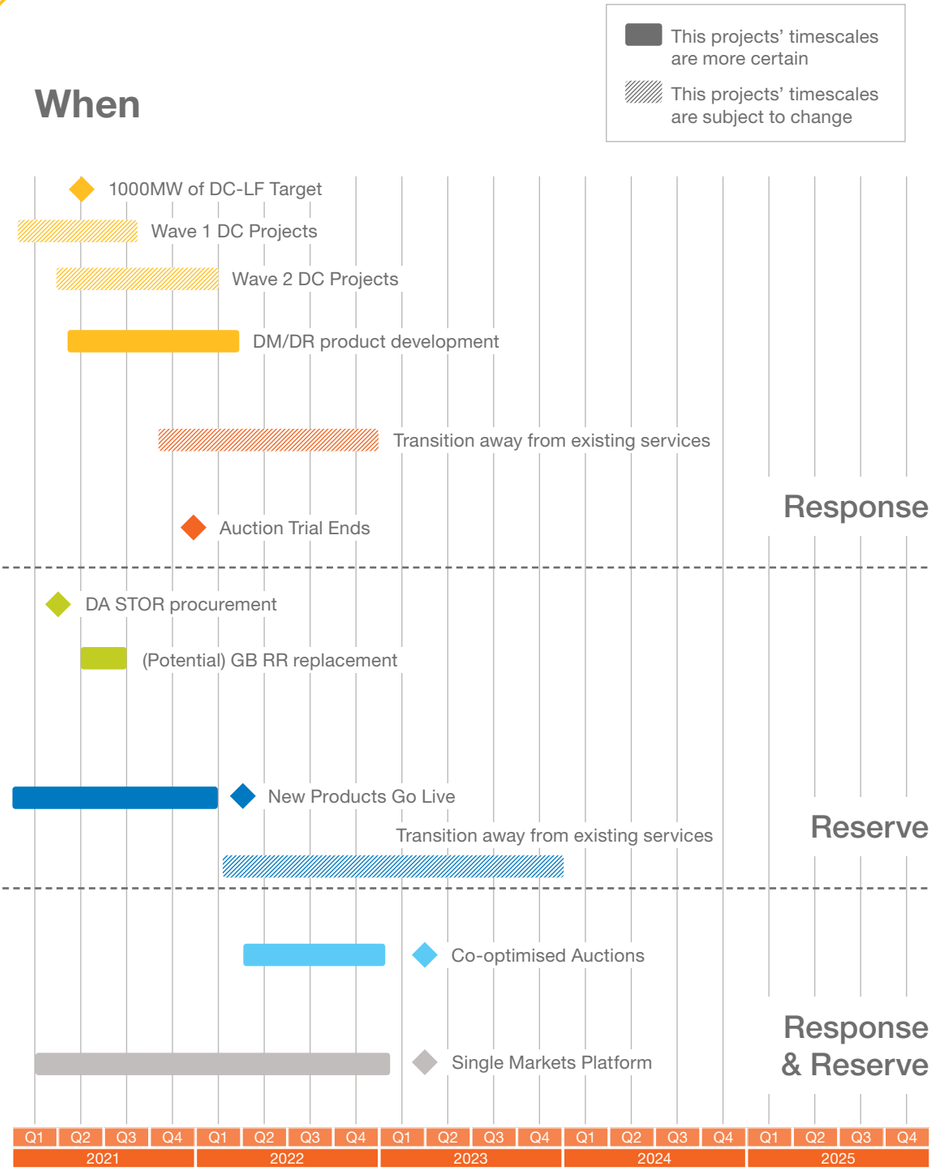
At the end of 2020 the UK and EU agreed a Trade and Cooperation Agreement (TCA) which indicates that the UK is unlikely to have access to the **TERRE** and **MARI** platforms. A Cost Benefit Analysis needs to be conducted to determine whether GB standalone versions are in the best interests of consumers.

Development of **new reserve products** began in October 2020 with product design co-created with industry followed by development and testing before the products go live by the end of March 2022. We are currently consulting with industry on ideas and principle for new reserve products.

Co-optimised auctions for response and reserve are scheduled to be introduced by the end of March 2023. This method of procurement will meet our needs in the most efficient way and offer the most valuable option to providers who are bidding in multiple markets.

The **Single Markets Platform** will go live at the end of 2022/23. This one-stop-shop will provide a portal as the focal point for parties of 1 MW and above to participate in all our balancing service markets. Communications on processes including contracting, testing, procurement events, performance monitoring and reporting, payment and portfolio management will all move from email to communication via this portal.

When



2 More information about the exact topics included in Wave 1 and 2 of DC development can be found on our website

Detail of Response and Reserve products

These tables show more information about our existing response and reserve products and the direction of travel for the future.

Response Product	In 2020	In 2025
Enhanced Frequency Response (EFR)	EFR is an ESO legacy product which was procured through a one-off tender event in 2016. Eight new-build battery storage sites were awarded 4-year EFR contracts which will end in 2022.	EFR will no longer exist in 2025. EFR providers will be able to offer their services into DC or DM.
Mandatory Frequency Response (MFR)	MFR covers the mandatory provision of 'Primary', 'Secondary' and 'High' Response as defined in the Grid Code and governed through a payment schedule in the CUSC. It is instructed through the BM in real time. Almost all Large Generators must have response capability. This is defined in their Mandatory Service Agreements (MSAs).	In 2025 we will still require a real-time (intra-day) procured response service. It is likely that MFR will still exist, but we will be exploring options for further development.
Firm Frequency Response (FFR)	FFR monthly tenders allows us to procure Primary, Secondary and High response from BM and non-BM providers as well as smaller volumes of non-dynamic response. FFR tenders are pay-as-bid and provide revenue certainty for the month for successful contract holders.	FFR monthly tenders will have been phased out and providers can move into the new response products or new reserve markets in accordance with their technical capabilities.
Weekly Auction Trial (DLH and LSF)	The Auction Trial, which is hosted on an EPEXSPOT built and owned bespoke auction platform, is trialling closer to real time procurement and exploring price formation in pay-as-clear auctions. It is funded through an Network Innovation Allowance (NIA) innovation project which will end in December 2021.	The Auction Trial will have ended and learnings from the trial will have been incorporated into the development of the new product suite which will use a pay-as-clear auction procurement approach.
Dynamic Containment (DC)	The first of our new response product suite, DC, was launched in October 2020. DC requires a response time from providers within one second of a deviation in frequency outside dead-band limits. It is currently procured through a pay-as-bid day ahead auction for 24-hour long contracts.	DC volumes will have increased and the market matured. We will have separated procurement of High Frequency and Low Frequency. We will be procuring the product through a day-ahead pay-as-clear auction. DC auctions will include a range of providers.
Dynamic Moderation (DM)	DM technical specifications are still in development and we will be looking to co-create these with industry. The product will need to be fast acting (1 second response) and support the ESO in managing sudden imbalances.	We expect to be procuring DM in the same timescales and through the same platform as DC.
Dynamic Regulation (DR)	DR will have a slower response time (around 10 seconds to maximum active power output) and will therefore be open to most existing response providers. It will support us to correct continuous but small deviations in system frequency.	We expect to be procuring DR in the same timescales and through the same platform as DC. DR will be an option for some of the technologies with a slower response time like wind.

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Detail of Response and Reserve products

Reserve Product	In 2020	In 2025
Short Term Operating Reserve (STOR)	STOR is a well-established service providing extra power to meet extra demand at certain times of day or if there's an unexpected drop in generation. We aim to procure 1700MW of STOR to cover our largest loss.	Standardised products created during Reserve Reform must ensure we retain the capability to fulfil our SQSS obligations. The future of STOR is dependent on the delivered outcomes from Reserve Reform.
Fast Reserve	Fast Reserve provides the rapid and reliable delivery of active power through an increased output from generation or a reduction in consumption from demand sources, following receipt of an electronic dispatch instruction. We currently have three categories of Fast Reserve: Firm Fast Reserve, Optional Fast Reserve and Optional Spin Gen.	In July 2020 we published a letter to industry confirming that we would no longer be procuring Firm Fast Reserve in its existing form. By 2025 all Fast Reserve services will have been replaced by a new standardised product suitable for Day-Ahead procurement timescales.
Operating Reserve	Operating Reserve provides access to injections of active power through the BM, forward trades or SO-SO services.	This is anticipated to continue; our ambition is that all dispatch occurs from one location to aid optimisation.
Replacement Reserve (RR)	This pan-European reserve product is harmonised across participating TSOs. It allows the TSO to access upwards or downwards injections of active power. The full activation time of the RR standard product is 30 minutes.	The UK will not have access to the LIBRA platform to access the standardised European RR product however we are going to be exploring more standardisation in our products through Reserve Reform.
Negative Reserve	A negative reserve service is one which provides the ESO with flexibility to reduce generation or increase demand and is usually instructed in the same way as operating reserve.	Access to negative reserve is an important tool to manage expected future system conditions. The Reserve Reform programme will result in both upwards and downwards products.

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Thermal

The ESO faces new challenges in managing transmission network thermal constraints, due to the changing profile of generation and demand in particular parts of the network.

Thermal constraints are caused when assets reach their physical limitation creating congestion on one or more parts of the transmission network. This causes bottle necks on the system which limits how energy can be transmitted across GB. We are finding new ways to manage these constraints to operate the system to deliver additional consumer savings, whilst meeting our zero-carbon operation ambition for 2025.

Electricity Ten Year Statement (ETYS) is our view of future transmission requirements and the capability of GB's National Electricity Transmission System (NETS). Network Option Assessment (NOA) is a key process recommending the major projects that are needed to deliver secure, cost-effective, and coordinated transmission system. Also, projects such as our Constraint Management Pathfinder (CMP) are focused on how we develop new market and operational tools for managing network costs for consumers whilst still enabling the net-zero ambition at pace.

Key Drivers for Change

- Lowering System Costs
- ESO Ambition: Competition Everywhere
- ESO Ambition: Zero-Carbon Operation

When renewable energy sources such as wind, solar and other Distributed Energy Resources (DER) are at their peak output at the same time, it can lead to severe network constraints and in some cases, this can be expensive. We must ensure we find economic and innovative solutions to manage these constraints and meet the demand.

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Thermal

Operational Need

Our need to manage thermal constraints on the transmission system is already increasing. Through the NOA process we identified that today, our most congested boundaries are constrained 85% of the time. Between now and 2025 we will require a range of innovative solutions to manage some of the increase in thermal constraint costs.

Operational Requirement

2020	2025
Today we ensure these thermal limits are maintained by instructing generators to modify their output. To manage thermal constraints, we need to balance the system by making up the difference of the electricity that generator would have produced. We make up the difference by buying energy from a generator in a different part of the transmission network. The volume of actions between April – September 2020 to resolve these types of constraint issues was approximately 50% higher than the same period in 2019.	Over the next few years, areas such as Scotland, North of England and East Coast will experience rapid growth in renewable energy. This is going to increase the need for network reinforcement in certain areas. New interconnectors connecting in the south region will also increase the transfer requirements on the network from north to south. The heat map on the following page illustrates the level of constraints on the system boundaries. The cost of transmission network constraints, especially in more northern regions, will be higher and we will continue to seek innovative solutions to alleviate them. Its worth noting there is an economic balance between the amount of investments on the network and the level of constraints on the network. It is expected that during 2027 to 2030 major network investments come online to increase the boundary capability; meanwhile, we need to alleviate constraints over the next 5-10 years and also manage some of the increase in congestion costs ahead of network reinforcements. More Distributed Energy Resources (DER) will be connected to the system and it is important for us to work closely with DNOs and other market participants to enhance the visibility and controllability of this DER in order to minimise zero-carbon generation curtailment, in regional constrained areas.

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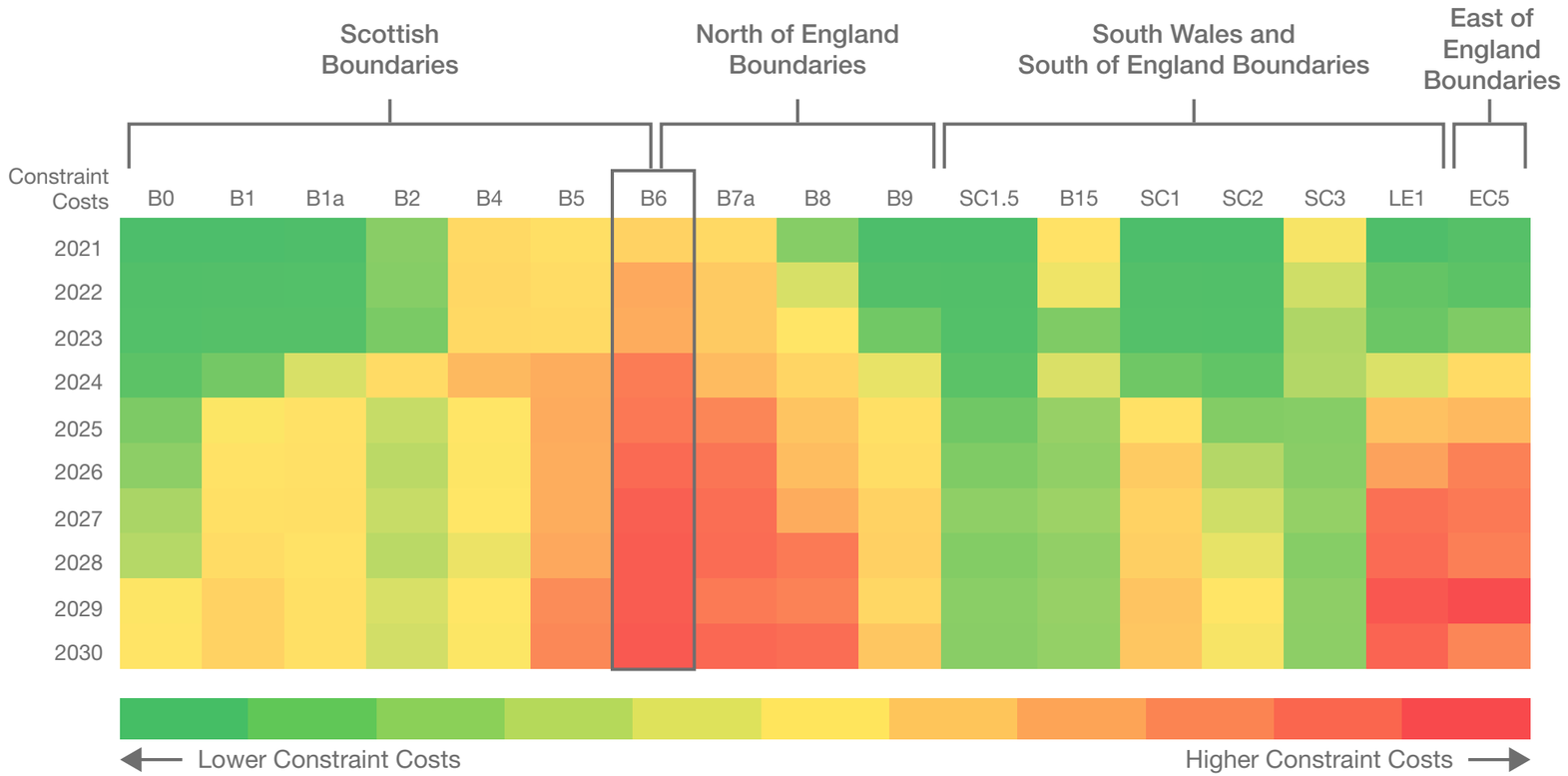
Thermal

Operational Need

This heat map shows the boundaries incurring significant costs as constraints increase in particular areas. The B6 boundary is the first phase for the NOA CMP. The B6 boundary has the highest constraints and with increasing costs over time (ETYS).



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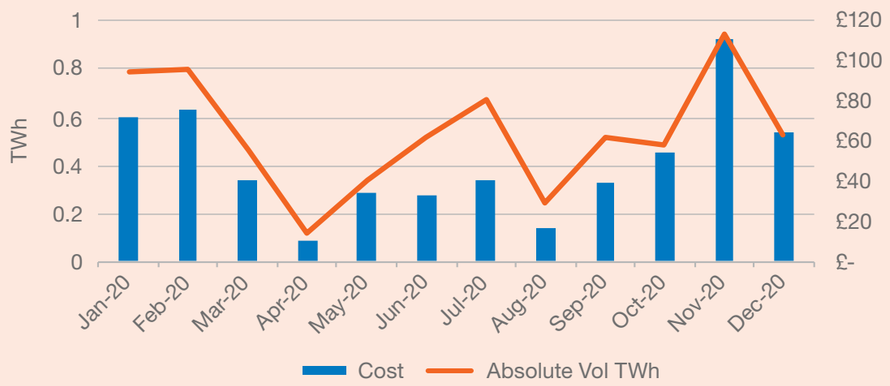
Thermal

Value of the Market

This chart shows the total cost and volume of transmission constraint services in the 2020 calendar year. We either pay providers for MW they would have generated during the time we curtailed them, or for accessing providers MW during times we need them to generate.

We paid just under £600m for transmission constraints in 2020. It is important to note that variations in demand pattern, output of weather dependant generators, and outages have impacts on the volume of transmission constraints over the year.

Value (£m) and volume (TWh) of Transmission Constraints in 2020



Thermal

Market Information

By 2025 we anticipate that constraint costs will rise, and we intend to manage some of the costs through innovative solutions and via different types of technology providers, as outlines in our Constraint Management 5-Point Plan. We anticipate that these new solutions will reduce (but not fully remove) the amount of actions we need to take in the Balancing Mechanism to manage our thermal constraint requirements today.

Market Information - Service Providers

2020	2025
In order or manage transmission network constraints, we sometimes ask a generator to reduce its electricity output. In order to balance the system, we also need to buy the same amount of electricity from another generator in a different part of the transmission system. We use several methods to manage transmission constraints. However, the largest proportion of actions are carried out pre-fault through Bid Offer Acceptances (BOAs) in the Balancing Mechanism (BM) and via trades at prices submitted by generators. The majority of actions to reduce generation in 2020 was on wind units; £400m for constraining just over 3TWh. This is mostly from wind assets in Scotland, where we see high generation, and lower demand, hence leading to the need to export power to demand centres further south. The NOA Constraint Management Pathfinder (CMP) is seeking solutions that will reduce the need to curtail pre-fault constraints (which tend to be more costly) to ensure post-fault limits are maintained for our most constrained boundary, known as B6. We intend to run this service as a competitive tender for existing connected generators. We will pay generators a fee when an intertrip to which they are connected is armed and an additional payment if the intertrip is utilised.	By 2025 we expect to contract constraint management services from an increased pool of service providers. Through increasing market liquidity, it is expected that this will reduce the volume of BOAs required via the BM and introduce additional market competition, thus reducing the overall cost of constraints. We anticipate the Constraint 5-Point Plan to offer innovative market-based solutions which potentially assist in the reduction of constraint costs. The forecasted number of actions in the BM would reduce (but not fully removed) due to the implementation of Constraint Management 5-Point Plan. Within Regional Development Programmes (RDPs) we take whole system approach and collaborate with DNOs to develop solutions that enable the connection of DER, whilst ensuring overall whole system operability is maintained. In many cases, this involves the development of market-based solutions to enable efficient transmission constraint management. As these projects progress, we will further develop these whole system solutions to expand their coverage across GB.

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Constraint Management 5-Point Plan

We have launched our intent for dealing with the management of rising constraint costs, especially with respect to some of our more heavily constrained boundaries. This medium-term strategy is our initial thinking on how we may mitigate some of the increasing congestion costs, ahead of transmission owner reinforcements. We want to develop this plan over the next 5 years, within existing frameworks and codes.

Ahead of the delivery of Eastern HVDC links, the 5-point plan will seek to enhance our thermal constraints management for the B6 (Anglo-Scottish) boundary, through the following areas:

1. **BSUoS Forecasting:** We want to enhance our forecasting by taking a new approach on how we get our data and capability. We will also be improving our transparency by sharing the methods we use to forecast, via our data portal. We hope these changes will help our customers to plan better for the future.

2. **Tender for intertrip north of B6 (CMP):** We want to accelerate the process to alleviate the transmission constraints across the B6 boundary, and are exploring an interim solution before October 2022, when the CMP service commences. We will use a similar approach and product design to the NOA CMP. We are planning to run an EOI in March for any existing generators connected to the transmission system.

3. **Regional Constraint Management Services:** DER have demonstrated that they can provide additional flexibility and competition. We want to explore the possibility of accelerating the elements of Regional Development Programme (RDPs) market in Scotland. We see local constraint markets being integrated with the ESO and DNOs systems and providing visibility, flexibility and coordinated control through appropriate systems and processes.

4. **Commercial Model for Storage:** We have seen some early work from innovation projects that show long duration storage to have benefits in solving constraints. We want to provide sufficient market signals to enable storage providers to build in the right areas to manage constraints. This work is in its relative infancy, but we would like to work with stakeholders to develop and shape this service.

5. **Enhancing the existing Network Capacity & Accelerating Asset Builds:** There are several methods we are assessing as potential means to enhance our network capacity, and accelerate asset build requirement to manage constraints. We want to work with Transmission Owners to evaluate these options, and ensure options are carried out in a coordinated way across geographical regions so we may achieve optimum level of benefits.

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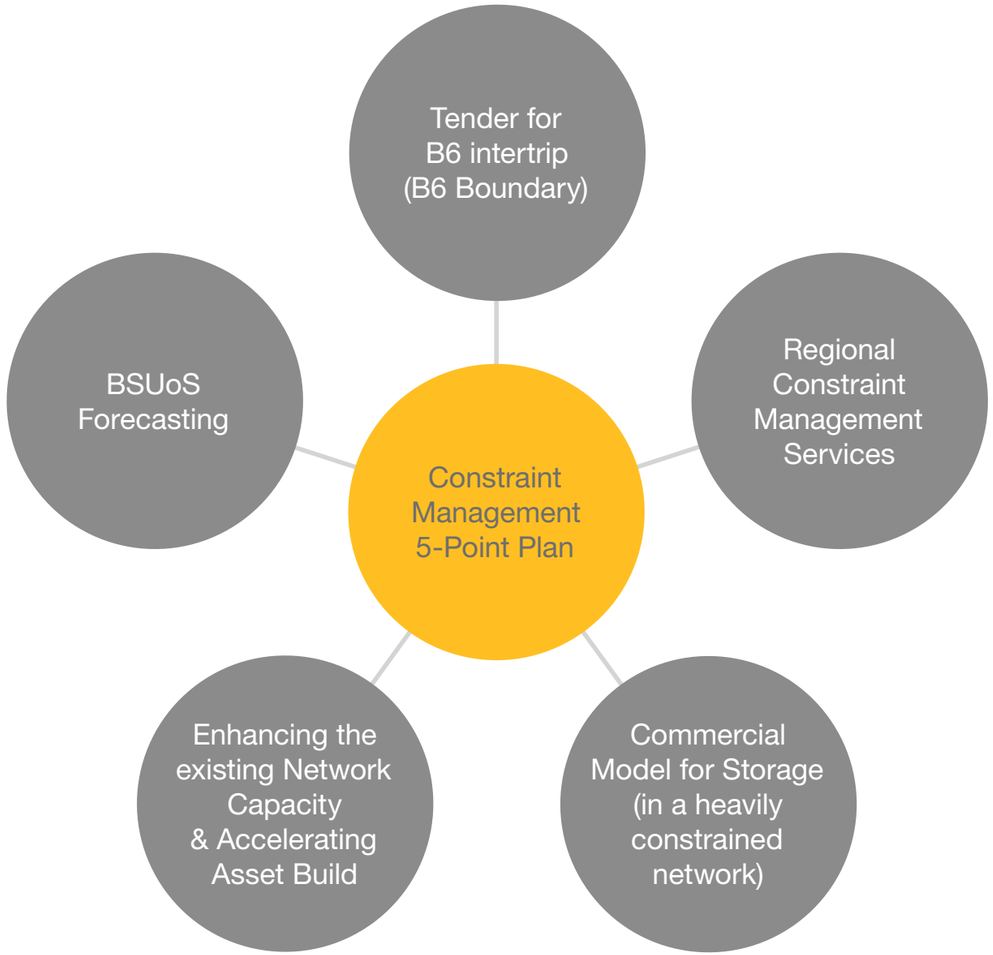
Constraint Management 5-Point Plan

Following the implementation of the plan for B6, we will look to extend similar activities on other parts of the system. We are seeking feedback on the proposed plan, which we would like to develop with industry; how do we manage medium-term network congestion challenges?

To provide your feedback on our proposal, please direct your comments to the following email address:
box.networkdevelopment.roadmap@nationalgrideso.com



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Regional Development Programmes

Regional Development Programmes (RDPs) utilise a strategic, whole system approach in order to deliver the most economic solutions for GB consumers. In many cases this enables additional DER to connect to distribution networks, whilst maintaining overall whole system operability. We will work with DNOs to facilitate increased participation in constraint management markets whilst also recognising the continued development of DSO flexibility markets and ensuring overall service requirements are co-ordinated with respective network needs.

N-3 intertrip RDP: This RDP is a joint venture between, UKPN, WPD & SSEN, to develop IT systems to manage constraints on the transmission network. The project focuses on maintaining regional demand security, under certain planned outages and faults on the transmission network. This type of condition is known as 'N-3'. This project seeks to enable more DER to connect in southern England whilst we manage the system more economically and efficiently.

UKPN south east RDP: This is a joint project with UKPN. As more DER connect to the South Coast of England, we need to manage thermal constraints. These solutions will deliver the process and systems necessary to procure and dispatch DER on a more routine basis.

WPD south west RDP: Together with WPD we are finding economic solutions to connect renewable generation to the whole network in the South West area of England. To continue to allow the region to absorb more energy after 2020 we are finding innovative solutions to increase network capacity.

WPD Storage RDP: We are collaborating with WPD to further understand the storage needs case at identified sites, and if necessary, we will progress to a transmission solution through a whole systems analysis process. We need to manage flexible demand connecting to the distribution networks, at various Grid Supply Points (GSPs) such as battery energy storage.

ENWL Heysham RDP: We are seeing increased demand of DER wishing to connect in the Heysham area. We need to make sure the site remains secure under certain outage conditions. We are currently developing commercial arrangements to compliment intertrip arrangements. We have concluded phase 1 of this project and are considering the scope and timeline for phase 2.

SPEN GEMS: We are working with SPEN to develop existing ANM principles to dispatch generators to manage the transmission system in south west Scotland, in the most economic manner. A Strategic Wider Works Assessment recommended that an operational tool is a more appropriate option than a transmission build solution, which will allow faster automated dispatch of BMUs. We would expect both transmission connected generation and DER would compete for fair access to the network to deliver constraint management services.

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Thermal

Upcoming events

- We are launching an Expression of Interest (EOI) for NOA Constraint Management Pathfinder (B6 Phase 1) service to reduce network congestion costs across the Anglo Scottish boundary. **A link to the EOI pack can be found Here.**
- If you wish to participate in this tender process, a complete Expression of Interest form must be submitted by **17:00 on Friday 16 April 2021 and sent to box.networkdevelopment.roadmap@nationalgrideso.com**

Useful links

- Operability Strategy Report – this ESO document is published annually and provides an accessible overview of our operational requirements out to 2025. Navigate to p70-81 to learn more about our Thermal operational needs and the system changes that are driving them.
- Network Options Assessment (NOA) – this ESO document is published annually and is our recommendation for which reinforcement projects should receive investment during the coming year.
- Electricity Ten Year Statement (ETYS) – this interactive ESO document is our view of future transmission requirements and the capability of Great Britain's National Electricity Transmission system. Learn more about our network planning process
- Regional Development Programmes | National Grid ESO – this webpage will keep you up to date with the latest developments for the Regional Development Programme.
- Whole electricity system | National Grid ESO – this webpage will keep you up to date with the latest developments on our whole systems approach
- NOA Pathfinders – this webpage will keep you up to date with the latest developments in the pathfinder projects

Contact

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Thermal – Roadmap

Why

Scotland contains much higher installed generation capacity than demand. Peak power flow is typically north to south at times of high renewable generation output. This has caused congestion across B6 boundary.

There might be a potential to accelerate our activities to manage imminent rising costs from thermal constraints on our Anglo Scottish boarder (B6).

N-3 intertrip to ensure regional demand security is maintained under certain combinations of planned outages and faults on the transmission network, known as 'N-3' scenario. Enabling more DER to connect in the specified regions of southern England.

We are developing '**GEMS**' with **SPEN** to evolve existing ANM principles to dispatch generators to manage the transmission system in south west Scotland in the most economic manner.

The South West of England requires economic solutions to allow DER to connect and enable increased network capacity. We are developing this RDP with **WPD**.

We are developing systems to dispatch DER connecting to the South Coast of England in order to manage thermal constraints. We are developing this **RDP** with **UKPN**.

We need to manage **flexible Storage** at certain GSP sites connecting to the distribution network. This RDP is a collaboration with WPD to develop a solution in the **Midlands**.

What

The NOA Constraints Management Pathfinder is seeking commercial solutions to deliver additional consumer savings. Ahead of Eastern HVDC link, the pathfinder aims to reduce operational costs across B6 boundary between Scotland and England, as more generation connects in the region (second plan in our Constraint Management 5-Point Plan).

- EOI March - April 16
- Commercial tender process (June-Sept 2021)
- Contract award (Sept 2021)
- Service commencement for 12 months (Oct 2022)

We intend to run a short-term service (12 months) as a precursor (Phase 1) to the NOA Constraint Management Pathfinder. We intend to use similar commercial arrangements, to the CMP for connected generators (second plan in our Constraint Management 5-Point Plan).

- EOI and tender - March -April 16th, 2021 (EOI), April-October 2021 (tender)
- Service commencement for 12 months from (Oct 2021)

This RDP is a joint venture between the ESO, UKPN, WPD & SSEN to develop IT systems which will manage constraints on the transmission under N-3conditions. UKPN project is now commissioned and in service.

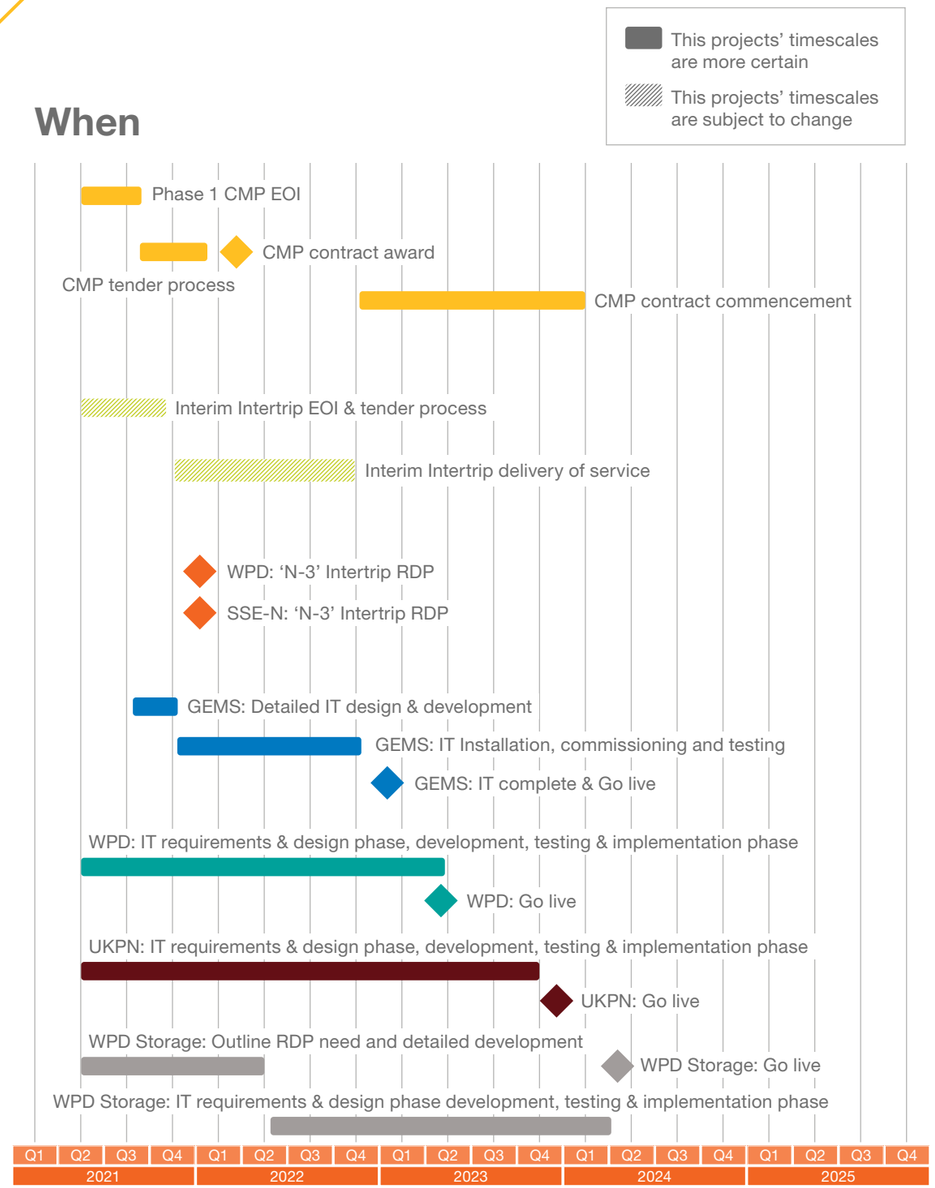
- Detailed design & development of IT solution: Q3-2021 – Q4 2021
- IT Installation, commissioning and testing: Q4 2021 – Q3 2022
- IT commissioning complete & go live: 30/12/22

We are commencing the requirements & design phase of IT work in April 2021. This work is scheduled to continue to March 2023 when the project will go live. Initial phases will consider joint development with WPD's storage RDP to ensure consistent approaches and efficient delivery.

The plan shown opposite is taken from the ESO's delivery schedule but we are currently working with UKPN to advance the requirements and design phase of IT work to April 2021. This would see go live for this RDP advanced to March 2023.

The plan shown opposite is taken from the ESO's delivery schedule. Initial works on this RDP will be undertaken jointly with WPD's south west RDP to ensure consistent approaches and efficient delivery. This may result in the timeline being advanced.

When



Reactive Power

As the share of renewable generation in the energy mix increases, the ESO faces new challenges in managing network voltage levels. Projects such as our Pathfinder projects are focused on providing long-term options within the Mersey and Pennines regions. The Future of Reactive Power project is seeking to develop, in collaboration with industry, reactive power services more broadly.

The ESO has a requirement to manage the voltage levels of the system and keep them within safe operational limits. To maintain voltage, we instruct providers to inject or absorb reactive power (MVAr) to and from the system or use network infrastructure assets. In the past, reactive power was provided by transmission network assets and generators to manage voltage levels. Reactive power also has a strictly locational requirement: reactive power need in one area cannot be met by a provider at the other end of the GB network. This creates unique challenges for our procurement of reactive power services.

Key Drivers for Change

- Changing System Conditions
- Lack of Access to Traditional Providers
- ESO Ambition: Competition Everywhere
- ESO Ambition: Zero-Carbon Operation

We are increasingly experiencing high voltage conditions on the National Electricity Transmission System (NETS) these are driven by a number of factors: increasing volumes of generation connected to the Distribution Networks, MVAr injection across the Distribution – Transmission Interface and changes in demand patterns. Our existing reactive tools need to be enhanced for the changing system needs.

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Reactive Power

Operational Need

Our requirements for reactive power will increase by 2025. We will need to manage higher voltage levels on the transmission system, requiring an increase in the provision of MVAr. The Future of Reactive work will develop further enhancements to projects such as the NOA Voltage Pathfinders to help meet future operability challenges.

Operational Requirement

2020	2025
Our requirement for reactive power depends on national and local flows of active power. When active power flows are low, network assets generate reactive power and the voltage rises. The reverse is true when demand for active power is high. There are other additional influences on our reactive power requirement including: regional reactive power demand, network outages which can remove access to TO owned reactors and capacitors which help us to manage voltage levels and our modelling of the worst potential network fault. Our Voltage Screening Report highlights the regions with potential voltage issues.	By 2025 our requirements for reactive power will have inevitably grown due to a need to manage increased voltage levels from planned outages, asset availability and forecast system conditions. The challenges that we face today will only grow in the future as system trends continue. High voltage levels on the Transmission System will become increasingly prevalent requiring MVAr absorption to manage. Recently we have seen a continual decrease in both minimum demand and reactive power consumption on distribution networks, resulting in an increasing need to absorb more reactive power on the transmission network. The Future of Reactive Power (FoR) project will have explored options for the ESO to access greater volumes of reactive power from previously untapped sources. Solutions as identified by the project will balance ESO Ambitions including Competition Everywhere, Zero-Carbon Operation and Whole Systems considerations.

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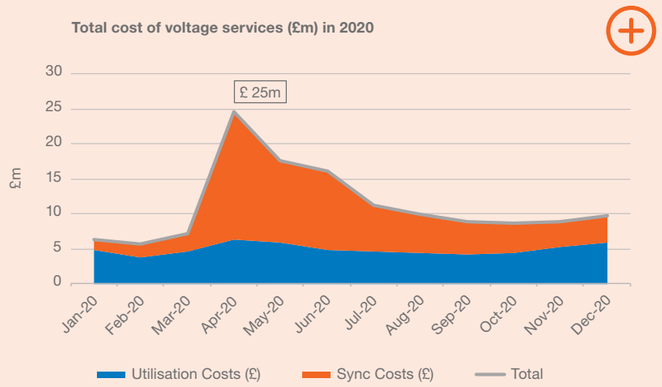
Reactive Power

Value of the Market

This chart shows our total cost of accessing reactive power from service providers in the 2020 calendar year. Our utilisation cost (£/MVArh) is typically constant as the price is fixed at an annual rate using the CUSC methodology and we have need for voltage support year-round.

In April we paid £25m to providers to manage low demand and high voltage system conditions. There was a small increase in MVAr requirement, however the cost increase was mainly driven by synchronisation costs, to procure MW of active power from generators in a required location.



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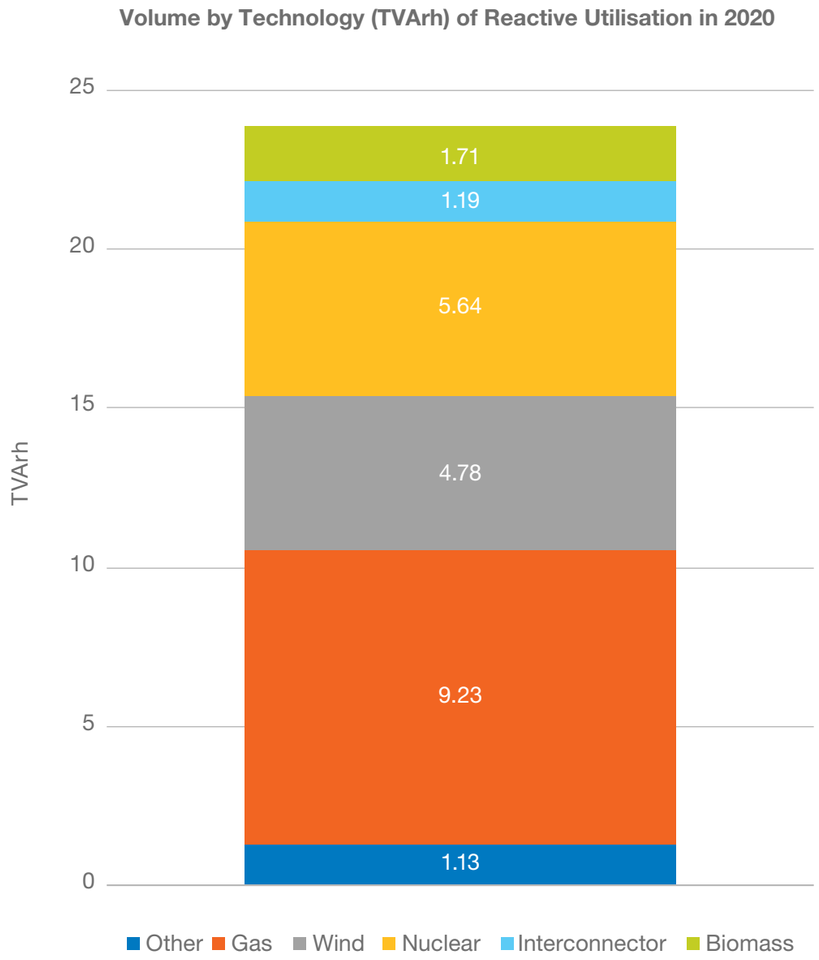
Reactive Power

Market Information

In 2025 and beyond, we will continue to find new ways of contracting our requirements to meet future system needs and provide opportunities to existing and new build technologies at the transmission and distribution level. We are developing approaches which aim to access reactive capability in more economic and sustainable ways.

Market Information - Service Providers

2020	2025
We currently access voltage support from a mixture of TO network assets and the Obligatory Reactive Power Service (ORPS) as defined in the Grid Code. The Grid Code also defines how we instruct all large generators with reactive capability to provide MVAr support via the ORPS. A payment is made at a standard £/MVArh rate to instructed generators and we update this rate monthly in line with the methodology in Section 4 of the CUSC. The graph shows the total cost paid in Reactive Utilisation services by technology type. Today, almost 50% of these costs are from carbon intensive generators. In the future, we anticipate a larger proportion of these costs being attributed to low-carbon technologies, as they connect to the electricity system.	We are progressing our work, through the Future of Reactive Power project, to better understand our reactive power requirements by 2025. This work also intends to determine how we procure these services in the future. The progression of this work could lead to wider market participation for reactive services for different types of providers and technologies. We will use what we have learned from the Power Potential project with UKPN. This may include procuring reactive services from distribution connected parties. Such services would be developed in coordination with the local DNO.



Reactive Power

Future of Reactive Power

We developed a six-step approach, set out below, to review our reactive power needs and the findings from existing reactive power projects to explore potential solutions.

The key objectives we will assess potential solutions against are:

- Will the solution enable us to access more reactive power in the required locations to maintain system voltage security?
- Will the solution enable us to procure reactive power service from more participants by being technology neutral to stimulate greater competition?
- Will the solution incentivise more cost-effective options for meeting reactive power requirements thereby driving the cost of managing system voltage down?

The completion of the six-step plan should also determine the direction of further work on Voltage Pathfinders and Power Potential Projects.

Key Approach

The Future of Reactive work takes a holistic approach to reviewing ESO's Reactive Power services.

1. Problem Statement
2. Problem Analysis
3. Future Vision

Iterative, collaborative and holistic review

4. Analyse Existing Projects
5. Gap Analysis
6. Develop Roadmap and Rollout Strategy

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Reactive Power

Upcoming events

- Future of Reactive: Industry webinar to be held on the 31 March 2021 from 3pm-4pm to set out the high-level scope and next steps for the Future of Reactive Power project and discuss how we can work more closely with stakeholders to develop solutions.

Useful links

- Operability Strategy Report: this ESO document is published annually and provides an accessible overview of our operational requirements out to 2025. Navigate to p52-61 to learn more about our Voltage operational needs and the system changes that are driving them.
- Network Options Assessment (NOA) – this ESO document is published annually and is our recommendation for which reinforcement projects should receive investment during the coming year.
- Electricity Ten Year Statement (ETYS) – this interactive ESO document is our view of future transmission requirements and the capability of Great Britain's National Electricity Transmission system. Learn more about our network planning process.
- NOA Pathfinders – this webpage will keep you up to date with the latest developments in the pathfinder projects.
- Reactive Power Services – this page will keep you up to date with the latest developments in the reactive reform workstreams.

Contact

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Reactive Power – Roadmap

Why

We are required to control high voltage in regional areas. We have experienced the need to absorb MVArs in recent years in some regions resulting in increased voltage management costs. We will need access to new reactive power services to manage these high voltage levels.

The trial aims to understand if we can procure directly from DER, to compete with transmission connected assets to provide reactive power services, delivering £412m of savings to consumers.

The Future of Reactive Power project is our strategy for how we will develop and procure reactive power services in the future, to meet our operability needs and maximise consumer benefits.

What

There are three regional voltage pathfinders procuring reactive power to help meet SQSS compliance. The NOA pathfinders are using a learn by doing approach aimed at merging network and competitive market solutions together:

Short Term Mersey Voltage – service provided from 1 April 2020 to 31 March 2021

- In Q4 2019 we ran a short-term event in the Mersey area to address the local challenge following the closure of Fiddlers Ferry power station. This focused on existing connections and facilitating providers embedded within the DNO network. We initially agreed contracts for 20/21, with a view to tender further for 2021/22. Results of an Expressions of Interest for 2021/22 resulted in agreeing bilateral contracts instead of an open tender.

Long Term Mersey Voltage – service to run from 2022-2031

- This event focused on comparing commercial solutions with Transmission Owner network assets. New connections were invited to participate alongside Distribution connections, aggregators, existing providers and the Transmission Owner. Contracts were awarded to a commercially owned transmission asset and a battery.

Long Term Pennines Voltage – from April 2024

- The Pennines pathfinder is ongoing, and adopts the lessons learned from the Mersey pathfinder to develop the service. This is especially important because the requirements for Pennines is greater as the region is significantly larger and has a high level of interactivity across sub-regions.

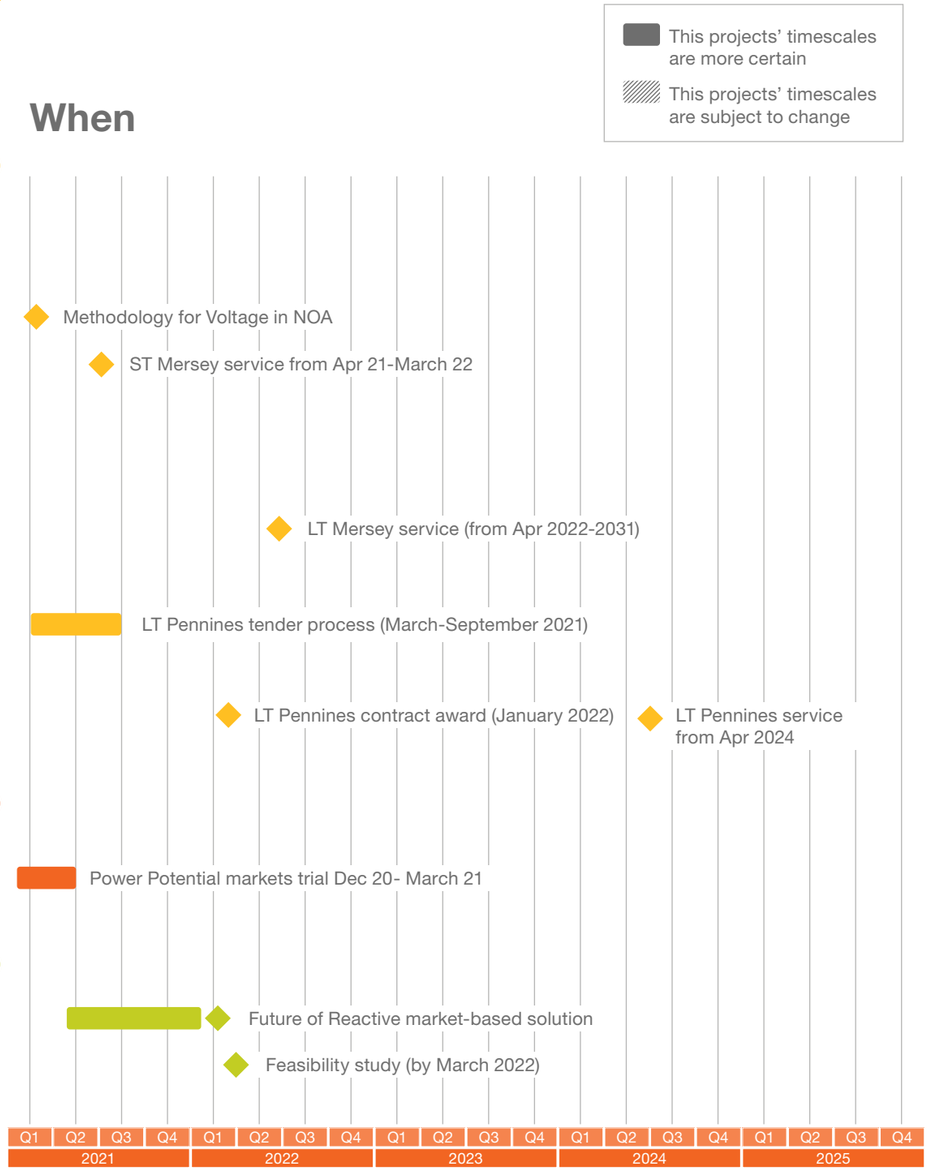
The Power Potential Project trial innovation project will bring together the ESO and UKPN in this world first initiative to provide reactive power services to the transmission network from DER.

The live trials launched on 14 October 2020 and are expected to run until Q4 2020-21.

We currently have two milestones for the Future of Reactive project:

- Design an effective market-based solution for future of reactive power procurement based on technical, commercial and market analysis. Deadline December 2021.
- Carry out a feasibility study based on the design solution and recommend next steps. Deadline March 2022.

When



Restoration

Our vision for Restoration is to run a fully competitive Restoration procurement process to existing and new technologies connected at different voltage levels on the network. Our reforms over the next few years will enable an enhanced restoration service should the need ever arise.

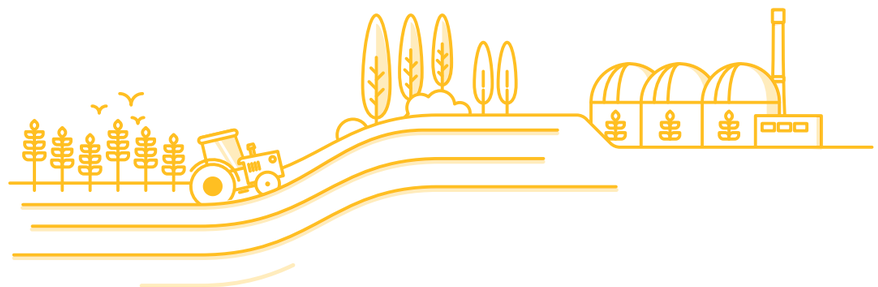
Restoration is the service that is used in the unlikely event that the electricity system fails, and the lights go out. Under this scenario we have a robust plan to restore power to the country as quickly as possible. The restoration process is made up of two key steps, the first is that we would enact a number of commercial contracts with providers across the system. These providers will have the technical capability to self-start without needing external electrical power. The second step is that an agreed plan that has previously been tested is then executed across the system to re-energise the transmission network.

Key Drivers for Change

ESO Ambition: Zero-Carbon Operation

ESO Ambition: Competition Everywhere

Historically this service has been provided by carbon intensive generators. As the energy mix continues its transition, we need to enhance this service so that low carbon technologies can provide this service. One way we hope to achieve this is through our Distributed Re-start project; a co-created solution by the ESO, SPEN, and TNEI, to allow DER to participate in restoration markets.



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Restoration

Operational Need

In the future we will look to integrate new forms of technology into this service. Outcomes of the Distributed Re-start project will become available, and as these are implemented into business as usual restoration processes, we will update our documented Procurement Methodology to reflect this.

Operational Requirement

2020/2021	2025
ESO has a Grid Code obligation (CC6.3.5) to ensure that Restoration Capability is available to enable the National Electricity Transmission System (NETS) to be re-energised in the event of a blackout. This operational need is driven by the Restoration Strategy. This identifies how the Restoration Time expectation is used to determine an appropriate level of Restoration Capability to restore the system. Once the capability requirement is known, this can then be procured procured (Black Start Strategy).	A GB Restoration Standard, and associated implementation methods are under development through the Black Start Task Group (BSTG), led by the Department for Business, Energy and Industrial Strategy (BEIS). The outcome of this work will require alignment between this Strategy and a GB Restoration Standard to fulfil obligations on ESO and the wider sector.

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Restoration

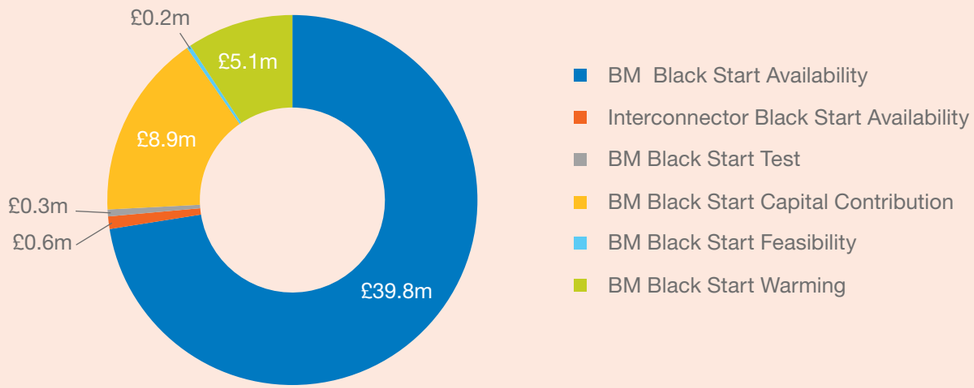
Value of the Market

There are several areas of costs associated with restoration as identified in the Procurement Methodology, which can be categorised into the elements below. The following is an explanation of how these costs are calculated, and the graph shows the value of restoration services and breakdown of costs for FY 2019/20.

1. **Availability Payments**: These are payments paid to the service provider to maintain capability through the year. We agree a fixed annual price with providers which is converted to a £/settlement period payment, paid monthly. Providers are only paid for settlement periods they have declared their availability for. This payment makes up most of the cost in the Restoration market.
2. **Capital Investment**: New restoration services are likely to require significant capital investment. Each contract will include a breakdown of costs including, where necessary, a milestone payment schedule.
3. **Feasibility Studies**: Costs may be incurred to determine whether a restoration service is possible from a particular provider, before a service provision is agreed.
4. **Testing**: In accordance with the Procurement Methodology, we will work together with the provider to develop a strategy to test the unit at the most economic and efficient time, mitigating any distortion to the market.
5. **Warming Requirements**: Restoration providers must be able to respond in specified times, to be deemed available for restoration. If certain technology service providers have not generated for a period, their units may not be warm enough to meet the required response time. In this event we may instruct a capable unit (in the same region), for warming, to maintain the minimum service level. Similar to Availability Payments, these costs are paid monthly.

For more information on calculation costs for Restoration, click Here.

Total Value of the Restoration Market FY 19/20



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Restoration

Market Information

By 2025 we expect that the Restoration Market will be open to a wider range of technologies, connected across both the transmission and distribution system. This could include technologies such wind, batteries, solar, and smart demand.

Market Information - Service Providers

2020	2025
Competitive and bilateral procurement for restoration largely from transmission connected generators. This is done on a regional basis, which are based on system needs. To date, we have tendered for regional services in the South West (SW) & Midlands and Northern regions. These services will commence in 2022.	The Northern tender has been used to determine the approach for the next competitive tenders which we expect to launch in 2022. Into 2025 we would hope to develop this tender process across all zones including requirements from Distributed Re-start. By 2025 we would have diversified the range of technology types which can support restoration and provide restoration services which will ensure we can continue to maintain the capability to restore the system from connected assets at both the transmission and distribution level.

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Tackling Uncertainties in our Restoration Reform Programme

System restoration is the ultimate safeguard on which the GB economy relies. The Restoration process is complex, and achieving restoration is reliant on the whole electricity sector's ability to assist. We currently do not have a defined standard, however, the outcome of the work by BSTG will drive alignment between our strategy and a GB Restoration Standard. This decision was delayed by the Covid-19 outbreak, but once the Restoration Standard has been approved our strategy will be developed accordingly.

Key questions we are currently still working to answer include:

- How a new Restoration Standard might impact the needs of this service in the future.
- How the outcome of the Distributed Restart project might evolve our current market principles.

Upcoming events

- **Distributed ReStart Podcasts:** week commencing 12 April 2021. A series of 6 podcasts will be available on Apple and Spotify accounts.
- **Utility Week** featuring Distributed ReStart Virtual roundtable event in September 2021. We will also publish a follow-up report, on Utility Week channels and launch a report on marketing activity in November 2021.
- **Black Start Strategy and Procurement Methodology** published on 5 February 2021 for consultation.

Useful links

- Operability Strategy Report: this ESO document is published annually and provides an accessible overview of our operational requirements out to 2025. Navigate to p62-69 to learn more about our Restoration operational needs and the system changes that are driving them.
- Distributed ReStart: this document is the Ofgem Project Progress Report December 2020.
- Restoration Overview: this ESO page will keep you up to date with the latest developments in our Restoration services. Here you will find useful document such as the Black Start Strategy and Procurement Methodology reports.

Contact

ReStart@nationalgrideso.com

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Restoration – Roadmap

Why

A competitive procurement process for Restoration will enable increased competition and lower prices for consumers. It will also ensure system security through a diverse portfolio, enabling a carbon free network.

Distributed ReStart project is a collaboration between ESO, SPEN and TNEI. This world-first initiative has been designed to re-energise the system in the event of a blackout from the bottom up through DER.

This project seeks to remove our dependence on carbon intense generators, and instead explore how technologies such as wind, solar & hydro can be used to restore power to the transmission in the unlikely event of a blackout.

Restoration Standard is a BEIS led industry (BSTG) initiative. The intent of the standard is to drive shorter restoration times across GB regions. The process used an evidence-based methodology which included socio-economic impacts and how likely a shutdown event would happen.

What

There are currently two regional competitive Restoration events

South West Midlands: six contracts were awarded in November 2020, to multiple technology providers for five years.

North West, North East & Scotland: Contracts for the second procurement process will be awarded in April 2021.

South East: We hope to launch an EOI for tender in this region in April 2022, with service commencing by 2025. Initially we intended to launch a tender in May 2021, however, given delays to the Restoration Standard and limited availability of new entrants, the most economic method to procure services in this region was to tendering activities in Q2-4 2022. The dates on the roadmap are indicative and may change.

This year the project will begin its final stage, the demonstration phase. Over the next few years, the project will look to resolve challenges such as, organisational coordination, commercial and regulatory frameworks, and power engineering solutions.

Once the project concludes on 31 March 2022, we will produce a roadmap for implementation.

Activities we would expect to implement include:

- Code modification proposals (see below)- Q4 2023/Q4 2024
- Engagement with industry on productionalisation- Q3 22/23.
- Productionalisation (including code, system development & new communication links-2023-2025/6

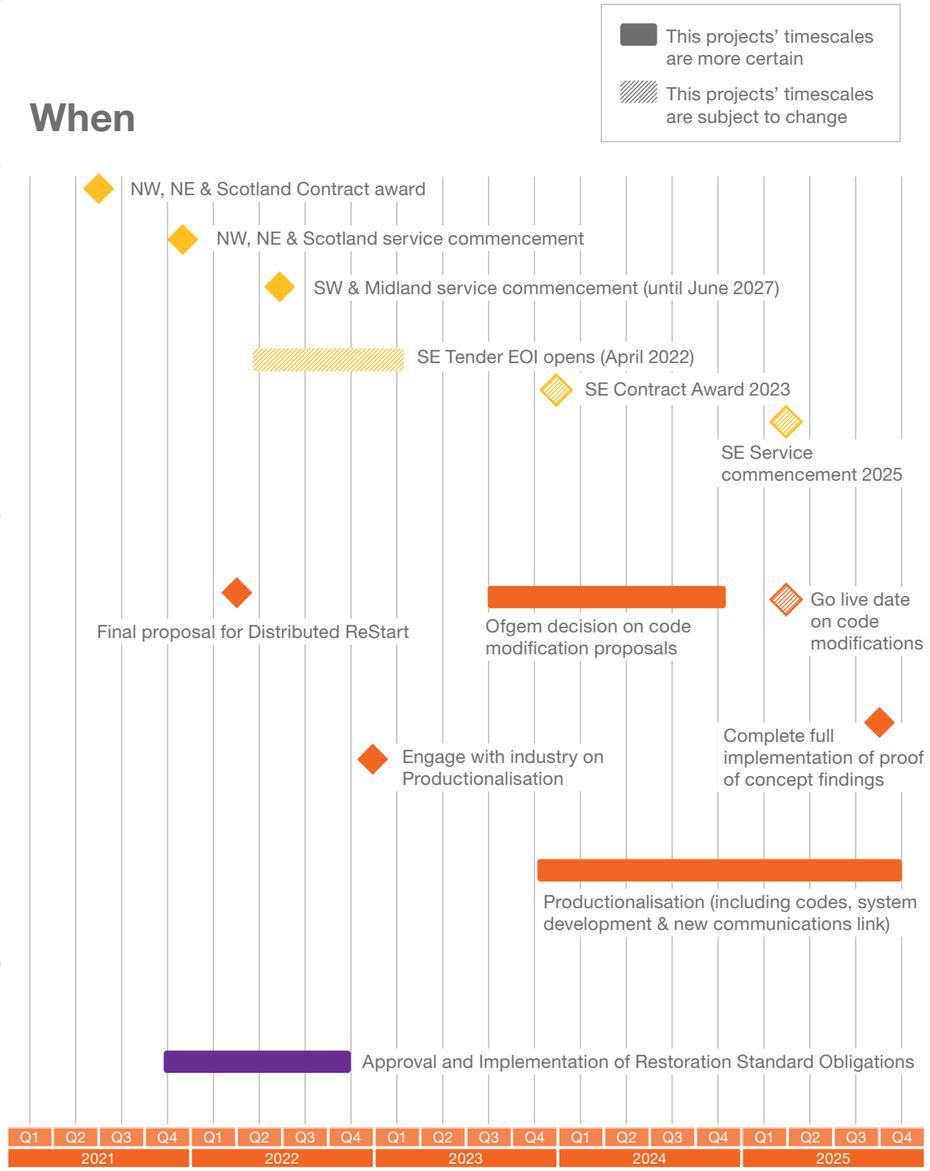
Distributed ReStart code modifications: there are plans to include Grid Code changes for this project into GC0148 (Emergency and Restoration Code Phase II). BSC and CUSC mods will begin once commercial terms for the service have been finalised.

Once the Government has confirmed the standard, we will have 12 months to implement:

- Annual assurance process for GB Restoration readiness
- Using the assurance data, Validate restoration timelines for GB electricity system.
- Maintain our obligations and requirements against the new standard for Restoration capability provision.

We expect the approval of the standard by November 2021. This was intended to be sooner, however the impacts from Covid-19 caused a delay in the decision.

When



Stability

The ESO aims to create new markets for stability services, to be procured via a combination of long- and short-term mechanisms. Stability markets are still relatively immature and therefore many questions remain around their future design.

Stability can be provided by network solutions (e.g. synchronous compensators) so market solutions will be compared against traditional network solutions, underpinned by the Network Options Assessment (NOA) process. A “learning by doing” approach is currently being used, with the pathfinder projects allowing testing of different approaches.

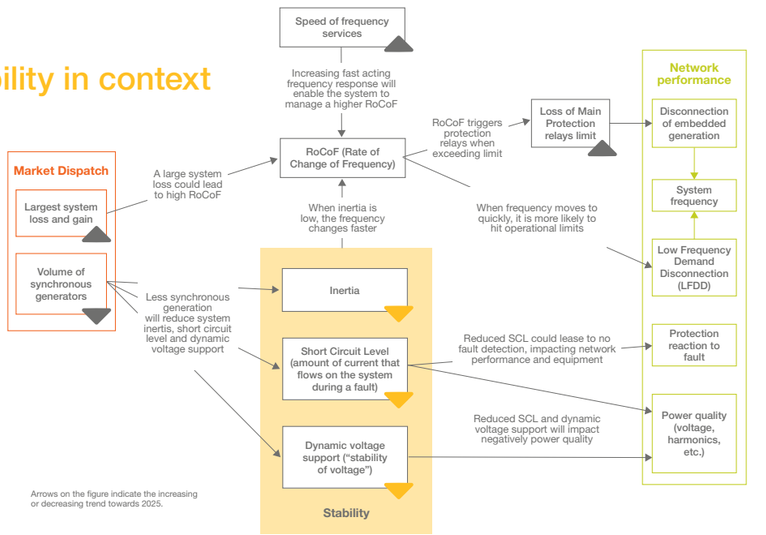
Stability products include inertia, dynamic voltage support (also called “stability of voltage”) and short circuit level (the amount of current that flows on the system during a fault). Inertia on the power system resists the Rate of Change of Frequency (RoCoF) and helps prevent generation loss. The common feature of all of these products is the rapid delivery of a predictable flow to or from the electricity system which prevents it becoming unstable.

Key Drivers for Change

- Changing System Conditions
- Lack of Access to Traditional Providers
- ESO Ambition: Competition Everywhere
- ESO Ambition: Zero-Carbon Operation

Throughout 2020 we have experienced conditions with low system inertia. The combination of low system inertia and high outputs from DER with Loss of Main relays caused a system constraint. In the future, the system will become less stable without intervention.

Stability in context



Stability

Operational Need

As the level of stability provided as a by-product of synchronous generation on the system changes, we will need to find other sources of stability and lower our overall stability requirement through other means (such as changes in DER protection limits and in the reserve and response services we procure).

Operational Requirement

2020	2025
Inertia level changes all the time but the estimated annual average national inertia level provided by the market in 2020 is 197GVA.s. Short circuit level and dynamic voltage support also varies by location. Current methods to calculate inertia level involve estimations based on generation and demand available information. The requirement for inertia will depend on the Rate of Change of Frequency (RoCoF) the system can manage. And the RoCoF depends on the size of the largest loss/ gain, the speed of frequency services and inertia. The relays limit gives the limit of the RoCoF. In 2020, we operated with a minimum inertia level of 140GVA.s. The inertia level being managed through market dispatch, using the Balancing Mechanism (~1.4GWh[1] Offers action) to add synchronous units to the network.	The annual forecasted average inertia provided by the market will decline in 2025, based on FES scenario to 131GVA.s (Consumer Transformation) - 119GVA.s (Leading the Way) - 180GVA.s (Steady Progression) - 140GVA.s (System Transformation). Short circuit level and dynamic voltage support are also expected to drop overall. In 2025, we will have significantly more accurate systems to measure and forecast full system inertia, with a more accurate understanding of the contribution from distributed generation and demand sources. In 2025, we will also be able to operate the system where RoCoF is greater due to two main developments: - Through the Accelerated Loss of Mains Change Programme (ALoMCP), relays are being updated to resist faster change of frequency. - New faster acting frequency services, like Dynamic Containment (DC), will enable the system to manage higher RoCoF (see response roadmap). We therefore expect the minimum inertia level for safe operation to be lower than 140GVA.s.

1 Please note that the data presented here is to be used for illustrative purposes only and should not be compared/ referenced to similar datasets published by NGESO. Actions taken within the control room are never taken in isolation and understanding the key driver for the action taken is challenging and will not be a prefect representation of the circumstances on the system at the point of instruction.

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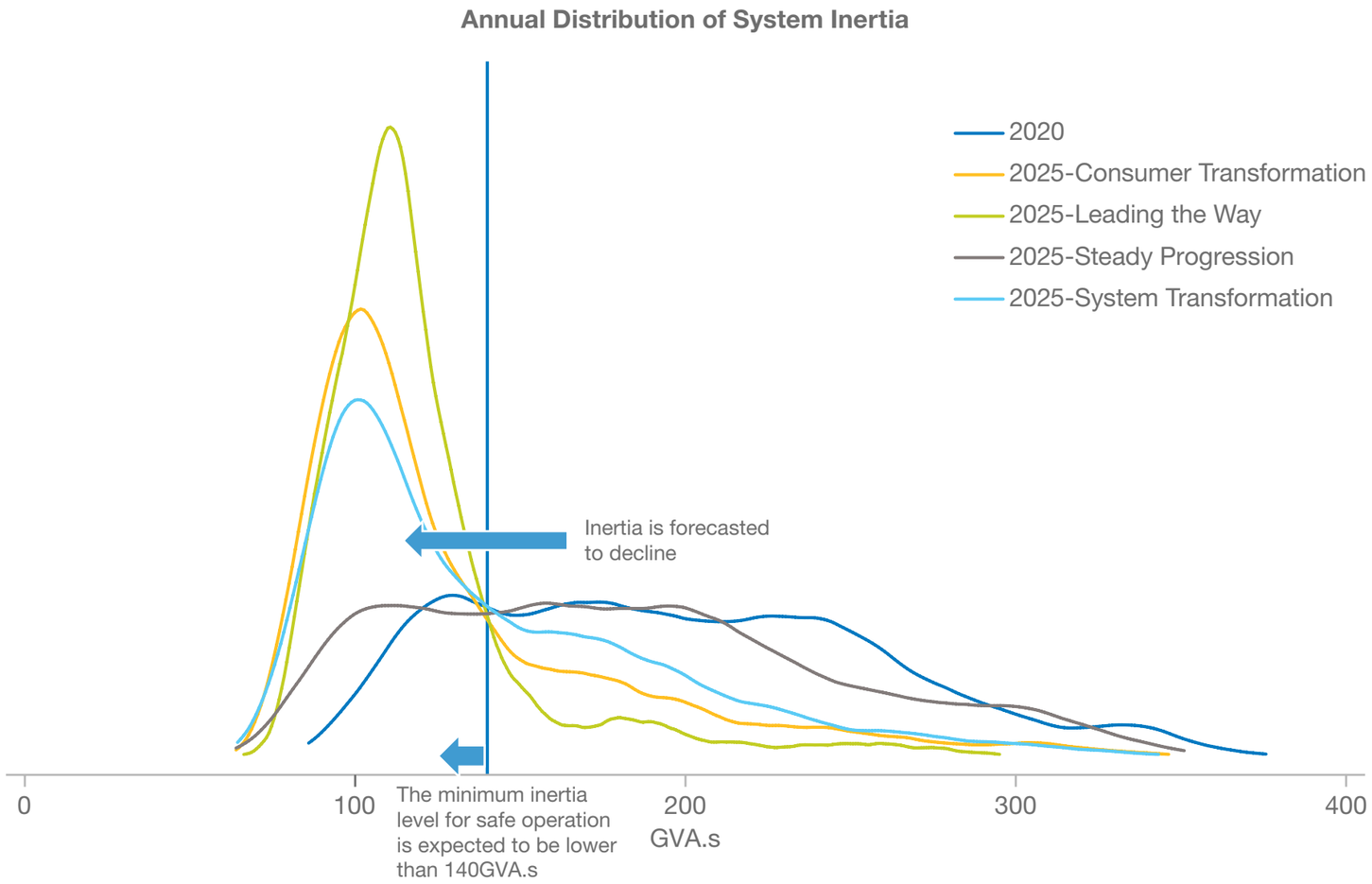
Stability

Operational Need

The figure shows the distribution of inertia values provided by the market (before we take actions to manage the system), estimated in 2020 and forecast for 2025 based on our FES scenarios. In 2020, we operated with a minimum inertia level of 140GVA.s. Going forward, the minimum inertia level will be determined by the Frequency Risk and Control Report (FRCR), it is expected to be lower in 2025.



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Stability

Value of the Market

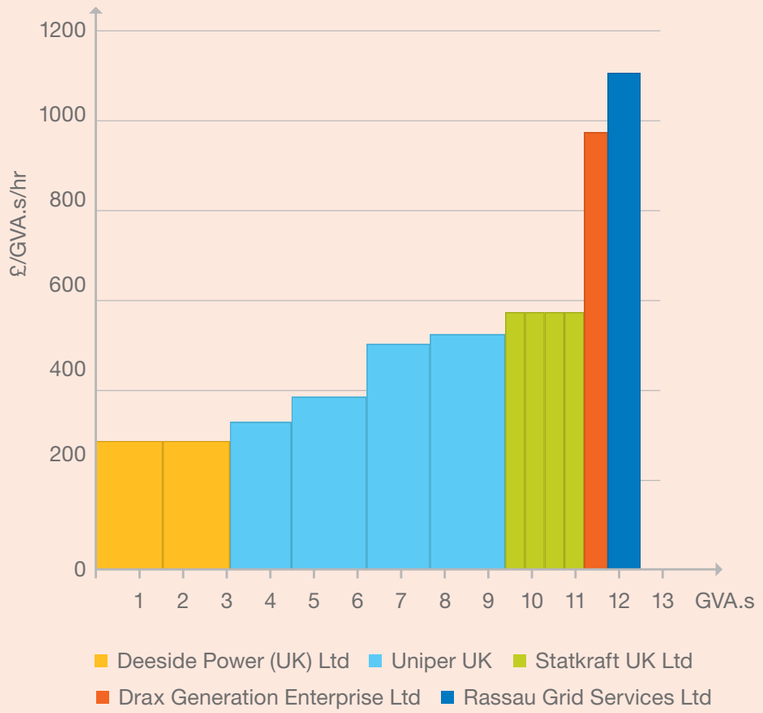
In 2020, stability has traditionally been available as a 'by-product' through market despatch of synchronous generation (MW) in the Balancing Mechanism.

In addition, we are trialling a long-term tender approach through Pathfinders.

- Stability Pathfinder Phase 1 procured 12.5GVA.s from 2020/2021 until 31 March 2026 from BM units and synchronous compensators.
- Stability Pathfinder Phase 2 is currently running a procurement for 8.4GVA of short circuit level (in Scotland only).

In 2020, our Stability Pathfinder Phase 1 costs amounted to £2.41m but by 2025 they will amount to £52.5m (12.5GVA.s at a volume weighted average availability price of £480/GVA.s/hr).

Stability Pathfinder 1 – tender results[2]



By 2025, this is expected to look quite different as it will depend on the development of new stability markets and the evolution of stability requirements, including developments in the inherent stability of the technology used to connect to the networks.

Stability will be procured through tenders. However, further details of product design are still to be defined, for instance:

- technical specification for inertia, SCL and voltage capability
- payment arrangement (e.g. £/GVA.s).
- how to split national and regional requirements
- stability provided as a by-product by synchronous generators could be or not included in the procurement.
- Stability services could be procured by MW providers or at 0MW input[3].

Stability will be procured through long-term contracts (several years), based on NOA identified needs. We are also investigating the possibility of developing a short-term stability market. The optimal mix between long and short-term procurement is still to be defined.

2 The figure shows Stability Pathfinder 1 tender results. The prices accepted in the Phase 1 were assessed against the alternative actions required for accessing inertia without the service. Stability Pathfinder Phase 2 is looking to meet a need for short circuit level in Scotland, a different need. Prices accepted in Phase 1 should not be used to indicate prices that will be accepted in Phase 2 or beyond.

3 This means that stability (GVA.s) will be provided without adding unnecessary MW on the system and having to take related actions to constrain other non-synchronous generation.

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Stability

Market Information

Stability has traditionally been available as a ‘by-product’ through market dispatch actions (MW). The ESO aims to create long- and short-term stability markets for stability to be provided by a range of technologies.

Market Information - Service Providers

2020	2025
BM: Synchronous generators, 90% gas-fired units. Stability Pathfinder Phase 1: Synchronous 0MW machines. Stability Pathfinder Phase 2: Synchronous machines, grid forming convertors.	By 2025, synchronous generators are expected to still provide stability when running. In addition, synchronous compensators and GB Grid Forming Capability[4] (previously called Virtual Synchronous Machines - VSM) will be stability providers. We are also very grateful to external developers such as Scottish Power Renewables who have trialled Grid Forming and Black Start at their Dersalloch Wind Farm. We also are a partner with Scottish Power in the Phoenix innovation Project to look at the potential for Hybrid Synchronous Compensators (H-SC) to help maintain system stability.

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4 A Grid Forming Plant could be a Synchronous Generator or Generation connected to a Power Electronic Converter (such as wind farm or solar park) or even a solid state reactive compensation device whose converter has been designed to produce the same characteristics of a synchronous generator which contribute to arresting the fall in system frequency or limiting vector shift changes during disturbances.

Tackling Uncertainties in our Stability programme

We are committed to deliver the best solution for consumers through competition and our aim is to create a liquid market for stability. However, there are still important questions that we need to answer regarding both the evolution of our stability requirements and the design of stability markets.

We want this process to be collaborative, and have many initiatives already underway to enhance our understanding of system stability and the technologies that could provide solutions:

- We are working with the 3 Transmission Operators on an innovation project to create a model of the GB transmission system that will allow us to study electromagnetic transient (EMT) behaviour.
- We are working with Imperial College London to create a short-term inertia forecast using machine learning techniques.
- We are testing how Grid Forming Capability can be provided by a battery system at the PNDC in Scotland, with Belectric and the University of Strathclyde.

Upcoming events

- Early Development work has started for the next phase of the NOA Stability Pathfinder (Phase 3), including initial connections discussions, technical requirements and timeline planning. We will be publishing further details regarding the tender for Phase 3 in Spring 2021.
- We are scoping an innovation project to assess the different ways in which we could design a short-term market for stability products.

Useful links

- System Operability Framework (SOF) – this page provides insights of medium-term and long-term operability challenges (reducing inertia, declining short circuit levels, etc.).
- Operability Strategy Report (OSR) – this ESO document is published annually and provides an accessible overview of our operational requirements out to 2025. Navigate to p37-48 to learn more about our operational needs for stability and the system changes that are driving them.
- NOA Stability Pathfinders – this page will keep you up to date with the latest developments of our Stability Pathfinders and how to get involved.
- ALoMCP – this page provides an overview of the programme and how to get more information if required.
- SQSS modification proposal GSR027 – this page provides documentation on the review of the NETS SQSS criteria that drive reserve, response and inertia holding on the GB electricity system.
- Grid Code Workgroup GC0137 - this page provides insights into the issues being considered at developing a minimum GB Grid Forming specification.

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Stability – Roadmap

Why

To manage the transition to net-zero, we need to **update industry standards**, reducing our requirement to procure stability services.

As this market is less mature, a **"learning by doing"** approach has been used, with the **pathfinder projects** allowing to test different approaches.

Long term market solutions will be compared against network solutions, underpinned by the Network Options Assessment (NOA) process.

The future of stability is potentially to be managed through a **mixture of long-term contracts and a close to real time market**.

It is also our desire to **lower the barrier to entry** to the stability market.

What

The system has lower stability than previously, and protection systems installed on DER are now too sensitive and pose a risk. The **Accelerated Loss of Mains Change Programme (ALoMCP)** is offering funding to generators connected before 1 February 2018 to upgrade hardware, supporting them to remain connected while frequency is changing rapidly. Compliance with new protection requirements must be delivered by September 2022.

GSR027 – 'Review of the NETS SQSS Criteria for Frequency Control that Drive Reserve, Response and Inertia Holding on the GB Electricity System' has been approved and will change the nature of ESO's inertia requirement going forward by allowing us to optimise how we manage frequency risks on the system. For example faster frequency services may allow us to operate with lower levels of system inertia.

Stability Pathfinder phase 1 has awarded 12 tenders from 5 providers across 7 sites for stability service. The contracts commenced in April 2020 and long-duration contracts will run to 31 March 2026.

Stability Pathfinder phase 2 aims to support new technology types participating. It is seeking to fulfil a specific locational requirement in Scotland and focused on procuring services to deliver short circuit level (SCL). Contracts are scheduled to be delivering by 2025.

Stability Pathfinder phase 3 is taking the learning of Stability Phase 1, Stability Phase 2 and the Voltage pathfinders and will move to a GB-wide long -term tender for stability procurement.

The **NOA process will be updated** to include a wider range of requirements – including stability – and solutions.

A **short-term market for stability** is being investigated through an innovation project. Its introduction would complement longer term stability solutions by offering a way to refine system requirements closer to real time, and for stakeholders to have an additional marketplace close to real time.

GC0137 – 'Minimum Specification Required for Provision of GB Grid Forming (GBGF) Capability' aims to define and codify technical standards for Virtual Synchronous Machines (VSMs). It would help non-traditional providers of inertia (solar farms, wind farms and interconnectors) to offer the service.

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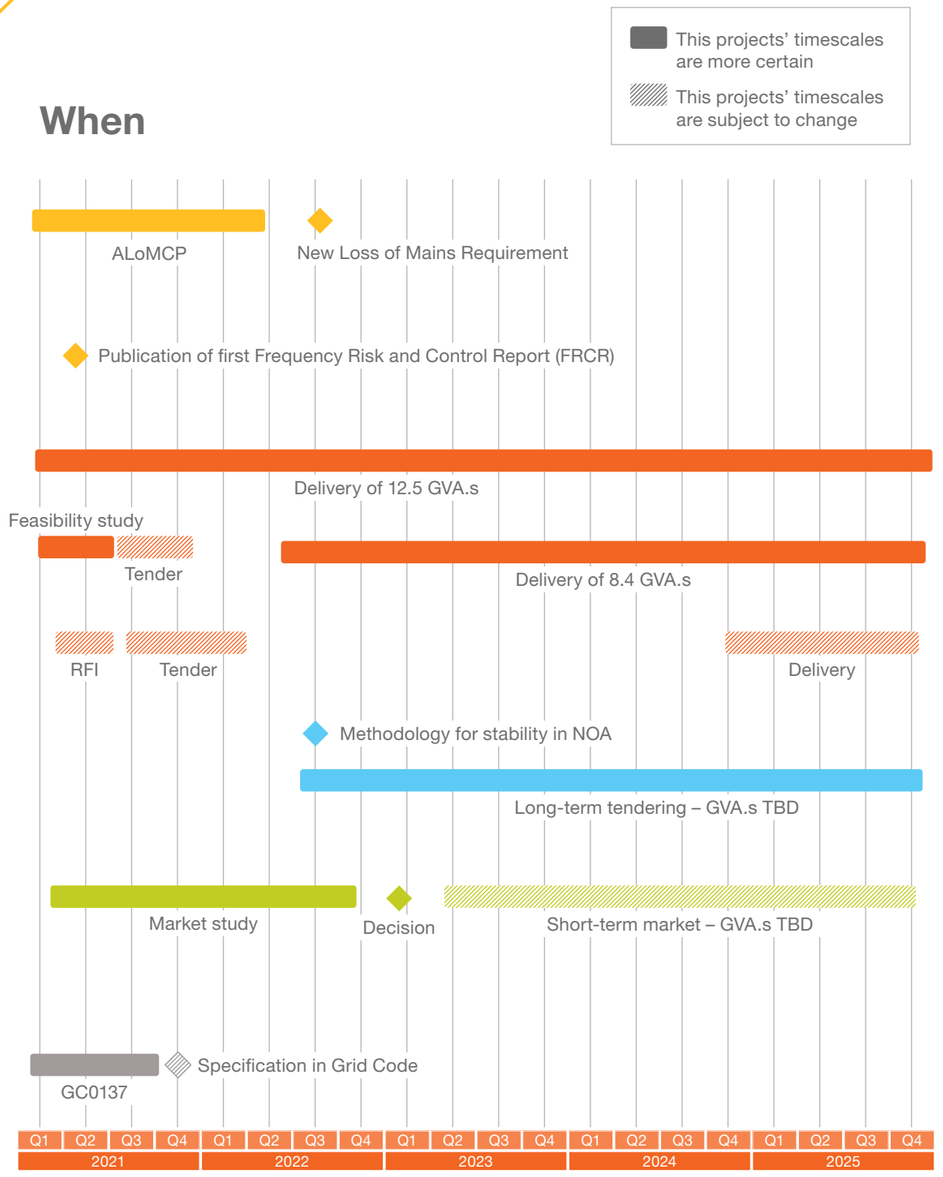


Balancing Mechanism (Bids and Offers)

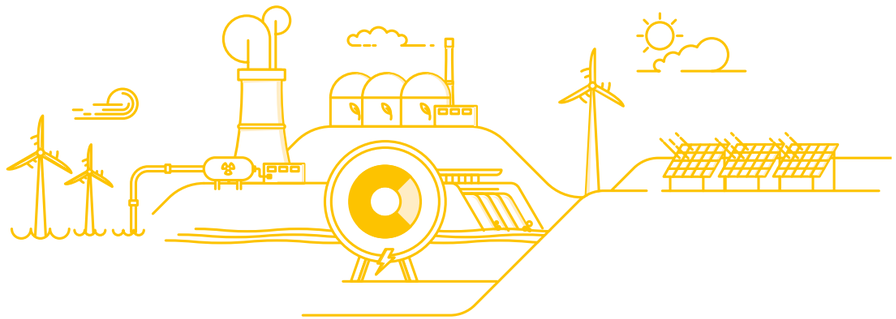
Our ambition is to simplify accessibility to the Balancing Mechanism for all technologies and providers along with increasing the transparency of system actions.

The Balancing Mechanism (BM) is the market tool we use to manage system operation in real time. It is used to dispatch Bids and Offers[1], as well as balancing services[2]. Note that this section is focussing only on Bids and Offers (as other services are covered in their respective market pages).

Key Drivers for Change

- ESO Ambition: Zero-Carbon Operation
- ESO Ambition: Competition Everywhere
- Transparency
- Technology and Data Analytics

Increasing levels of intermittent generation and new forms of smart demand management technologies will likely lead to increasing numbers of actions being required in our real time markets. We therefore need smarter functionality and tools to be able to dispatch a greater number of market participants than today.



1 Bid Offer Acceptance (BOA): Bids and Offers are commercial services offered by generators and suppliers and represent a willingness to increase or decrease the energy output from Balancing Mechanism Units (BMUs) in exchange for payment through arrangements set out in the Balancing and Settlement Code.
2 Balancing services are procured to balance demand and supply and to ensure the security and quality of electricity supply across Britain's transmission system.

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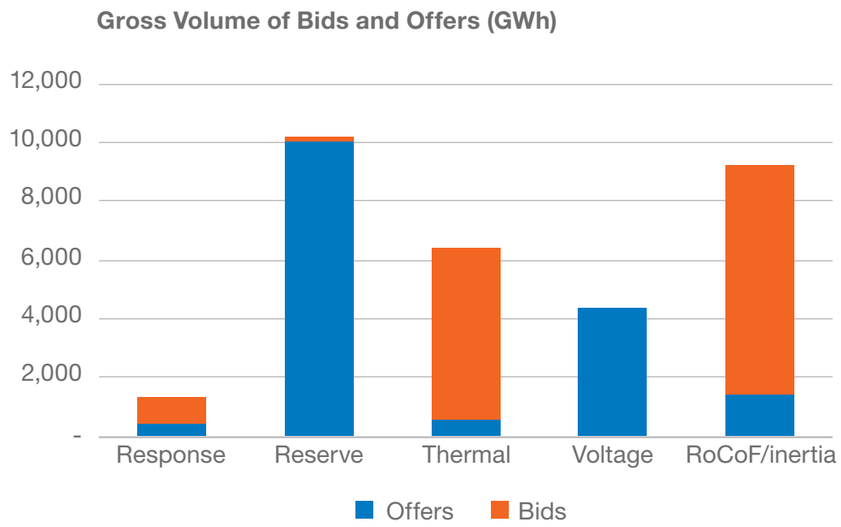
Balancing Mechanism (Bids and Offers)

Operational Need[3]

The Balancing Mechanism will remain the system real time market. The use of bids and offers and diversity of actions interact with the development and delivery of other ESO services.



Operational Requirement

2020

Today bids and offers are being used in addition to balancing services. They are therefore used for a range of different reasons:

- **Response:** used to position the response providing units into their frequency sensitive mode.
- **Reserve:** to manage the overall imbalance in the system, based on generation and demand outturns, forecasting and available margin (headroom and footroom).
- **Thermal:** to manage thermal (also called congestion) constraints in the network.
- **Voltage:** to manage the voltage level by controlling the volume of reactive power that providers can absorb or generate.
- **RoCoF/inertia:** to manage a safe system, we have sometimes to reduce the largest loss/gain and/or to increase the number of synchronous generation units on the system.

In 2020, the gross volume of bids and offers amounted to 31.6 TWh (14.7 TWh of bids and 16.9 TWh of offers).

Dispatch of instructions requires manual decisions and are issued according to participants' submitted prices, qualified by recommendations from our dispatch optimising software, plus any strategic needs.

2025

Bids and offers will continue to be used in conjunction with other balancing services, as a mean to operating the system in real time and providing sufficient flexibility to maintain system security.

The ongoing use of bids and offers may evolve as we look to reform services such as response and reserve and develop inertia products as part of our stability market development.

So, in 2025, the extent to which bids and offers are used is unknown due to the number of different factors that can drive system needs (e.g. network capabilities, emergent operational challenges, market behaviour and ability to self-balance, technological capabilities, optimising forecasting). We do however anticipate that the enhancements to other markets will decrease the range of operational circumstances in which bids and offers are used.

Our new dispatch facility will enable us to assess more data and more complex scenarios. Market participants will also better understand our decision-making process as we enhance transparency of our data and decision making, and as automatisation increases.

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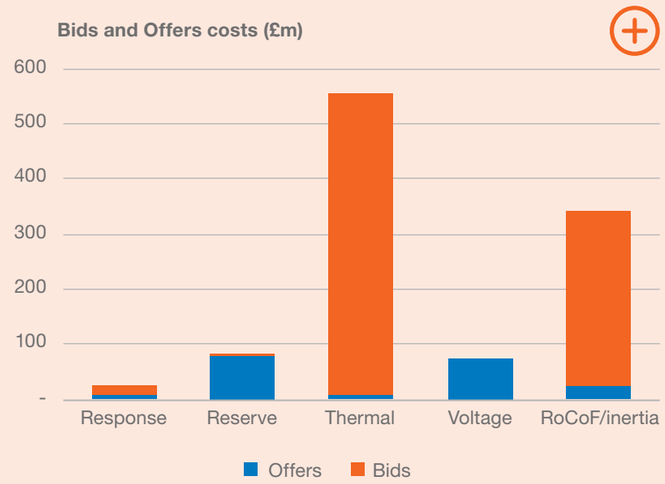
Balancing Mechanism (Bids and Offers)

Value of the Market

The BM is a paid-as-bid[4] market (utilisation only). Instructions are firm and mostly carry an unwinding cost. The balancing costs generated by the bid and offer actions in 2020 amounted to £1,080m.

By 2025, we will still be using bids and offers in addition to balancing services. As a consequence of reserve reform and wider service development, change could transpire in the BM (pricing, technical characteristics, etc.).



4 A derogation has been granted to the ESO for the BM to continue to have their balancing energy payments settled on a pay-as-bid basis, rather than the pay-as-cleared basis required by the Electricity Regulation.

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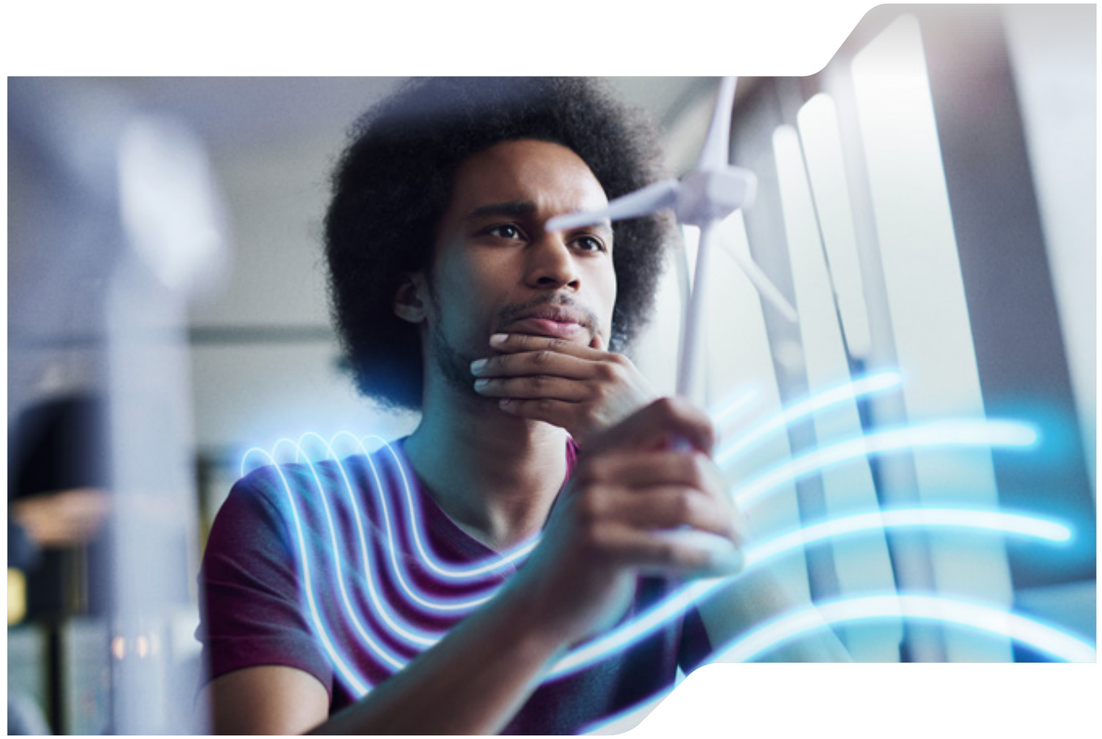
Balancing Mechanism (Bids and Offers)

Market Information

We are removing barriers to entry, facilitating competition and providing cost-effective routes to market to enable participation of smaller and aggregated units in the BM.

Market Information - Service Providers

2020	2025
Traditionally participants have been a few hundred large transmission connected generators, but smaller parties are entering the market via newly available access routes.	Several thousand providers are expected to participate in the BM, both large and small - with an increasing participation of smaller (e.g. behind the meter assets, distribution connected generators and storage assets) as barriers to BM participation are further reduced.



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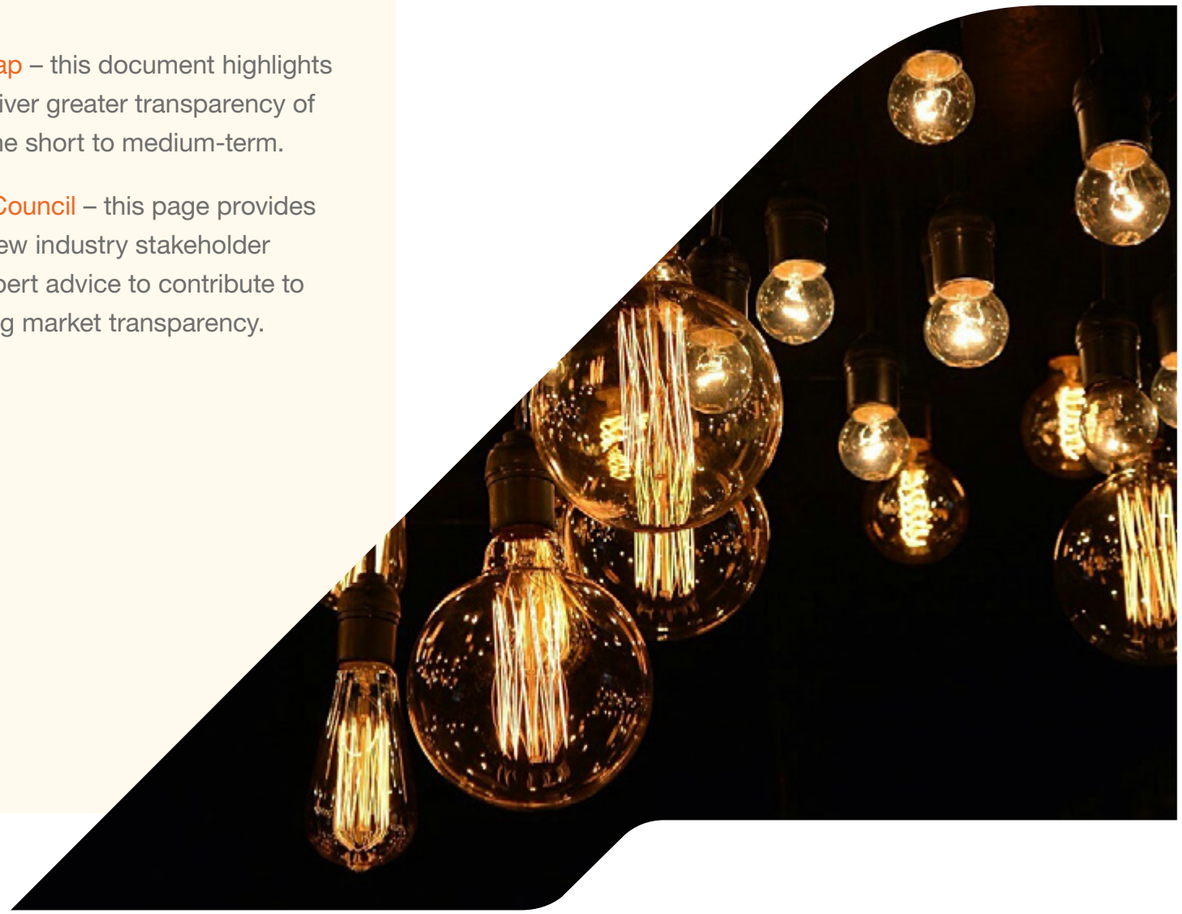
Balancing Mechanism (Bids and Offers)

Ongoing events

- We hold a weekly Operational Transparency Forum every Wednesday at 11am in response to requests for greater transparency from the industry. This forum has been launched as an enduring method to keep you updated on the operational actions taken in previous weeks and to answer wider industry queries.

Useful links

- Wider access – this page provides information on how to enter the Balancing Mechanism and the latest developments on wider access.
- Data portal – this page provides access to our open data portal.
- ENCC transparency roadmap – this document highlights the activities planned to deliver greater transparency of our operational actions in the short to medium-term.
- ESO Technology Advisory Council – this page provides information on one of our new industry stakeholder groups that is attracting expert advice to contribute to our decisions and enhancing market transparency.



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Balancing Mechanism (Bids and Offers) – Roadmap

Why

Requirements for participating in the BM can be onerous and it is our desire to simplify how participants access the BM.

As we open access to the BM, it is our intent to **ensure a level playing field** across different stakeholders and technology types.

We understand from stakeholders that real-time price signals will become increasingly important. **Transparency** is therefore key. As system conditions become more variable, and system margins become tighter, there is increasing focus on short term markets and price signals.

What

The roles between the Balance Responsible Party (BRP) and Balancing Service Provider (BSP) in the energy market is now separated. The BM was only available to energy suppliers and licensed generators but a new route to market has been created through a new type participant, a **'Virtual Lead Party' (VLP)**. Non-traditional participants (as small as 1 MW) and aggregators are now able to participate in the BM as well as deliver balancing services.

A new IT interface, the **Application Programming Interface (API)** has been created for providers to connect and communicate in real-time with our systems and the BM. It is an alternative to the fixed line connections that providers have traditionally used for electronic data transfer (EDT) and electronic dispatch logging (EDL).

To accommodate the anticipated increase in the number of participants, we plan to update our software with the **New Dispatch Facility**. We will create additional data storage capacity, re-platform our multi-dispatch tool, and replace our existing dispatch optimiser so that it can solve for more complex scenarios.

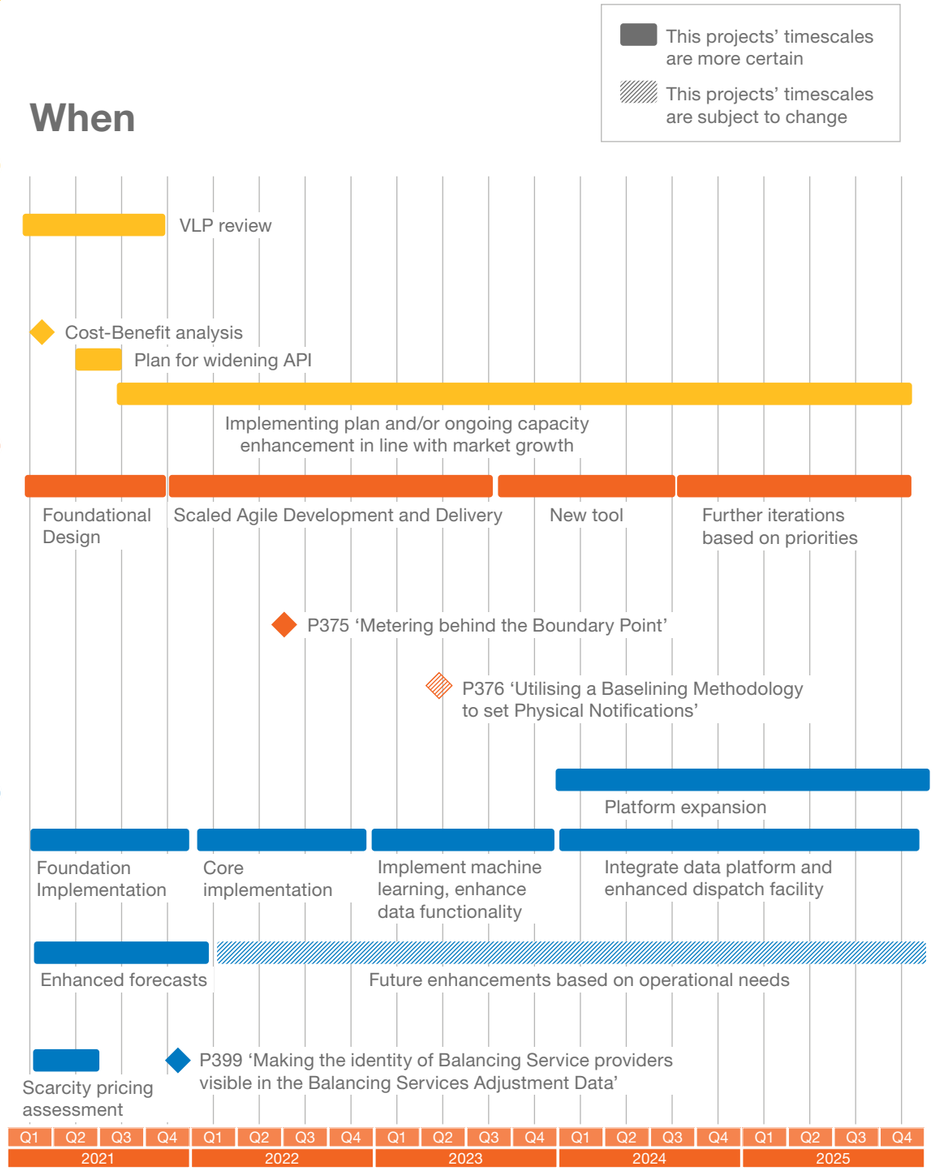
Balancing and Settlement Code (BSC) modifications aim to level the playing field between small scale and larger generation:
- **P375** allows 'Metering behind the Boundary Point' and will enable efficient participation of smaller flexible assets by addressing an issue with being able to provide a Balancing Service, but this not being visible.
- **P376** - 'Utilising a Baselining Methodology to set Physical Notifications' proposes the creation of a Baselining Methodology to produce another FPN-like value to use in Settlement but different to the FPNs submitted in the BM.

Data & Analytics Platform (DAP). We aim to publish the data that is most valuable for stakeholders, accessible through our data portal. We will also share analysis and insight of how we make operational decisions. Giving more clarity of operational decision making will allow stakeholders to make better informed decisions.

IT forecasting accuracy - As well as seeking to minimise our forecasting inaccuracies (demand and wind) on a day-to-day basis, we are also developing the Platform for Energy Forecasting, which supports market participants in making informed decisions by providing more accurate, frequent and granular forecasts.

Further examples of increasing importance of data and price signals are:
- **P399** will provide more timely data by ensuring that Balancing Service ID data is published.
- **Reserve Scarcity Price issue group** will consider the role of the Loss of Load Probability Statement (LOLP) and the Reserve Scarcity Price in the imbalance price calculation.

When



Capacity Market

We will build on our role in the Capacity Market (CM) to provide strategic advice on the CM rules to BEIS, Ofgem and the Capacity Market Advisory Group (CMAG) while improving key user experience via the Single Markets Platform. Enhanced modelling capability will support the continued progression of our procurement target recommendations.

The CM was designed as part of Electricity Market Reform (EMR) and first introduced in 2014. It supports security of electricity supply by paying Capacity Providers that have been awarded Capacity Agreements regular payments in return for being available to generate (or, in the case of DSR, to reduce consumption) during CM Stress Events.

Our role in the CM is:
EMR Delivery Body, running Capacity Auctions, assessing Prequalification Applications, maintaining the Capacity Market Register, managing Capacity Agreements and;

Electricity System Operator, forecasting capacity procurement requirement and advising on de-rating factors, providing Balancing Services Data, issuing Capacity Market Notices (CMNs) and producing post-event analysis of a Capacity Market Stress Event.

Key Drivers for Change

- ESO Ambition: Trusted Partner
- ESO Ambition: Competition Everywhere
- Increased System Complexity

We recognise that our CM systems and processes can be improved to make participation easier for our stakeholders. We want to improve these processes to support our ambition of ‘Trusted Partner’ to industry. The Single Markets Platform and enhanced strategic advice to BEIS and Ofgem will support our work in this area.

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Capacity Market

Operational Need

Peak system demand is expected to rise from the mid-2020s, after years of gradual reduction, as electrification of heat and transport gathers pace. Throughout the decade we also expect growth in new-build Contracts for Difference (CfD) capacity which is not eligible for participation in the CM. The balance between growth in peak demand and new generation capacity (de-rated for availability) will determine the direction of the CM procurement target out to 2030.

Operational Requirement

2020/2021	2024/2025
Capacity requirements for the 2020/21 delivery year were informed by the annual Electricity Capacity Report (ECR) and the final decision for capacity to be procured was made by BEIS. Capacity for the 2020/21 delivery year was secured through two auctions: • The T-4 2016 Auction secured 52.43GW of capacity for 2020/21. • The T-1 2019 Auction secured a further 1.02GW of capacity for 2020/21.	Our annual Electricity Capacity Report (ECR) recommends the MW level of capacity to be secured through the CM and is independently scrutinised by a Panel of Technical Experts. The final decision on the procurement target to be met through the CM is taken by BEIS. The procurement target for the T-4 2021 auction is 40.1GW for delivery in 2024/25[1]. This is lower than in previous years largely due to an increase in previously contracted capacity from CM units awarded multi-year agreements in recent auctions; a lower peak demand for 2024/25 than for 2023/24 in the 2019 ECR; higher non-CM renewable capacity, and a small net decrease due to other changes. A further 2GW has been set aside for the future T-1 auction for delivery in the same period.

1 BEIS' letter setting out the 2025 CM procurement target.

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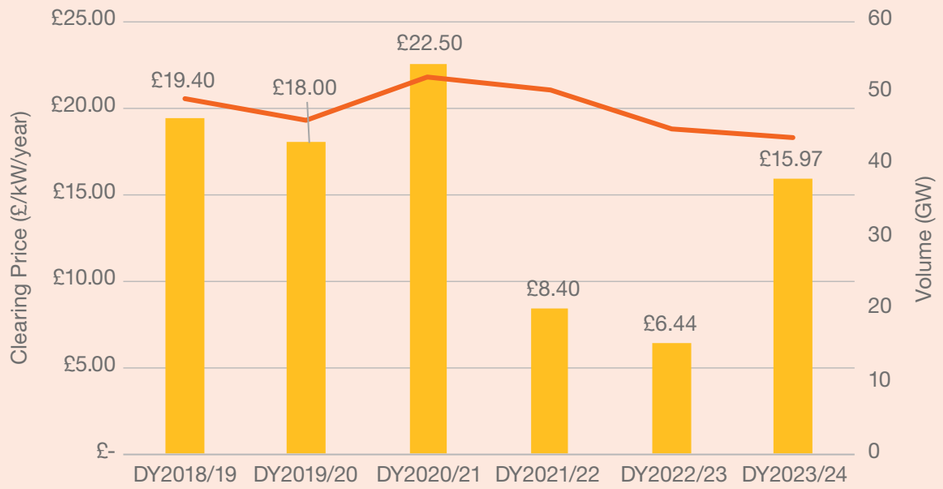
Capacity Market

Value of the Market

There have been six T-4 auctions in the CM's history with the auction clearing between £6 and £23. A number of large conventional thermal units, mostly coal plants, are expected to close by 2025 and this will likely put upward pressure on the clearing price for the latter half of the 2020s.



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Capacity Market

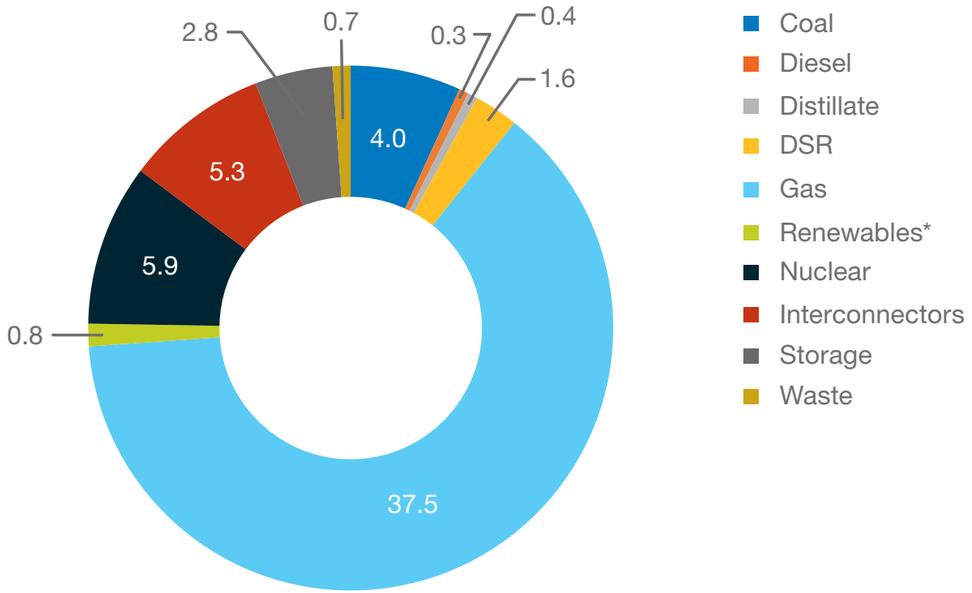
Market Information

In 2025, gas capacity will continue to dominate the CM auctions as coal and diesel close or are prevented from participating in the CM due to incoming emissions limits. Older Renewable Obligation (RO) and Feed in Tariff (FiT) renewable capacity may seek to enter the CM to access an alternative revenue stream as support schemes end. High prices in the CM T-4 auctions could signal lower prices in the wholesale and BM markets for the delivery year, all else being equal, as many providers have recovered more of their annual underlying operating costs from CM revenue.

Market Information - Service Providers

2020/21	2024/2025
For eligible industry participants, a Capacity Agreement is a valuable revenue stream and is stackable with most balancing services. This means that a Capacity Provider can offer system services to us while successfully fulfilling the requirements of their Capacity Agreement. Gas, mainly large CCGT units, dominates the Capacity Market in 2020.	By 2025 carbon emissions limits will be applied to 'existing capacity'[2] participating in the CM as required by the EU's Clean Energy Package (CEP). This will prevent coal units, older inefficient gas plant and some diesel gensets from participating in the CM.

T-4 2020 Auction for DY2023/24 -Participating Technologies (GW)



2 Existing capacity is that which connected before 4th July 2019.

Tackling Uncertainties in our Capacity Market Programme

Our role in the Capacity Market means we aren't the only party driving change in this area and ultimate strategic direction sits with the UK government. However, there are still some important questions that we want to support BEIS, Ofgem and industry to answer regarding the implementation and ultimate end state of the Capacity Market.

Key areas to consider include:

- Whether the UK will pursue cross-border participation in the CM as a third country outside the EU;
- What the role of the Capacity Market is in a net-zero world; and
- Whether the Capacity Market price signals align well with wholesale, ESO and DSO service markets, BM and network charging signals and if they could be improved.

Recent events

- **T-1 Auction 2021 – 2 March 2021**
  The T-1 auction for delivery in winter 2021/22 took place on the 2 March 2021. The auction clearing price was £45/kW/yr, the highest clearing price thus far in GB CM auction history. Provisional results suggest battery storage was a major winner with all 17 units which entered receiving agreements for a total of 114MW.
- **T-4 Auction 2021 – 9 March 2021**
  The T-4 auction for delivery in 2024/25 took place on the 9 and 10 March 2021. The clearing price was £18.00/kW/year. Provisional results suggest solar energy was awarded CM agreements for the first time in a T-4 auction and the level of onshore wind trebled to 28MW in comparison to last year's T-4 auction whilst DSR managed to exceed 1GW of successful capacity for the second year running. Due to publication deadlines for this report we have not shown the clearing price or technology breakdown for this auction in the graphics throughout this section.

Upcoming events

- 2021 Capacity Market Launch Event – July 2021
- BEIS are currently consulting on incremental improvements to the Capacity Market with the consultation window closing on 16 April 2021. Improvements taken forward would be implemented for the T-1 and T-4 auctions in 2022. More information on how to respond to the consultation and share your views can be found here.

Useful links

- EMR Delivery Body Portal
  This page provides information on upcoming auctions, important CM deadlines and offers an opportunity to sign up for CM updates.
- Capacity Market Rules
  This page contains the latest and previous versions of the CM Rules. The Rules are updated in July every year

Contact

emr@nationalgrideso.com

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Capacity Market – Roadmap

Why

The ESO will support BEIS and Ofgem's reviews and the development and operation of a CMAG in its capacity as both Delivery Body and a TSO. This support will be in the form of advice on delivery timescales for administrative changes, advice on the strategic direction of the CM and its compatibility with net-zero and information on system operation impacts. More detail on our role is expected after the Ofgem CM Rules change process consultation later in 2021.

Feedback from stakeholders has been that prequalifying and entering assets into ESO balancing services markets and the CM is too onerous. We want to make accessing our markets easier and reduce administrative burdens on industry.

The recast Electricity Regulation part of the EU's Clean Energy Package (CEP) drives compliance in these areas.

We need to be aware of the CM timetables for rule changes when planning and implementing our market reforms.

What

BEIS will complete the second five-yearly **review of the CM** in 2024, 10 years after the launch. The review will again assess whether:
- The objectives of the CM and its implementing legislation remain appropriate.
- The extent to which those objectives are being met.
- Whether the objectives can be achieved in a way that imposes less regulation.

A **Capacity Markets Advisory Group (CMAG)** will allow the Rules change process to remain dynamic and capable of adapting to changing market conditions but would also increase transparency and engender a more consultative approach to policy making.

The **Single Markets Platform** will go live at the end of 2022/23. It is designed to remove the current "pinch points" identified by stakeholders and make participating in a range of markets including the CM easier.

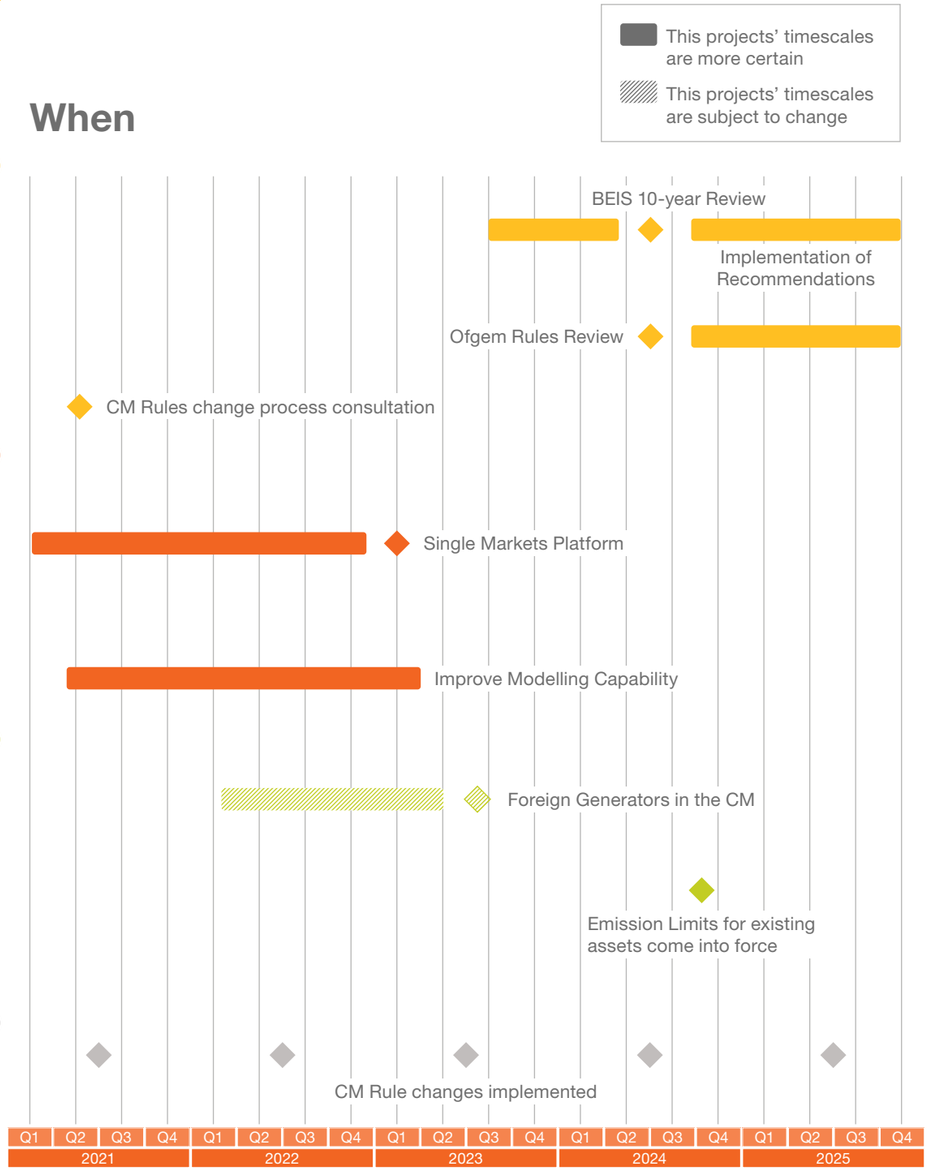
We will **improve our security of supply modelling capability** to account for greater interconnection, intermittent and distributed generation. This role will be extended to provide analysis to inform government decisions on future CM auction parameters.

The direct **participation of foreign plants** in the GB CM is a requirement of the Electricity Regulation, part of the CEP, as it applies in the EU. EU Exit has altered policy rationale for implementing cross-border participation, and the Electricity Regulation as retained and applied in the UK has been amended to remove the requirement. The UK government is currently considering the future policy position on cross-border participation in light of latest developments and will announce a position in due course.

Emission limits. Capacity providers which emit more than 550g of CO_2 per kWh and more than 350kg/kW of CO_2 on average per year will no longer be eligible to receive Capacity Agreements. This is expected to affect coal, diesel and some inefficient gas generators.

CM rule changes implemented – the CM rules can currently only be updated once per year, this may change with the introduction of the CMAG.

When



Market interactions

Market interactions

Exploring some key interactions between electricity markets

There are many interactions between ESO markets and those in the wider electricity sector, and it is vital that we design and develop them in the most optimised and interoperable way. In this section, we explore some of these key market interactions, and discuss how we are working with key stakeholders to ensure coordination across these activities.

Government strategy for energy is a big input into how our markets will develop for the future. Late last year we saw the publication of two important documents: the 10 Point Plan for the Green Industrial Revolution[1] and the Energy White Paper: Powering Our Net Zero Future[2]. These documents will transform the energy landscape, and we must build this into our long-term planning and market development activities. We are also working closely with BEIS to share what our market plans look like through to 2025 and how some of our priorities will also coordinate with the upcoming upgraded Smart Systems and Flexibility Plan[3], which we understand will be published in the Spring 2021. We are committed to realising the benefits digitalisation can bring to enhance transparency across our markets. In our Digitalisation Strategy we have highlighted where we support the recommendations of the Energy Data Taskforce (EDTF) as we recognise the leading role we will play in their delivery. The diagram below sets out the various market revenue opportunities in the sector, existing and developing, along with cost recovery mechanisms. We go on to explain the interactions between different market elements and the steps we are taking to manage these interactions (as indicated by the numbers on the diagram).

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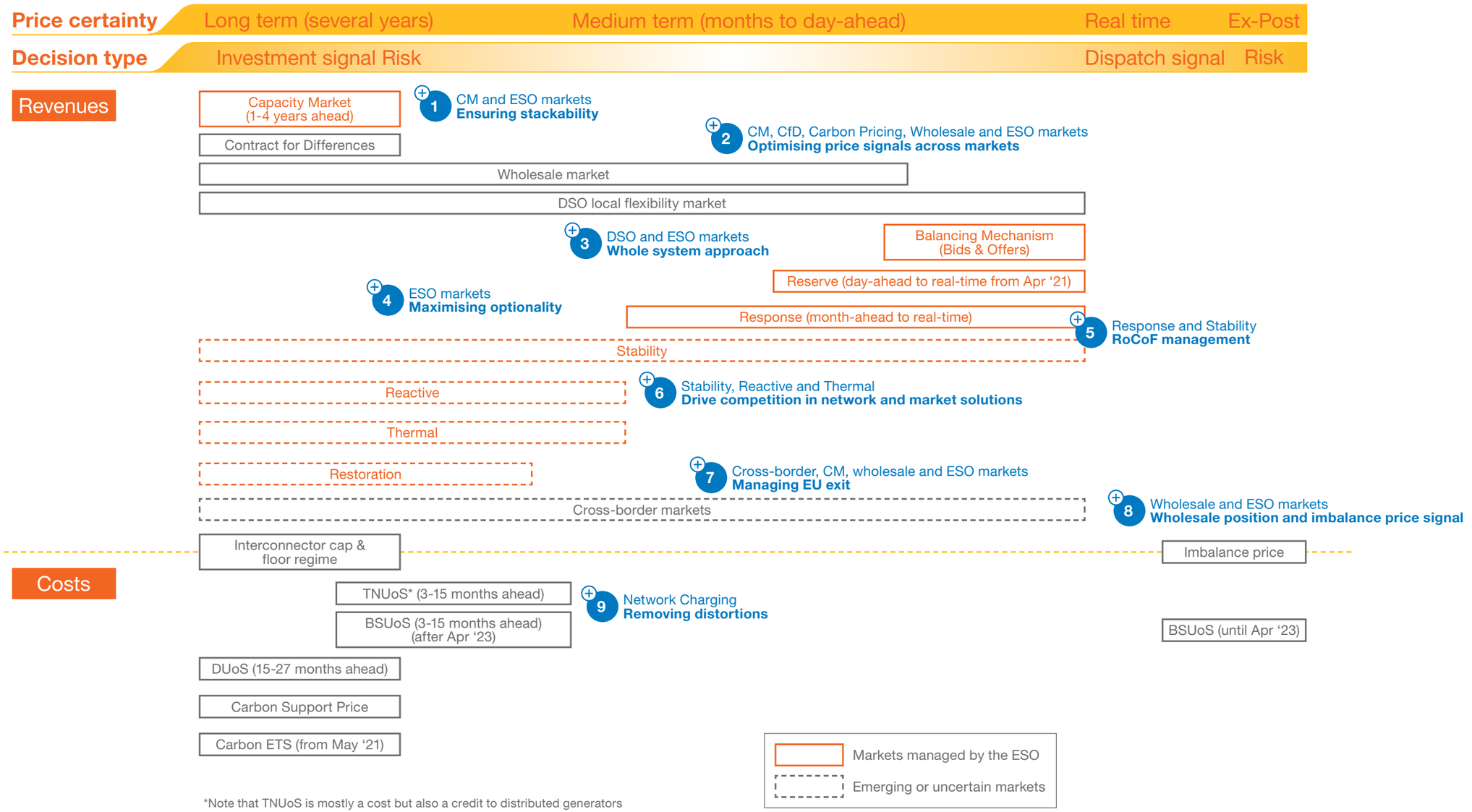
1 For more information visit gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution
2 For more information visit gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future
3 For more information visit ofgem.gov.uk/publications-and-updates/upgrading-our-energy-system-smart-systems-and-flexibility-plan

Market interactions



*Note that TNUoS is mostly a cost but also a credit to distributed generators

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nationalgridESO