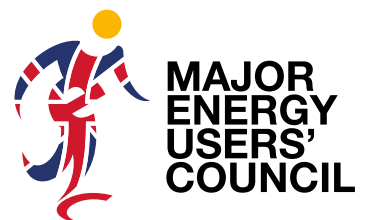


Balancing the electricity system with demand side flexibility and storage

Eddie Proffitt

The Major Energy Users' Council in association with National Grid ESO

nationalgridESO

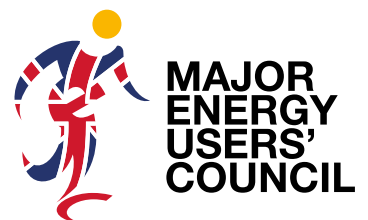


Balancing the electricity system with demand side flexibility and storage

Eddie Proffitt

The Major Energy Users' Council in association with National Grid ESO

nationalgridESO



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Contents

Kayte O'Neill

Head of Markets, National Grid ESO

Chapter 1: The growing need for flexibility **6**

The key to controlling future energy costs
Understanding the price messages from the market
What the future holds
Getting started
National Grid ESO's Power Responsive programme

Chapter 2: Using flexibility to reduce charges **14**

Transmission charges
Balancing Services Use of System charges (BSUoS)
Distribution charges
Levies and taxes
Getting better supplier contract prices

Chapter 3: Demand side flexibility opportunities **22**

Reserve services
 What are reserve services?
 Short Term Operating Reserve (STOR)
 Fast Reserve

Frequency Response
 What are Frequency Response services?
 Firm Frequency Response (FFR)
 Frequency Response weekly auction trial
 Dynamic Containment

Wider access to the Balancing Mechanism
 What is the Balancing Mechanism?
 Routes into the Balancing Mechanism?
 Systems

The Capacity Market
 What is the Capacity Market?
 Routes into the Capacity Market
 Bidding into the Capacity Market

Distribution Network Operator (DNO) opportunities
 Schemes from your local distribution network operator
 Electricity North West
 Northern Ireland Electricity Networks
 Northern Powergrid
 Scottish and Southern Electricity Network
 Scottishpower Energy Networks
 UK Power Networks
 Innovation Portfolio
 Western Power Distribution

Chapter 4: Accessing the schemes	44
Going direct or using an aggregator or supplier?	
Working with National Grid ESO	
Working with an aggregator or supplier	
Bidding into the Capacity Market	
Getting started	
<hr/>	
Chapter 5: Electricity storage for industrial and commercial energy users	47
The growing importance of grid-scale storage	
Historical background	
Storage market growth	
Types of battery technology	
UK storage projects	
National Grid ESO's system balancing	
Joint location of renewable generation and storage	
Aggregation of demand-side response with storage	
Potential revenue streams	
Storage for I&C energy users	
<hr/>	
Chapter 6: Case studies of demand side response and storage schemes	56
Saint-Gobain, a manufacturing company	
Marriott International Hotels – Europe	
Marks & Spencer	
Colchester Hospital University NHS Trust	
The University of East Anglia	
Ardagh Glass	
Norish	
Philip Dennis Foodservice	
Demma	
<hr/>	
Appendix I: Power responsive programme from National Grid ESO	67
Appendix II: Commercial aggregation service providers	68
Appendix III: Flex assure – compliance scheme for DSR aggregators	69
Appendix IV: Distribution network charges	72



Kayte O'Neill

Head of Markets, National Grid ESO

Welcome to the third edition of this guide, produced collaboratively between the Major Energy Users' Council (MEUC) and National Grid Electricity System Operator (ESO). Much has changed since the second edition. Demand Side Flexibility (DSF) remains a key area of focus and part of our toolkit to balance the GB electricity system on a second-by-second basis with opportunities evolving at pace.

As we progress towards decarbonisation it therefore feels like a suitable time to reflect on our role at the heart of the energy landscape with the new edition of this guide.

The energy landscape is evolving. Conventional generation such as coal is being replaced by small-scale renewables, storage and demand-side participation. This is enabling the transition to net-zero but also making the system more challenging to operate and increasing the need for flexibility.

As the ESO, our mission is to enable the transformation to a sustainable energy system and ensure the delivery of reliable, affordable energy for all. Success in 2025 looks like:

- **An electricity system that can operate carbon free;**
- **A whole system strategy that supports net zero by 2050;**
- **Competition everywhere; and**
- **The ESO as a trusted partner.**

Industrial and commercial energy users are already playing a significant role in delivering flexibility through the opportunities available to them with National Grid ESO, energy suppliers, aggregators, and increasingly, local Distribution Network Operators (DNO). We

must therefore continue to remove barriers to entry and provide customer focused services that are compelling for all. Ultimately this will help us to deliver a secure, cost-effective, and clean energy system.

Power Responsive, a programme of work facilitated by National Grid ESO, was launched to achieve just this. Our Steering Group and Working Groups stimulate conversation and action within the industry, at both policy and operational levels. We aim to address barriers to entry, whilst helping to support the creation of attractive markets that are suitable for both current and future needs.

This guide is a great starting point for anybody looking to understand the demand side proposition, and access additional revenue by providing Balancing Services to National Grid ESO or your local DNO, whether directly or through a third party. Businesses from many sectors including manufacturing, health services, retail, and transport, to name just a few, are continuing to support our energy system. There are likely to be opportunities whatever your business. Aggregators and suppliers are numerous, and their support can be extremely valuable in helping to identify flexibility opportunities where you might not think possible.

It's a great time to be part of the energy industry, and as we continue to innovate and transition to a zero-carbon future, we actively encourage industrial and commercial energy users to be a part of it by exploring and benefiting from the demand side flexibility landscape.

Contact our Market Services team at National Grid ESO on 01926 654 611 or commercial.operation@nationalgrideso.com to start your demand side journey. We're looking forward to hearing from you.

Chapter 1

The growing need for flexibility

The term "demand side flexibility" has evolved to cover the rapidly developing areas of demand side response schemes, storage and distributed generation. This book focuses on the options business customers have available to reduce their electricity costs by changing their pattern of consumption and benefiting from reduced transportation charges and payments from established industry schemes.

Energy efficiency, by reducing overall demand, will always be the best option for reducing cost, however becoming flexible with your demand can also contribute substantially to your bottom line.

At any moment in time, available electricity supply must match fluctuating demand. Every second by second, National Grid Electricity System Operator (ESO) must maintain this vital balance to prevent equipment failures and blackouts. This is especially important with sudden changes in demand or generation, for example when everyone turns on their kettle at the end of a major sports event or popular television programme, or where a source of generation unexpectedly fails.

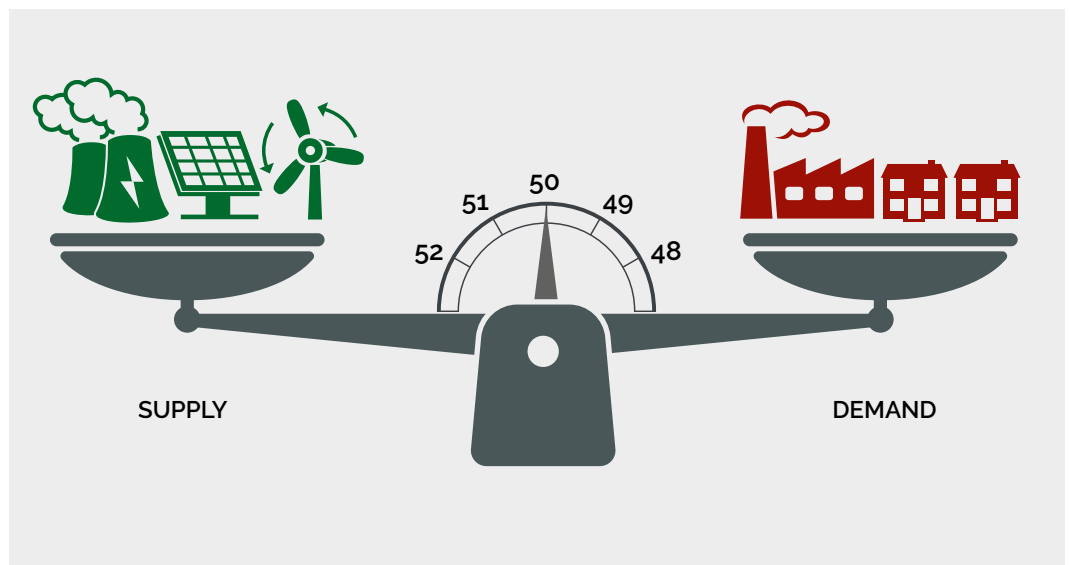
National Grid ESO, in its role as System Operator in Great Britain, has a statutory mandate to keep power balanced between 49.50 – 50.50 Hz. If demand exceeds supply, the frequency of the electricity will fall. If supply exceeds demand, the frequency will rise. It's a fine balance as both can have severe consequences.

The key to controlling future energy costs

Maintaining the national balance of supply and demand has fundamentally changed. Instead of large 'must run' coal plant, where the cost of running them flexibly was prohibitive, we now have wind and solar generation, both of which help decarbonise our electricity system but are somewhat unpredictable in their ability to generate, making balancing the system more difficult.

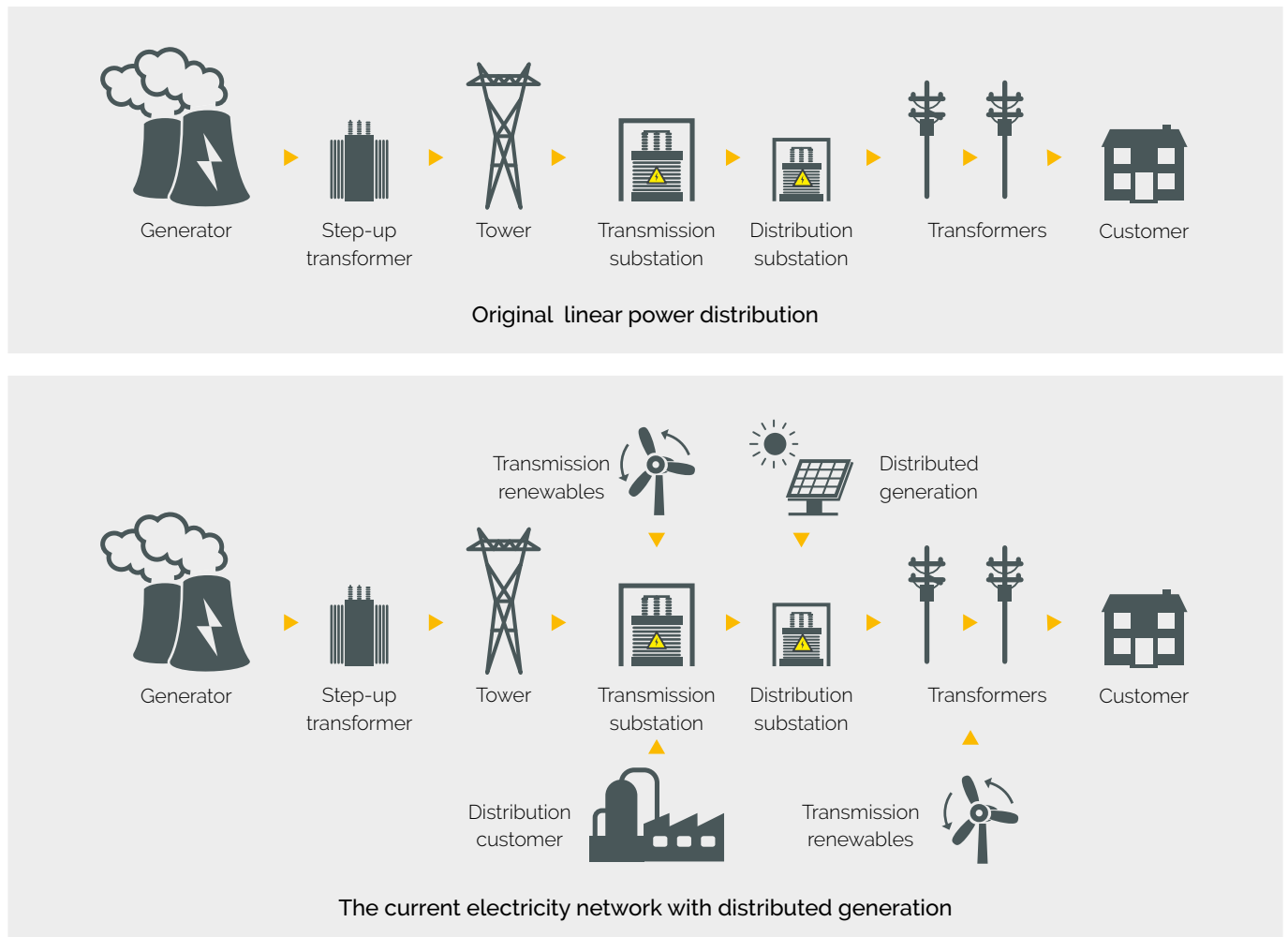
Wind and solar locations are also typically well away from areas of highest demand with a great deal of wind capacity being built in the north of Scotland and offshore, and with solar predominantly in the south, especially in the south west of England.

Figure 1.1: Balancing electricity supply and demand



Source: AEMO

Figure 1.2: The changing face of power supply



Source: Western Power Distribution

National Grid ESO finds itself operating with a much smaller margin of combined generating capacity compared to the potential maximum demand on the system, leading to the need to contract for contingency balancing services.

Because of the unpredictability of wind and solar output, National Grid ESO has the options of calling on stand-by plant, which must be kept available, battery storage or calling on consumers to decrease their demand. Likewise, at times of low demand and high wind/solar generation National Grid ESO now encourages large customers to increase their demand rather than having to curtail generation and pay generators for not producing.

This is where a consumer's flexibility of operation can contribute to balancing the system and improve profitability. By increasing or decreasing consumption dependent on system needs, businesses can earn revenues by helping National Grid ESO (and increasingly Distribution Network Operators) to manage their network. By providing this flexibility, businesses are also enabling more renewable generation onto GB's network, thus supporting the transition to a clean, carbon-free future.

Before considering these options, let us first look at some of the basic principles of the power market.

Understanding the price messages from the market

To meet environmental targets, our national electricity system is increasingly relying on wind and solar, which are more decentralised, less predictable and less flexible, particularly during the winter peak that occurs when solar is not available. This leads to more flexible plant such as gas fired generation having to fill the void at periods of high demand. Running such plants for reduced hours significantly increases their costs, thereby raising the cost of peak generation.

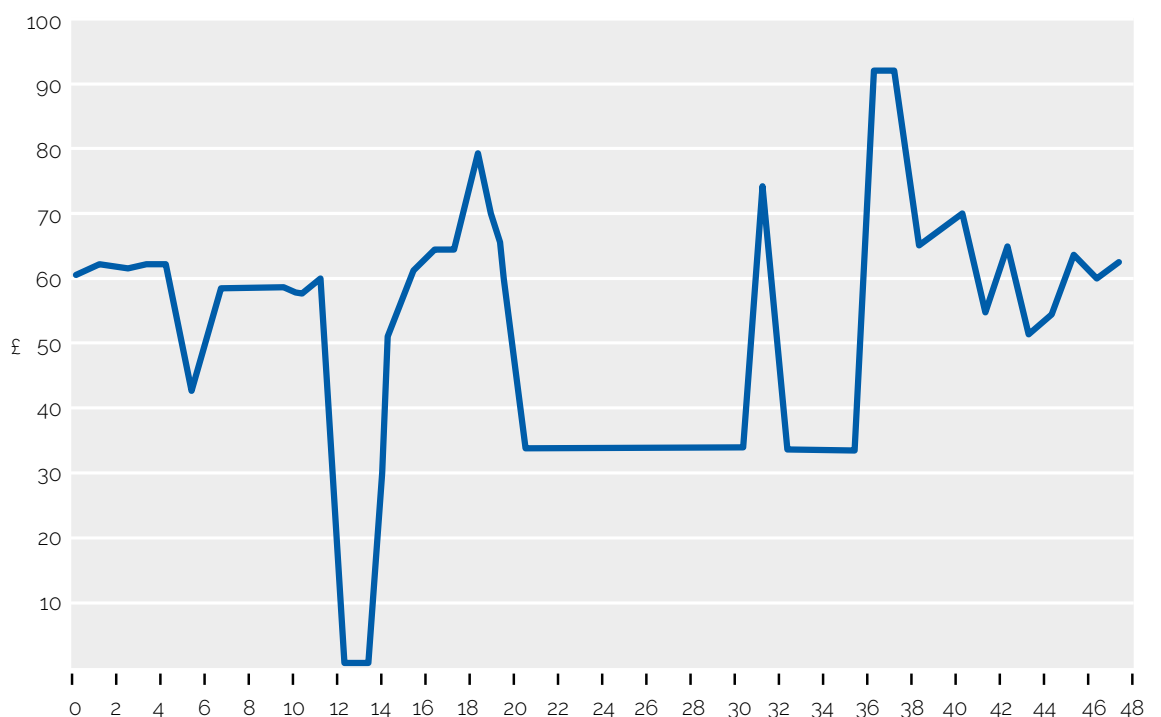
The alternative to running expensive plant for short periods is to access the flexibility that other assets can provide ahead of time through the various balancing services markets. These markets are open to all technology types, such as battery storage, onsite generation or demand reduction. Technology types such

as these connected at a distribution level, as opposed to large transmission-connected power stations, are known collectively as demand side response (DSR) providers. Balancing services markets help the System Operator, National Grid ESO, to balance supply and demand at times of system stress at the lowest cost, and DSR providers play an important role in these markets.

Advances in information and communications technology have made the use of DSR more feasible, resulting in the term 'smart grids'. This has led to distribution networks developing their own balancing services markets to access flexibility from DSR in addition to those available from National Grid ESO.

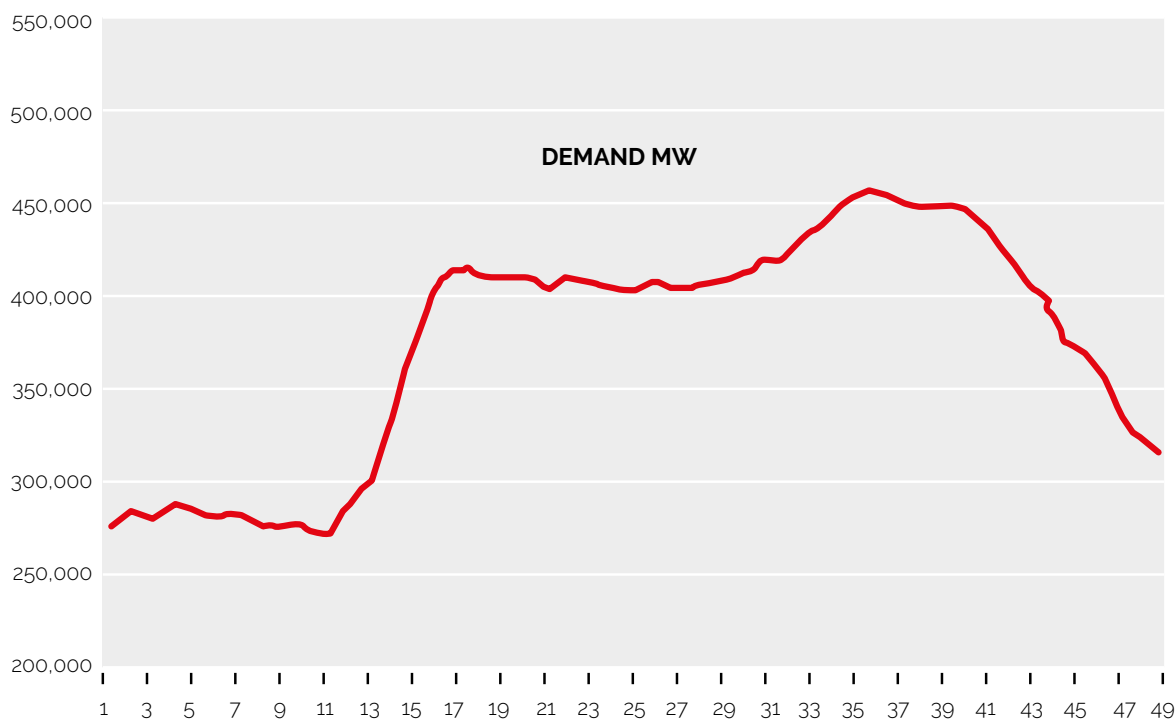
Unplanned plant outages, variations in fuel costs and ever-changing output from renewable sources all contribute to fluctuating power prices, as does excessive wind at times

Figure 1.3: How wholesale power prices can fluctuate during 24 hours (£/MWh)



Source: Drax Electrical Insights

Figure 1.4: Fluctuating demand across the day is a key driver of wholesale prices



Source: Drax Electrical Insights

of low demand, where we have even seen negative prices during off-peak periods.

To encourage investment, there have been several Government initiatives, one of which is the Capacity Market (described in detail later). The Capacity Market offers all capacity providers (new and existing power generation, electricity storage and DSR providers) a steady, predictable revenue stream on which they can base their future investments. In return for capacity payments, providers must deliver energy at times of system stress, or face penalties.

The payments made to providers are passed on to customers through additional charges applied to their usage during winter weekdays, from 4pm to 7pm, when combined with network charges this makes it more important than ever for large customers to reduce demand during this period.

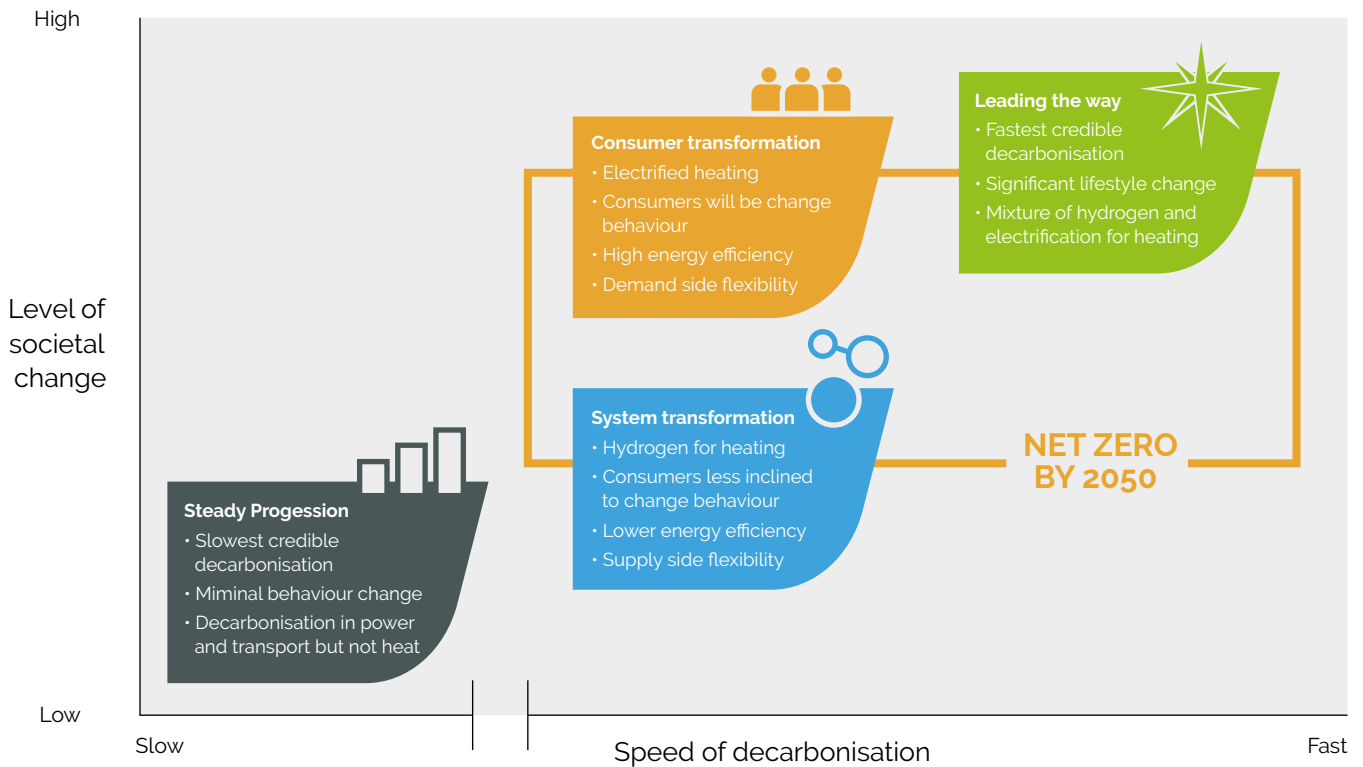
What the future holds

The most significant change affecting energy since the publication of previous books of this series has been the commitment of the Government to achieve net zero carbon emissions by 2050.

In its role as System Operator, National Grid ESO produces on an annual basis its Future Energy Scenarios that examine the future for energy through to 2050. The Scenarios compare GB's prosperity with its green ambition while balancing security of supply, affordability, and sustainability.

Three of the four 2020 scenarios meet the requirement to achieve the net zero by 2050 commitment, with Steady Progression being the only one that fails to meet the Government target. The four scenarios are:

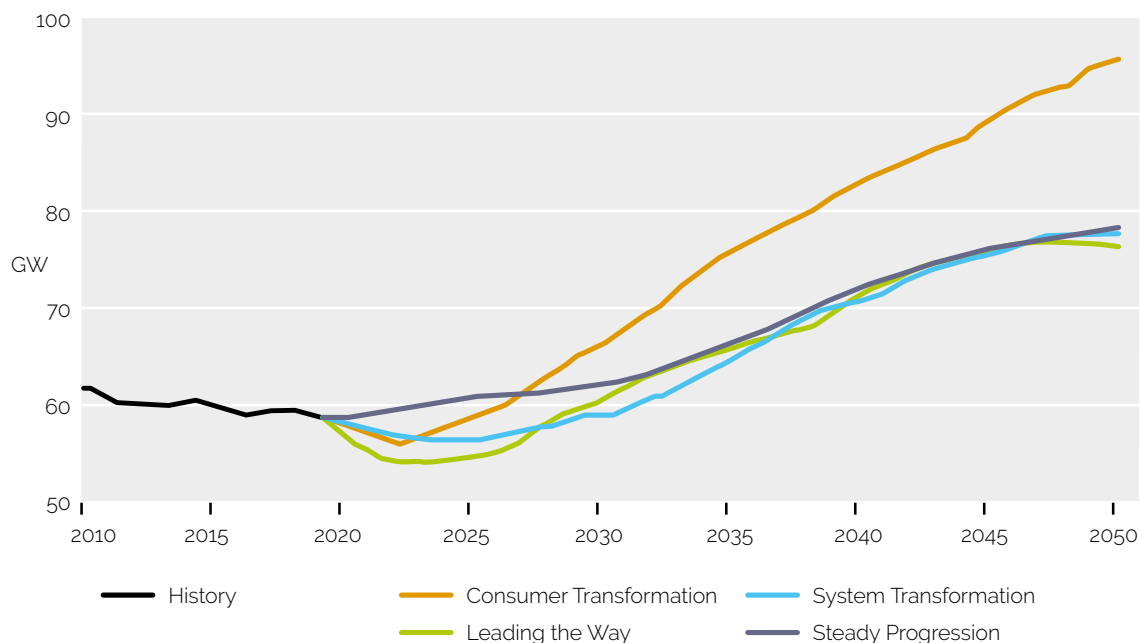
Figure 1.5: National Grid's future energy scenarios



Source: National Grid ESO – Future Energy Scenarios 2020: <https://www.nationalgrideso.com/document/173821/download> p.6

- **Leading the way** – We assume that GB 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. This scenario includes the highest and fastest improvements in energy efficiency to drive down energy demand, with homes retrofitted with insulation such as triple glazing and external wall insulation, and a steep increase in consumer participation in smart energy services. Hydrogen is used to decarbonise some of the most challenging areas of society such as some industrial processes, with this hydrogen produced solely from electrolysis powered by renewable electricity.
- **Consumer transformation** – The 2050 net zero target is met with measures that have a greater impact on consumers and is driven by greater levels of consumer engagement. For example, a typical homeowner will use an electric heat pump with a low temperature heating system and an electric vehicle. They will have had extensive changes to their home to improve its energy efficiency and most of their electricity demand will be smartly controlled to provide flexibility to the system. The system will have higher peak electricity demands that will be managed with flexible technologies including energy storage, demand side response and smart energy management.
- **System transformation** – The typical domestic consumer will experience less disruption than in Consumer Transformation as more of the significant changes in the

Figure 1.6: Electricity peak demand (including losses)



Source: National Grid ESO – Future Energy Scenarios 2020: <https://www.nationalgrideso.com/document/173821/download> (p.57, Fig SV.4)

energy system happen on the supply side, away from the consumer. For example, a typical consumer will use a hydrogen boiler with a mostly unchanged heating system and an electric vehicle or a fuel cell vehicle. They will have had fewer energy efficiency improvements to their home and will have lower engagement with opportunities to use their demand to provide flexibility to the system. Total hydrogen demand is high, and it's mostly produced from natural gas with carbon capture and storage.

- **Steady progression** – There is still progress on decarbonisation compared to the present day, however it is slower than in the other scenarios. While home insulation improves, there is still heavy reliance on natural gas, particularly for domestic heating. Electric vehicle take-up grows more slowly, displacing petrol and diesel vehicles for domestic use, however decarbonisation of other vehicles is slower with continued reliance on diesel for heavy goods vehicles.

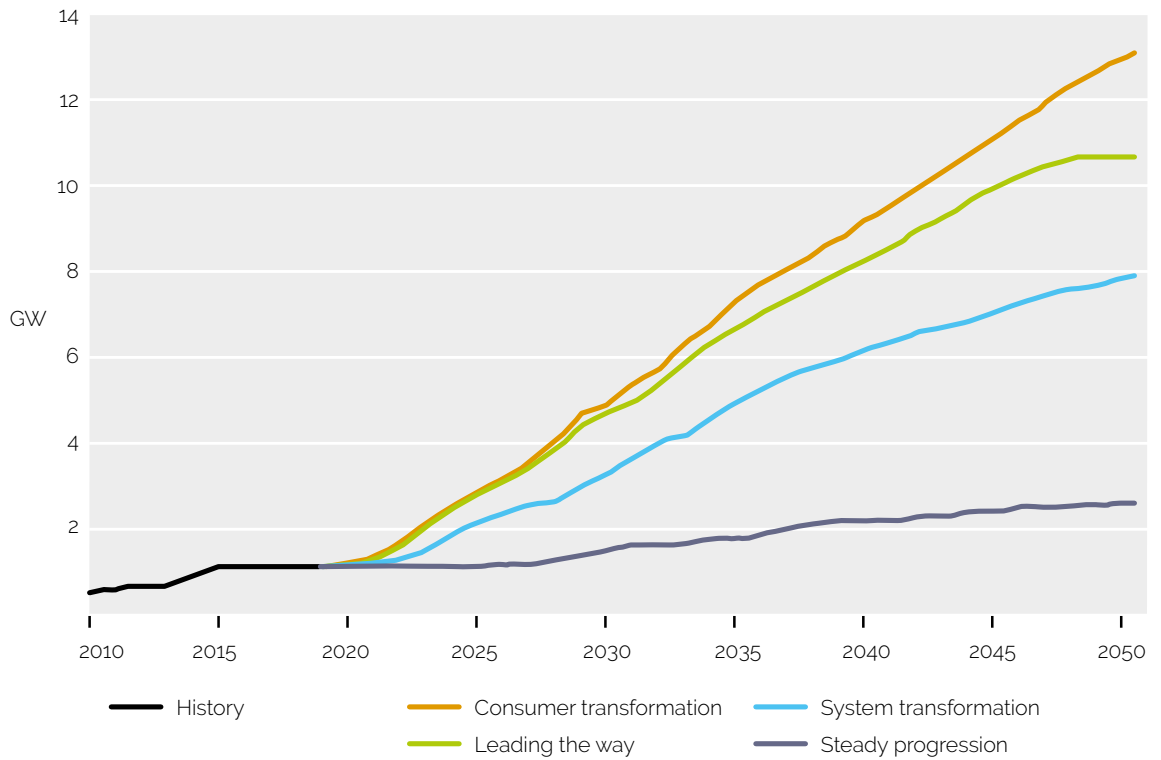
In 2050 this scenario still has significant annual carbon emissions, short of the 2050 net zero target in UK legislation.

It is likely that the world will not look exactly like one of the scenarios; instead, these scenarios set out a possible envelope of future supply and demand technologies and behaviours. They help with network planning and help to inform the types of services that could be needed in future.

The energy system must evolve while safely and reliably delivering low carbon energy to end consumers; when and where they need it to meet net zero. This will involve increasing scale, complexity and interdependency of energy conversions from one fuel to another as well as the importance of flexibility to manage differences in when and where energy is produced and consumed.

As demand becomes smarter and end consumers begin to increase their consumption at times of low prices caused

Figure 1.7: Total pure industrial and commercial demand side response



Source: National Grid ESO – Future Energy Scenarios 2020: <https://www.nationalgrideso.com/document/173821/download> (p.105, Fig SV.39)

by high renewable output on the energy system, it is possible that the consumption at these times of high renewable output could exceed the traditional peak demand (Fig. 1.6). The emergence of electricity demand from electric vehicles and hydrogen electrolyzers will significantly amplify this effect. Conversely, when renewable output is low, flexible demand (e.g. EVs and electrolyzers) will reduce their consumption and technologies like battery storage and vehicle to grid will discharge power back into the energy system.

In the net-zero scenarios new sources of flexibility beyond generation become more important to meet peak demand. If there is too much renewable generation compared to demand such as on windy, sunny summer days, this excess can be met by demand side flexibility, such as demand side response (DSR) or battery storage.

In all scenarios, we see DSR potential grow. As the market for flexibility increases it becomes more valuable; with much faster increases in the net zero scenarios as the market develops faster and uptake of smart technology increases (Fig 1.7)

Increased use of DSR is demonstrating the technology's potential to increase efficiency and provide businesses with a new revenue stream. Thousands of additional UK businesses can further reduce their energy costs using demand side technologies and approaches. The ADE (Association for Decentralised Energy) calculates that 16% of the UK's peak electricity requirement – or 9.8GW – could be provided by businesses shifting demand away from busy periods and by making better use of onsite generation. If utilised, this could save UK energy consumers £2.3bn by 2035.

Chapter 1

The growing need for flexibility

Getting started

The starting point for anybody considering offering flexibility services must be to understand your use of electricity: how much you use, when you use it, and the flexibility of your system to vary the time and volume. In addition, if you have stand-by equipment, you should understand its capability and your organisation's willingness to use it to earn revenue.

Begin by obtaining from your supplier your half hourly consumption data and overlay this with pricing information to show when it would be most beneficial to reduce demand. Remember that some Government levies and network charges (described later) vary with the time of day and season.

Transmission charges – for using the high voltage network – are, for the next two winters, based on the demand for electricity at peak periods, with changes due from April 2022. Distribution charges – for using the low voltage network – are also focused on peak periods, with lower charges during the day and evening, and the lowest reserved for overnight and weekends. The actual charges will be covered in more detail in the next chapter but moving demand away from peak times will reduce overall use of network charges.

National Grid ESO has a number of markets for Industrial & Commercial (I&C) consumers to help with frequency balancing and reducing overall demand which will be covered in detail in Chapter 3.

Knowing your consumption profile combined with flexibility will also pay dividends when tendering for a new supplier, as they are keen to limit their risk and prefer to contract with knowledgeable consumers with a proven track record of managing their consumption.

To help market participants understand where the value is and which revenue streams deliver the most value for their flexibility, National Grid ESO's Power Responsive initiative publishes an annual report into its flexibility markets with a particular emphasis on how DSR is performing against more traditional types of provider. The latest Annual Report can be found under Updates on the Power Responsive website: <http://powerresponsive.com/updates/>.

National Grid ESO's Power Responsive programme

In June 2015, National Grid ESO launched the Power Responsive programme, with the aim of promoting the delivery of I&C demand side flexibility in the GB electricity markets.

Power Responsive continues to play a prominent role in supporting the demand side proposition and its success can be seen through the increased participation that continues to join the market.

Through Power Responsive National Grid ESO works collaboratively with stakeholders across the energy and I&C sectors via forums and a high-level steering group to drive and steer progress. The MEUC is represented on this steering group along with a number of its members and its approach has been that 'balancing' is not an industry problem but rather a I&C opportunity.

The purpose of the steering group is to promote demand side flexibility in GB electricity markets; ensuring coordinated delivery of objectives to achieving increased scale.

The developments and achievements of the campaign are described in more detail in Appendix 1.

Using flexibility to reduce charges

There are three different types of charge which are billed to customers based on their use of the transmission and distribution networks. You might be liable to pay one – or all of them, depending on the type of user you are:

- 1. Transmission Network Use of System (TNUoS) charges** – recovers the cost of installing and maintaining the transmission system.
- 2. Balancing Services Use of System (BSUoS) charges** – recovers the cost of day-to-day operation of the transmission system.
- 3. Distribution Use of System charges (DUoS)** – recover the costs to run and maintain a safe and reliable system to transport electricity from the transmission system and other sources of directly connected generation to businesses, homes and other consumers.

The following paragraphs discuss these charges in more detail and what they mean for I&C demand users and how they can take action to reduce their overall charge.

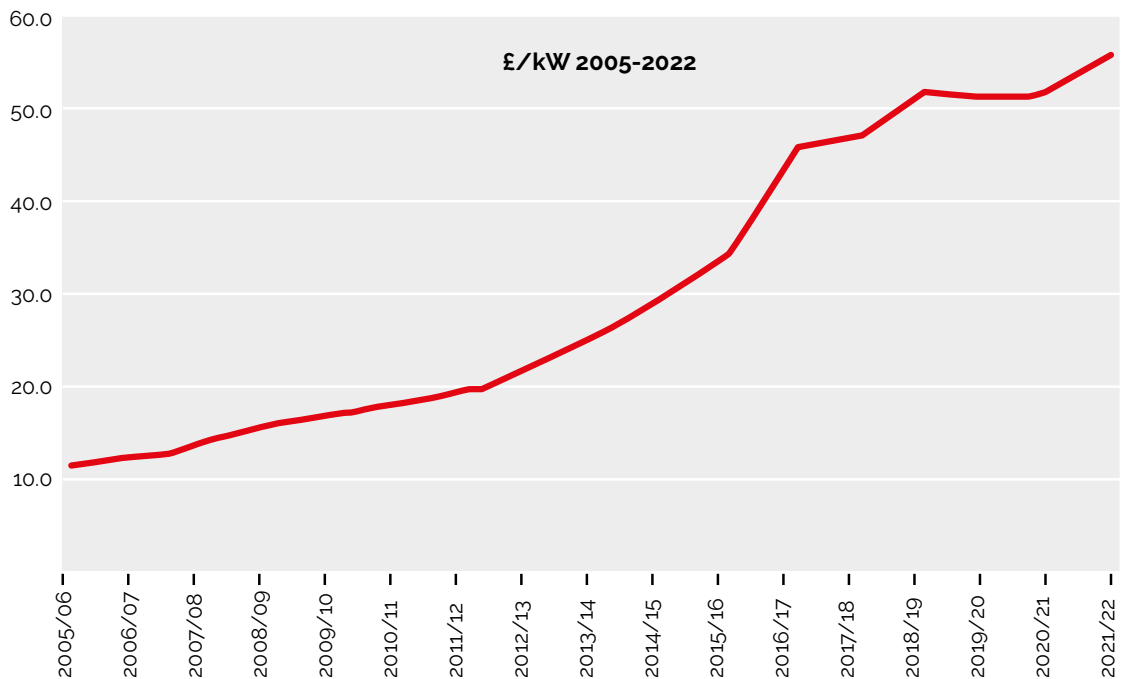
Transmission charges

Transmission Network Use of System charges (TNUoS) recover the cost of providing and maintaining a safe, reliable system of high voltage power lines to transport electricity from sources of power generation to the distribution networks. The total demand TNUoS charge for 2020/21 is £2,468.1 million, currently about 8 per cent of a business electricity bill.

It can be seen from the graph (Fig 2.1) that the TNUoS demand residual tariff has significantly increased in recent years and is forecast to significantly increase further significant in the foreseeable future.

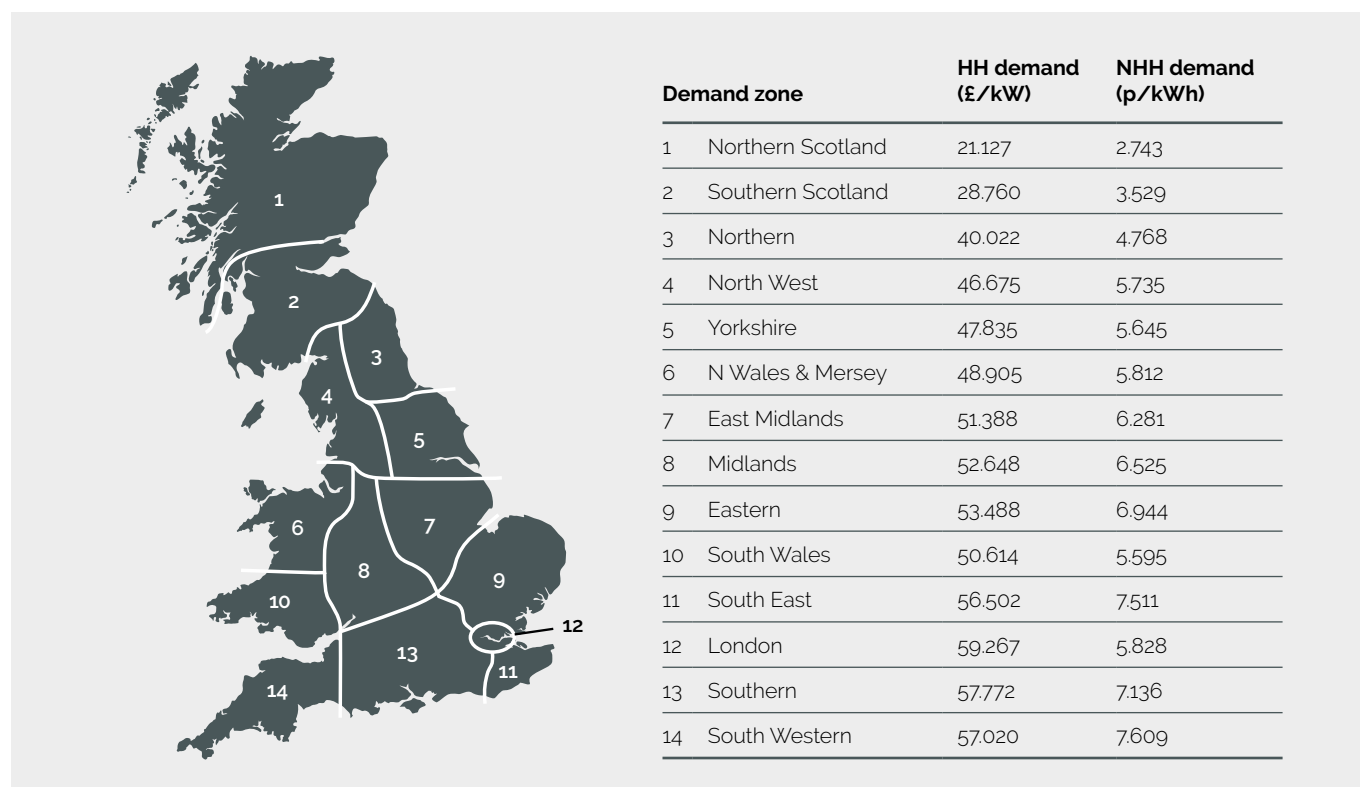
The increase in the TNUoS demand residual price is being driven by three main factors: an increase in the cost of transmission infrastructure in order to facilitate new generation connecting to the system; a limit in the amount that can be charged to transmission connected generators; and a decreasing peak demand in GB.

Figure 2.1: TNUoS demand residual tariff



Data source: <https://www.nationalgrideso.com/charging/transmission-network-use-system-tnuos-charges>

Figure 2.2: National Grid ESO's transmission charging zones and rates 2020/21



Source: National Grid ESO – Final TNUoS Tariffs for 2020/21: <https://www.nationalgrideso.com/document/163311/download> p.22

For half-hourly metered consumers, the charges are currently recovered using what is known as the 'triad charging system'. Triads are the three peak half-hours of demand between November and February, separated by at least ten days. These peaks of 'triads' normally occur on weekdays between 16:00 and 19:00 hours, and are only established at the end of the winter.

Locational demand zonal charges are then applied to this average peak consumption with the lowest being in the north and highest in the south, reflecting, in principle, the distance power must travel from sources of generation to areas of main demand.

Half-hourly metered consumers can, therefore, reduce their transmission charges by avoiding consumption at periods of peak demand – known as Triad avoidance. Triad avoidance has been widely practiced since the competitive

market started in the 1990s and customers are helped by suppliers providing an early warning triad forecasting service. Further details on TNUoS charges can be found at:

<https://www.nationalgrideso.com/charging/transmission-network-use-system-tnuos-charges>

Transmission charges from April 2022

Following Ofgem's Targeted Charging Review (TCR), TNUoS residual charges will be fixed for each site depending on their voltage level and annual consumption. The following table is an ESO estimate of the charges for each sector from April 2022. It is important to note that the table is a forecast, based on the information available to the ESO in March 2020 and the methodology to create the final bands has not yet been approved by Ofgem, as of August 2020. The change to the demand residual will remove the benefit of Triad avoidance.

Chapter 2

Using flexibility to reduce charges

Balancing Services Use of System Charges (BSUoS)

National Grid ESO incurs a cost for the day- to-day operation of the transmission system; this cost is recovered via the BSUoS charge. Generators and suppliers are liable for these charges, which are calculated daily as a flat tariff and passed on to demand users.

National Grid ESO has an obligation to provide a best estimate of the total balancing charges, which for the year 2019/20 was £738.6 million or £2.56/MWh of consumption. As this is a

charge on all MWh used there is no benefit from moving demand.

There is currently a BSUoS Task Force which is looking at who should pay BSUoS and how this should be charged to users in the future. This is due to conclude in September 2020. For more information on the Task Force please visit:

<http://www.chargingfutures.com/charging-reforms/task-forces/second-balancing-services-charges-task-force/what-is-the-second-balancing-services-charges-task-force/>

Indicative demand residual tariff under TDR

Band	Consumption (GWh)	Consumption portion (%)	Revenue by bands (£m)	Site count	TDR charge (£/site)
Domestic	80620	33.60%	719.2	27,800,000	£26
LV_NoMIC_1	1142	0.48%	10.2	715,298	£14
LV_NoMIC_2	4413	1.84%	39.4	536,323	£73
LV_NoMIC_3	5193	2.16%	46.3	268,160	£173
LV_NoMIC_4	15653	6.52%	139.6	268,188	£521
LV1	8904	3.71%	79.4	73,131	£1,086
LV2	12011	5.01%	107.1	59,237	£1,809
LV3	6818	2.84%	60.8	21,649	£2,809
LV4	19050	7.94%	169.9	26,904	£6,316
HV1	4648	1.94%	41.5	9,165	£4,524
HV2	13104	5.46%	116.9	7,462	£15,665
HV3	9156	3.82%	81.7	2,680	£30,475
HV4	28674	11.95%	255.8	3,407	£75,074
EHV1	167	0.07%	1.5	517	£2,878
EHV2	3949	1.65%	35.2	395	£89,182
EHV3	5093	2.12%	45.4	174	£261,083
EHV4	17610	7.34%	157.1	192	£818,176
Trans'n con.	3699	1.54%	33	65	£507,600

Source: Ofgem TCR decision document

Chapter 2

Using flexibility to reduce charges

Table 2.3: Distribution charges – Western Power Distribution (South West) rates for all distribution regions appear in Appendix III

Time period	Red time band	Amber time band	Green time band
Monday to Friday	17:00 – 19:00	07:30 to 17:00 19:00 to 21:30	00:00 to 07:30 21:30 to 24:00
Weekends		16:30 – 19:30	00:00 to 16:30 19:30 to 24:00
HV half-hour	6.084	1.484	1.368

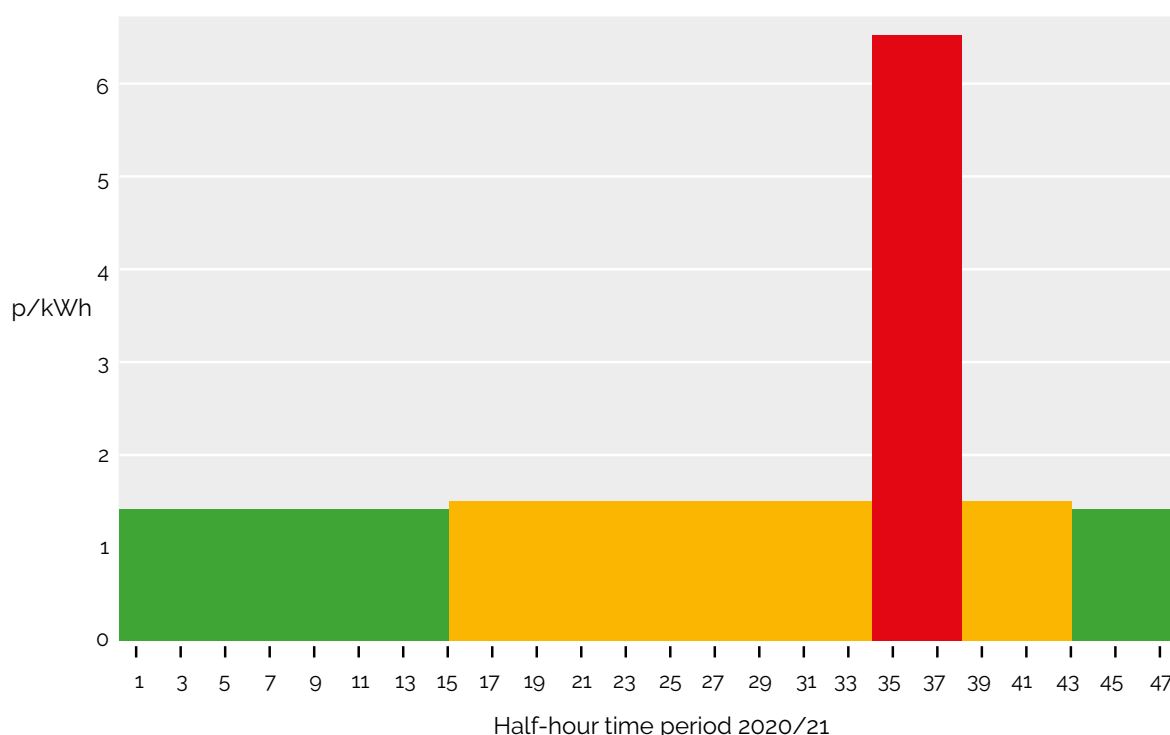
Distribution charges

Distribution Use of System charges (DUoS) cover the costs to run and maintain a safe and reliable system to transport electricity from the transmission system and other sources of directly connected generation to businesses, homes and other consumers. Distribution charges amount to about £5.5 billion, about 16 per cent of a business electricity bill and therefore more than double that of transmission charges.

There are 14 distribution zones or networks owned and operated by six Distribution Network Operators (DNOs) whose infrastructures include overhead lines, underground cables, substations, transformers and of course control rooms to manage their system.

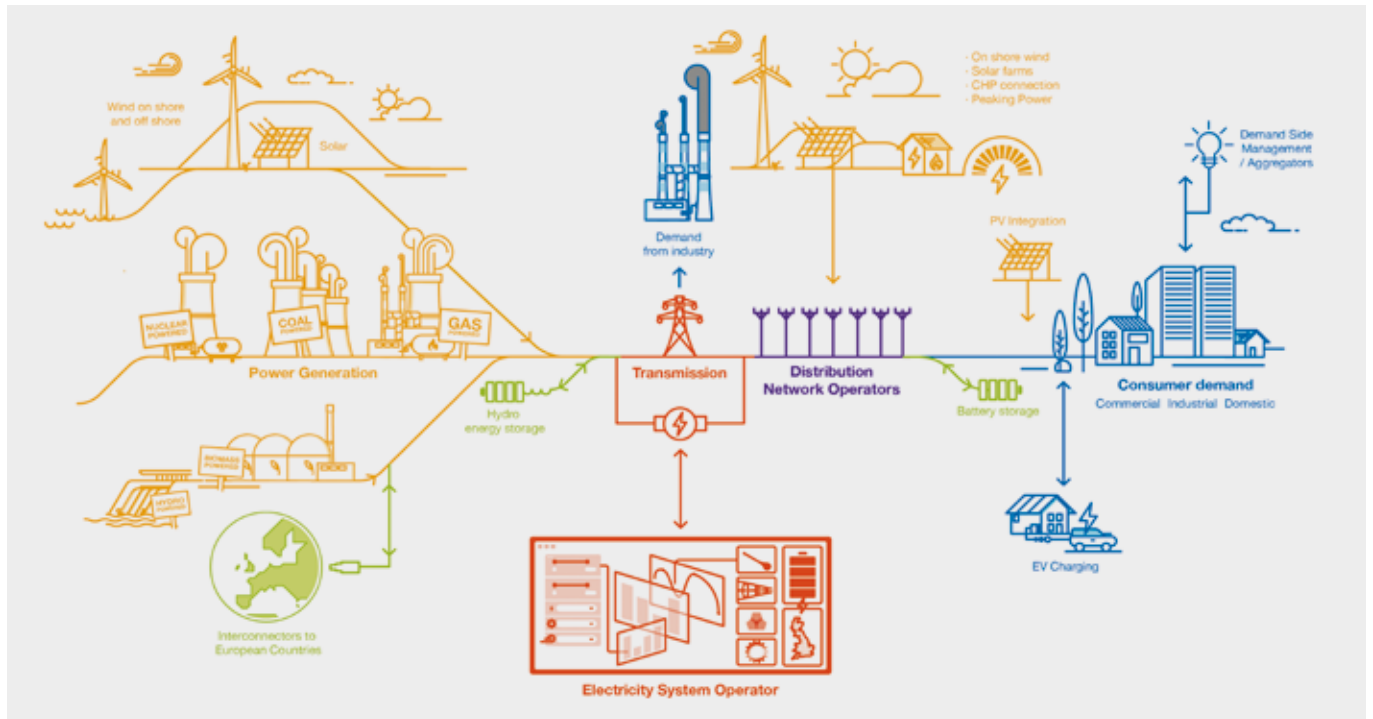
As the DNOs have a natural monopoly position in this distribution process, their total revenue was set by the industry regulator Ofgem, for periods of eight years from 2015 to 2023. The DNOs then use a common charging methodology approved by Ofgem to determine their charges.

Figure 2.4



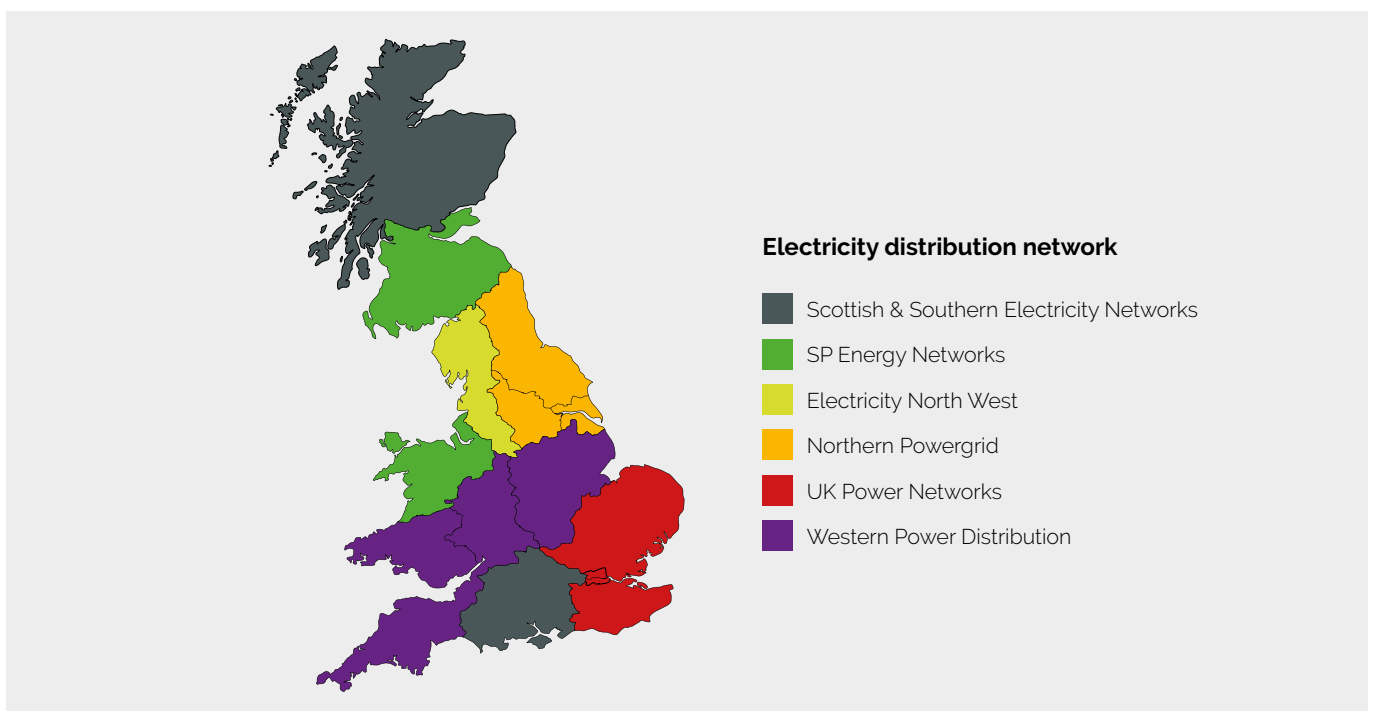
Chapter 2
Using flexibility to reduce charges

Figure 2.5: The distribution network from transmission to consumers



Source: National Grid ESO

Figure 2.6: The distribution network operators



Source: Ofgem

Chapter 2

Using flexibility to reduce charges

Published DUoS charges are based on what is commonly known as the 'traffic light' system of red charges at peak times, amber for the shoulder periods and green for off-peak times at night and over the weekends.

The following table shows charges for Western Power Distribution (South West England). It is worthwhile taking advantage of moving demand away from the peak red period when distribution charges can exceed the cost of the energy itself.

Levies and taxes

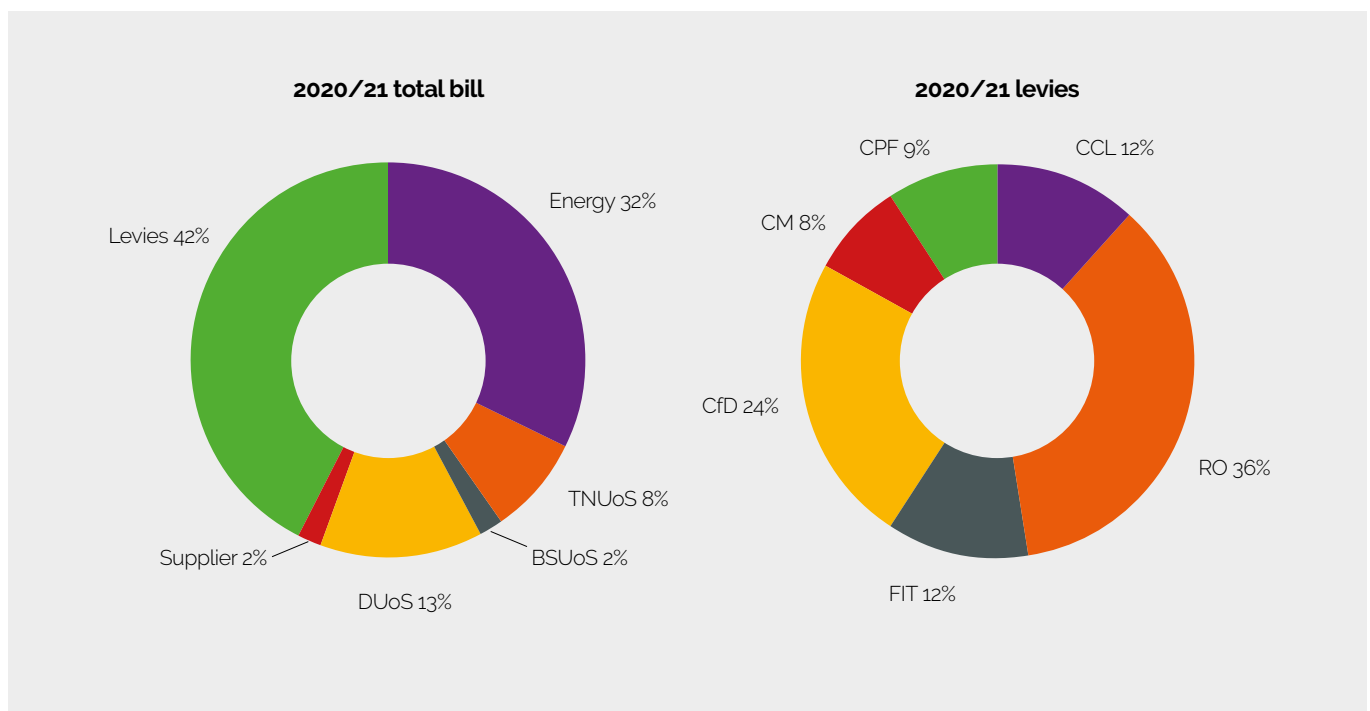
A major portion of the electricity bill now goes to meet Government levies and taxes, and these are considerably exceeding the energy element of industrial & commercial consumers in 2020/21.

The growing list of these schemes includes the Climate Change Levy (CCL), the Carbon Price Floor (CPF), the Renewables Obligation (RO) scheme, Feed-in-Tariffs (FITs), the Contracts for Difference (CfD) payments to protect new generators from fluctuating market prices and the Capacity Market (CM) paid to ensure sufficient back-up power is available at peak times.

Most of these levies are calculated against each customer's annual consumption. Charges to recoup the CM payments, however, are recovered on consumption between 16:00 – 19:00 hours, Monday to Friday, November to February.

The most expensive capacity auction to date (shown in the next table) has been for this coming winter 2020/21, when a total capacity of 52.425 GW was agreed at £22.50 per kW in

Figure 2.7: Principal components of business electricity bills



Source: BEIS and Ofgem

Chapter 2

Using flexibility to reduce charges

Table 2.8: Capacity market auction results

Year	£/kW/yr	Capacity kW	Annual cost	Peak	Annual
2017/18 EA	£6.95	54,433,634	£378,313,756	£30.85	£1.30
2018/19 T-4	£19.40	49,258,938	£922,082,000	£75.19	£3.16
2018/19 T-1	£6.00	5,782,892	£34,697,352	£2.83	£0.12
2019/20 T-4	£18.00	46,350,000	£834,300,000	£68.03	£2.86
2019/20 T-1	£0.77	3,626,196	£2,792,171	£0.23	£0.0096
2020/21 T-4	£22.50	52,425,302	£1,179,569,295	£96.18	£4.04
2020/21 T-1	£1.00	1,024,409	£1,024,409	£0.0835	£0.0035
2021/22 T-4	£8.40	50,410,119	£423,445,000	£34.53	£1.45
2022/23 T-3	£6.44	45,058,832	£290,178,878	£23.66	£0.99
2023/24 T-4	£15.97	43,748,988	£698,671,338	£56.97	£2.39

* The values in red are charged each year for every MWh consumed between 16:00 and 17:00 Monday to Friday, November to February inclusive

Source: National Grid ESO, data at – <https://www.emrdeliverybody.com/CM/Auction.aspx>

the T-4 auction four years ago with a further £1 million agreed in the T-1 auction year giving a total cost of £1.18 billion. The MEUC calculates this to be £96.26/MWh for energy consumed during the peak period and when combined with the distribution red band charges reinforces the value of reducing demand during this period.

Some suppliers estimate your usage during the peak winter hours and use the auction price to calculate your total cost for the year. They then spread it over the whole year, which makes the £4.04/MWh look reasonable. However, if you elect to pay the whole amount in February and take action to reduce demand during the winter peak, a saving of £96.26 for each MWh can be achieved.

Getting better supplier contract prices

Due to the wide variation in energy prices, delivery charges, and some levies linked to different time periods, the most important data to provide to your supplier is your annual half-hour consumption, when asking a supplier to quote for your business.

Once you contract with a supplier, they are mandated to pay on your behalf the wholesale energy and balancing charges, the network charge and the taxes and levies.

For contracts with pass-through charges, the risk is taken from the supplier and any uncertainty passed to the consumer. For fixed price contracts, the risk is totally transferred to

Chapter 2

Using flexibility to reduce charges

the supplier who must build in a risk premium to allow for variations in transportation charges and levies and decide whether to buy the energy in advance.

To minimise this risk, suppliers will closely examine each customer's profile and determine how typical this is to your normal operations. They will wish to know of any planned changes to work patterns and whether the customer intends to take part in any demand side flexibility activity, as this will of course affect demand.

Knowing your profile and operations is essential to securing a competitively priced contract. Any uncertainty will result in suppliers bidding high or even refusing to quote.

Being involved in demand side flexibility, including avoiding Triad and red zone charges, will benefit the supplier if they have bought the energy in advance, which they can then sell at higher market prices.

Consumers with their own generation plant are normally aware of the benefit of operating flexibly, stopping at periods of low system prices, and running to their maximum at peak prices. In addition, consumers with stand-by plant may see an advantage in operating them commercially to make savings on energy, transportation, and levies.

Increasingly consumers are discussing the potential of using batteries to move their demand from peak periods by charging the batteries overnight and using the energy at peak. In addition, those with wind or solar generation see storage as an opportunity to exploit the energy generated to the maximum.

The following chapters explore the services on offer from National Grid ESO and the Distribution Network Operators to encourage flexibility and reward additional capacity being made available or consumed.

Chapter 3

Demand side flexibility opportunities

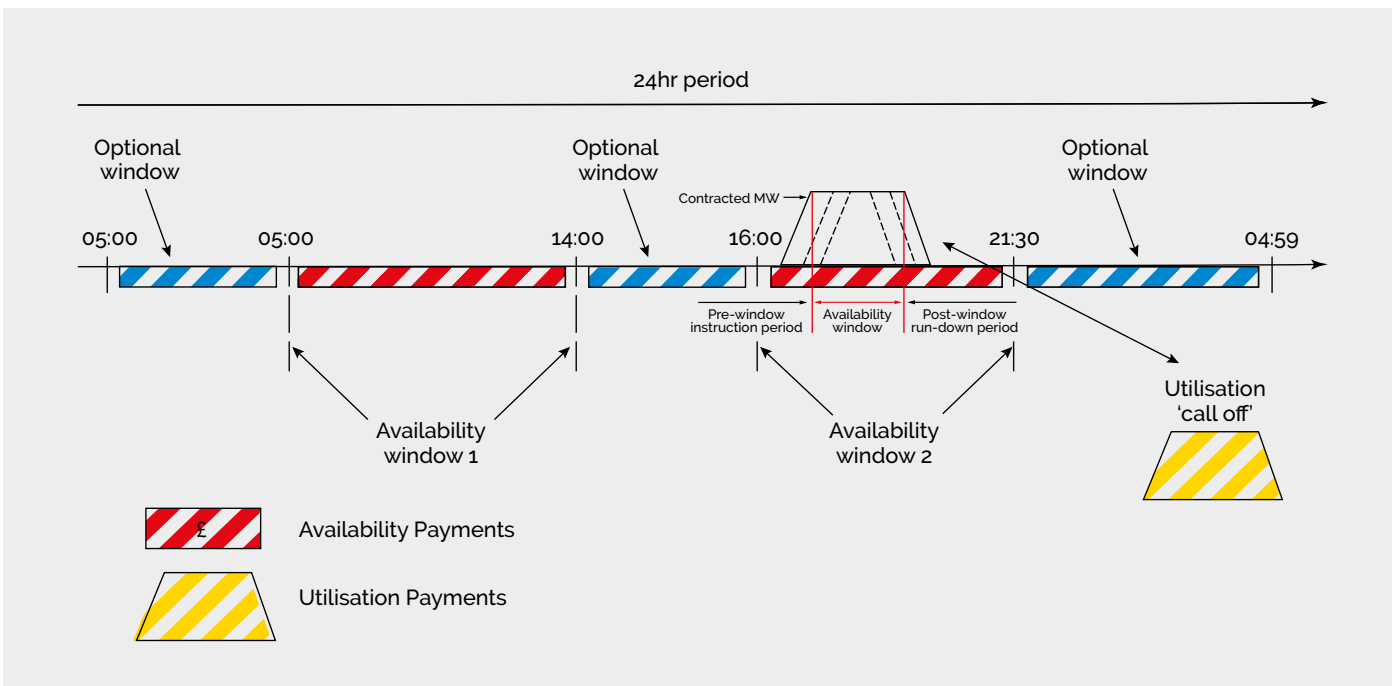
As the System Operator, National Grid ESO provides a number of opportunities for major energy users to get involved in demand side flexibility.

Demand side flexibility is the ability to change electricity output (generation) or demand (consumption) in response to an external signal and in order to help efficiently and effectively keep the GB electricity grid in balance and secure. The use of demand side flexibility will be particularly important in the shift to a zero carbon future, and business customers can benefit financially by offering demand side flexibility to market actors, whilst significantly contributing to our cleaner future.

However, with so many potential routes to market, new providers can find it difficult to pick out the right programme. This chapter aims to provide a clear and straightforward picture of the services that can be accessed through National Grid ESO, aggregators, and suppliers, weighing up the merits of each programme and asks why a business might choose one avenue over another.

Armed with this information, new providers should find it easier to choose a route that's right for their business. The National Grid ESO Market Services team is also on hand to answer any questions you have. Call them on 01926 654 611 or via commercial.operation@nationalgrideso.com.

Figure 3.1: STOR availability and utilisation payments



Reserve services

What are reserve services?

In order to deal with unforeseen fluctuations in demand or generation, National Grid ESO requires access to sources of additional flexibility in the form of generation or demand. These additional sources of power are referred to as 'reserve' and there are a number of reserve services that National Grid ESO procures from providers, such as large energy users, to help balance supply and demand within various timescales.

National Grid ESO is currently reforming its reserve services to help it meet efficiently and securely the changing requirements of the GB energy grid. Having recently committed to ending its Fast Reserve, National Grid ESO currently only procures reserve through its STOR (Short Term Operating Reserve) service. All current National Grid ESO Ancillary Services can be reviewed on its website – www.nationalgrideso.com/industry-information/balancing-services

The following paragraphs summarise the STOR service and the opportunity available to potential providers.

Short Term Operating Reserve (STOR)

STOR is an important source of reserve energy and is traditionally the first service that businesses participate in. The STOR service can be viewed as the most accessible service to new providers, with a 3MW entry capacity and a response time of up to 20 minutes from instruction.

STOR represents about 2GW of reserve energy that National Grid ESO can call upon if there's a sudden loss of power or increase in demand anywhere on the system. The STOR year is split into six seasons in line with the varying

requirements across the year. Each season comprises at least two windows to account for the ramp-up in demand in the morning and evening. An example of this can be seen in Figure 3.1.

Current STOR procurement

Requirements under the Clean Energy Package (CEP) to procure certain services (including STOR) at no more than day ahead resulted in the suspension of all STOR tenders with effect from 1 January 2020.

Providers are still able to offer their capacity through the Optional STOR service. Where availability has been rejected by National Grid, the Reserve Provider may continue to offer the availability. If it does so and National Grid actually utilises the service, then the Reserve energy provided will be paid for at the Optional Utilisation Price. Please note that no Availability Payments will be made for service availability within any Optional Windows.

The minimum requirements for participating in STOR include:

- Offering a minimum of 3MW generation or steady demand reduction (this can be aggregated, as discussed in Chapter 4).
- A maximum response time for delivery of 240 minutes following instruction, although National Grid ESO typically contracts for 20 minutes or less.
- The ability to deliver the contracted MW for a continuous period of not less than two hours.
- Being able to deliver at least three times per week.

Providers are still able to offer their capacity through the Optional STOR service where they can submit their utilisation prices for the windows which they are available for.

Chapter 3 Demand side flexibility opportunities

Table 3.2: The Six Seasons of STOR

Year 14 Seasons 2020/21							
Season	Dates	Weekdays		Non-weekdays		Indicative hours	
		Start time	End time	Start time	End time	WD	NWD
1	05:00 on Wednesday 1st April 2020 – 05:00 on Monday 27th April 2020	06:00	13:00	10:00	14:00	140	24
		19:00	21:30	19:30	21:30	50	12
2	05:00 on Monday 27th April 2020 – 05:00 on Monday 17th August 2020	06:30	14:00	10:30	13:30	705	54
		16:00	18:00	19:30	22:00	188	45
		19:30	22:00	00:00	00:00	235	-
3	05:00 on Monday 17th August 2020– 05:00 on Monday 21st September 2020	06:30	13:00	10:30	12:30	188.5	12
		16:00	21:00	19:30	21:30	145	12
4	05:00 on Monday 21st September 2020 – 05:00 on Monday 26th October 2020	06:00	13:00	10:30	13:00	210	12.5
		17:00	20:30	17:30	20:00	105	12.5
5	05:00 on Monday 26th October 2020 – 05:00 on Monday 25th January 2021	06:00	13:00	10:30	13:30	525	48
		16:00	20:30	16:00	19:30	337.5	56
6	05:00 on Monday 25th January 2021 – 05:00 on Thursday 1st April 2021	06:00	13:00	10:30	13:00	399	22.5
		16:30	20:30	16:30	20:00	228	31.5
						3,456	342

Future procurement at day ahead

National Grid ESO will be looking to recommence procurement of the firm STOR product at day-ahead from 1 April 2021. Each day-ahead tender will apply to the following STOR day, which runs from 05:00 – 05:00 (GMT), and all availability windows within the STOR day must form part of a single tender. STOR providers will still only be able to submit a day-ahead tender if their unit/s are pre-qualified in accordance with the STOR registration procedure.

The tender submission itself will only require availability price £/MW/h and the MW (up to the pre-qualified MW). There will be no requirement for any other technical parameters as these will be held within pre-agreed Framework Agreements. All availability prices for firm STOR will be settled using pay-as-clear mechanism. 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.

In summary – STOR

What type of business is STOR best suited to?

As an established service, STOR is ideal for any business that can provide either generation or demand reduction through its operations. The opportunity of guaranteed revenue for a maximum of a two-year period is attractive for many parties as energy prices continue to rise and alternative revenue streams become increasingly sought after. It also offers flexibility for businesses as they can tender for the flexible service and declare their availability a week ahead of delivery.

Fast Reserve

Fast Reserve is used by National Grid ESO to control frequency changes that arise from sudden, often unpredictable, changes in generation or demand. Commonly, it's used to balance out TV pick-ups, which occur when large numbers of people watching the same TV programme cause a surge in demand when they turn on their kettles simultaneously during an ad break.

Providers of Fast Reserve must be able to start delivering the service within two minutes of instruction and reach a minimum of 25MW within four minutes of instruction. This reserve energy should be capable of being both delivered and removed at a reciprocal rate to the commencement, with delivery being sustainable for a minimum of 15 minutes. It is essential that providers have the ability to be despatched electronically – in Fast Reserve timescales.

This rapid and intensive requirement has resulted in a Fast Reserve market that's dominated by pumped hydro assets which store vast quantities of water in reservoirs, and can simply open a valve and generate power extremely quickly. Combined cycle gas turbines (CCGT) have also begun providing the service, where live stand-by generators (typically 20MW) aggregated up to 60MW to provide the service. Opportunities therefore exist and can be explored.

No type of technology is discounted and anyone can participate as long as they can start responding within two minutes of instruction and have the ability to be dispatched automatically. It's therefore a question of whether it's economical for a business to do so and whether it has the technical capability to deliver Fast Reserve.

Changes to Fast Reserve procurement

To help meet 2030 and 2050 emissions targets the Clean Energy Package (CEP) aims to increase energy efficiency, increase low-carbon generation, and reduce barriers to the internal energy market. As a result, changes to National Grid ESO balancing services, including Fast Reserve, are required in order to align with the CEP.

National Grid ESO has taken the decision not to make the existing Fast Reserve product compliant with CEP and therefore will not be procuring any further Firm Fast Reserve. The ESO intends to look at how Fast Reserve fits with the future design of standardised fast acting reserve products, and intends to continue to use optional contracts including optional fast reserve contracts as well as Balancing Mechanism Units (BMUs) with dynamic parameters to deliver fast energy to meet the requirement for Fast Reserve. The Optional Fast Reserve Service is utilised within half an hour ahead of real time (after 'gate closure') for any unexpected supply or demand changes.

In summary – Fast Reserve

What type of business is Fast Reserve best suited to?

Those who can make a large volume – a minimum of 25MW – available to the grid extremely quickly.

Why would a business choose Fast Reserve over other services?

Most likely because they have the specific technical capabilities to deliver this rapid, high volume service. Financial rewards reflect the challenging technical requirements for the service.

Frequency Response

What are Frequency Response services?

System frequency is a measure of the balance between energy generated and consumed – a constantly shifting number that has to be managed and controlled. National Grid ESO is duty-bound to keep it within plus or minus one per cent of 50Hz, so it must ensure that enough generation or demand is automatically available to balance out any fall or rise in frequency.

To do this, National Grid ESO needs energy users to provide frequency response services, where they're expected to act

quickly – in some cases within one second – and increase, decrease or shift demand to help stabilise the grid.

Most services can be dynamic or static. Dynamic frequency response is concerned with the management of system frequency under normal operation before a fault occurs. Static frequency response, meanwhile, is concerned with containing system frequency within set limits in the event of a fault. As a result, dynamic response is a continuously provided and automatic service, whereas static response is triggered at a defined frequency, as shown in Figure 3.1.

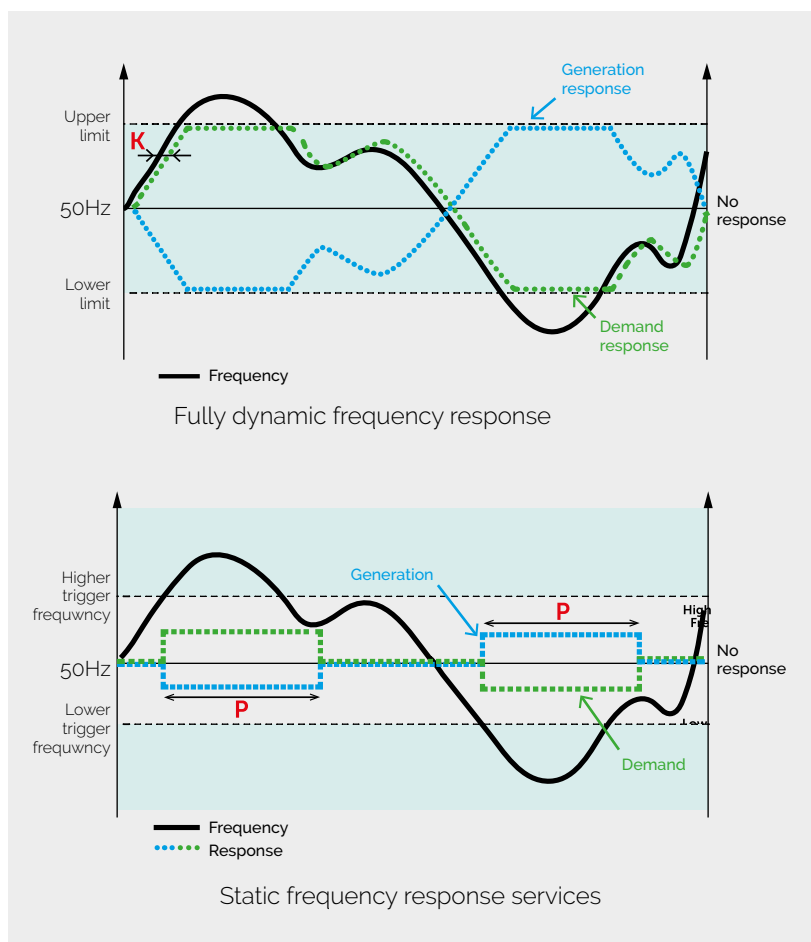
There are several markets currently available for providers to offer frequency response services to National Grid ESO:

- **The Mandatory market** – open only to large transmission connected generators who have signed up to the various network codes as Balancing Mechanism Units
- **Firm Frequency Response (FFR) market** – open to all providers and tendered monthly
- **The weekly frequency response auction trial** – a temporary trial of a new approach to procurement.
- **Dynamic Containment** – the first of a new suite of three faster-acting frequency response products that the ESO is transitioning to.

Firm Frequency Response (FFR)

FFR is one of the most valuable balancing services markets on a £/MWh basis, although the prices paid will change month-on-month depending on competition in the service. Historically, DSF providing Firm Frequency Response has been done by businesses turning on generation rather than switching off demand, but the service doesn't preclude demand reduction if a business has the flexibility to do so.

Figure 3.1 Dynamic and static Frequency Response



Chapter 3

Demand side flexibility opportunities

FFR product type		Response spread	Length of response
Non-dynamic – Secondary response is the only Non-Dynamic response currently procured		Within 30 secs	30 mins
Dynamic – A Dynamic service can provide Primary, Secondary, and High Response, or Primary and Secondary only, or High only	Primary	Response required within 2 secs, with full response by 10 secs	20 secs
	Secondary	Within 30 secs	30 mins
	High	Within 10 secs	Indefinitely unless otherwise agreed

FFR products

The FFR service is split into two physical products, Non-Dynamic (static) and Dynamic FFR. There are three main Dynamic service types – primary, secondary and high.

- **Non-dynamic FFR** – is triggered at a defined frequency deviation which is specified in the providers Framework Agreement, which must be in place before tendering. No response is required within the operating range.
- **Dynamic FFR** – is continuously provided and is used to manage second-by-second frequency variations. Dynamic response is automatically delivered for all frequency variations outside of the deadband (50Hz \pm 0.015Hz).

National Grid ESO currently tenders for both High and Low FFR in the dynamic service, but only Low FFR in the static service.

Service delivery

The FFR service is open to both BM and Non-BM providers. Providers can offer other balancing services when they are not providing

FFR. Aggregated loads, when summated, must be equal to or greater than 1MW. There must be a single point of dispatch or a method in which the total output of the combined loads can be monitored to demonstrate to National Grid that the service is available.

Providers are paid an availability price for the times they make their energy available. However, unlike other balancing services, providers do not receive a utilisation fee for the frequency response service. Those who hold a contract to deliver frequency response are expected to do so by responding to onsite measurement of system frequency.

Tender process

National Grid ESO purchases FFR from providers, such as major energy users, through a monthly electronic tender process.

Once a Framework Agreement is in place, the provider will be given access to the online portal, COUPA, where tenders can be submitted each month.

In summary – Firm Frequency Response

What type of business is FFR best suited to?

Those who can turn on generation or switch off demand within 30 seconds

Why would a business choose FFR over other services?

FFR is one of the more valuable balancing services to National Grid ESO. It is also one of the more technically challenging services to provide and remuneration reflects this.

Frequency Response weekly auction trial

National Grid ESO launched a trial of a closer to real time market for frequency response services in December 2019. The intention of this trial was to reduce barriers to entry for parties who couldn't forecast what their assets would be doing a month ahead (as required in FFR monthly tenders). The total procurement volume in the trial was capped at 100MW for dynamic and 100MW for static at the beginning, the cap has been increased from November 2020.

There are two types of service available in the FFR market that providers can tender for – Low Frequency Static (LFS) and Dynamic Low High (DLH).

Low Frequency Static

LFS requires that providers change their output once the system frequency reaches a certain trigger point. Frequency data from National Grid ESO suggests static FFR providers can be expected to be called upon roughly 10 times a year (but can be used at any time when they are contracted to provide the service) at the pre-set frequency trigger point of 49.6Hz. In other words, the service is provided when the system frequency drops to 49.6Hz or below.

Those who wish to participate in the static service must be able to provide a minimum of 1MW to the grid within 30 seconds of a frequency event, or in the case of the weekly auction trial within 1 second of a frequency event.

Dynamic Low High

DLH is a bundled Primary, Secondary and High product that involves continually varying either generation or demand and doesn't, therefore, have a pre-set trigger level. Instead, frequency is continually traced. It's challenging for demand users to do this, so the service is best provided as part of an aggregated portfolio (as described in Chapter 4) rather than as a single site.

The requirements for businesses providing FFR include:

- Those who wish to participate in the dynamic service must provide an equal volume of primary, secondary, and high response (e.g. 1MW primary, 1MW secondary, and 1MW high). They must also provide a minimum of 1MW response within 2 seconds, reaching required primary response within 10 seconds and maintaining output for a further 30 seconds. Secondary responses must continue to deliver for a further 30 minutes or until the system frequency recovers.
- Having suitable operational metering and frequency relay equipment to automatically interrupt demand.
- Operating at their tendered level of demand/generation upon receiving a signal.

To find out more about the weekly auction trial with National Grid ESO, please visit:

<https://www.nationalgrideso.com/balancing-services/frequency-response-services/frequency-auction-trial>

Dynamic Containment

National Grid ESO delivered the soft launch of Dynamic Containment (DC) on 1 October. DC is a fast-acting post-fault service to contain frequency within the statutory range of +/-0.5Hz in the event of a sudden demand or generation loss. Providers will deliver 5% of contracted capacity up to a frequency deviation of +/- 0.2Hz and then deliver quickly once +/- 0.2Hz.

The service will run tenders seven days a week, procuring for 24 hours at a time from 11pm, moving the frequency response market closer to real time. It creates further opportunity for renewables to participate, supports our work to widen access and increase competition, and also delivers better value for consumers.

Chapter 3

Demand side flexibility opportunities

Initially only 500MW of low frequency response will be bought from providers, which is set to evolve to 1GW next year (2021) and to include high frequency response as part of the full delivery of the service. All technology types can participate, with batteries anticipated to make up the majority of providers in the early phase while the service is being developed in conversation with industry.

We have implemented a number of transitional arrangements following provider feedback for the soft launch to allow providers more time to set up new or amend their existing assets. These include:

- **Operational metering** – Non-BM providers have six months from go-live to connect to Data Concentrator
- **10Hz data** – providers have six months before they must deliver 20Hz data
- **Baselines** – Non-BM providers have six months to connect and submit baselines in real-time
- **ITE (Independent Technical Expert) reports** – participants must conduct testing with self-certification however they have until 31 December 2020 to provide an ITE report for pre-qualification

- **Aggregation at GSP group** – for a period of 12 months the ESO will continue to consult before making any decision to restrict aggregation to GSP

Dynamic Containment is the first in a suite of new fast-acting frequency services to be introduced by the ESO to maintain the system close to 50Hz. Dynamic Moderation and Dynamic Regulation products will complete the suite later, with the former designed to manage sudden frequency imbalances in intermittent generation and the latter to manage small deviations when frequency is close to 50Hz.

The introduction of DC marks a further development in the ESO's operational capability, making the system more resilient to the low inertia conditions associated with a zero-carbon grid.

To find out more about frequency response services with National Grid ESO, please visit:

<https://www.nationalgrideso.com/industry-information/balancing-services/frequency-response-services/dynamic-containment>

In summary – Dynamic Containment (DC)

What type of business is DC best suited to?

Assets that can react dynamically within 1 second.

Why would a business choose DC over other services?

If the assets have the technical capability to participate in the fastest acting frequency service. Currently the DC tender results are clearing at higher prices than other frequency markets that we tender. This is reflective of the value that ESO place on the speed of delivery for DC.

Wider access to the Balancing Mechanism

What Is the Balancing Mechanism?

Often described as the 'ultimate flexibility market', the Balancing Mechanism (BM) is the primary tool used by National Grid ESO to balance electricity supply and demand close to real-time.

Following gate closure of the Wholesale Market trading (up to hour before the start of the any particular half-hour settlement period), National Grid ESO operates the BM, accepting or rejecting 'bids' and 'offers' from market participants to either increase or decrease generation or consumption to balance supply and demand in each half hour trading period, every day.

On National Grid ESO's acceptance of a 'bid' or 'offer' participants are issued with a BOA (Bid Offer Acceptance) Participants are then committed to ensure that their BM Units produce the required level of output. Failure to do so will result in an imbalance charge to that participant in question.

The Balancing Mechanism (BM) has previously been a market only accessible to BSc (Balancing & Settlement Codes) parties – typically the large incumbent and traditional industry actors – and inaccessible to non-BSc parties.

However, National Grid Electricity System Operator (NGESO) has committed to enabling Wider Access to the Balancing Mechanism. Wider Access to the BM is designed to promote competition and provide the Electricity National Control Centre (ENCC) with greater access to flexibility, which in turn will lower costs to consumers and contribute towards zero carbon operation of Great Britain's electricity system by 2025.

Routes into the Balancing Mechanism

There are currently three routes for entering the BM. Through each route parties will be required to accede to the Connections Use of System Code (CUSC), through NGESO and the Balancing and Settlement Code (BSC) through Elexon.

- **Traditional** – the traditional route is through the NGESO Connections team, where you will require an NGESO Connection Agreement and to register your unit(s) as a Primary BMU.
- **Supplier Route** – the Supplier Route requires a party to be a registered as a supplier with Elexon, who can issue 14 base BMUs. Under this route, aggregation of BMUs is permitted, but is limited to Grid Supply Point Groups (Distribution Network Owner areas).
- **Virtual Lead Party (VLP)** – the newest route to market is to become a Virtual Lead Party (VLP). This route was developed for TERRE (Trans-European Replacement Reserve Exchange) and has a different registration process for participating in the BM. This route requires registration as a VLP via NGESO's Connection team, and uses an online portal to register Secondary BMUs.

Systems

There are several systems required before a unit can become active in the BM to ensure it has the ability to communicate with the Electricity National Control Centre (ENCC).

Electronic Data Transfer (EDT) and Electronic Dispatch Logging (EDL) are two systems

Chapter 3

Demand side flexibility opportunities

which are used for control communications. EDT allows the BMU to submit technical and commercial parameters about the unit and EDL allows the ENCC to send instructions to the BMU. Other systems include Control/ System Telephony and Operational Metering data submission.

To ensure the appropriate communications systems are in place parties can:

- Utilise an existing connection.
- Utilise another company's connection with their agreement.
- Engage with NGENO IS team on a new API system.

There are different requirements and timescales for each of the routes, further information can be found on the National Grid ESO website <https://www.nationalgrideso.com/balancing-services/wider-access>

If you are interested in finding out more about Wider Access, please contact commercial.operation@nationalgrideso.com

The National Grid ESO website is a great starting point for anyone interested in finding out more about the services it buys – see <https://www.nationalgrideso.com/industry-information/balancing-services>

For updates on the progress and developments of new and future balancing services with National Grid ESO, please refer to the 'Future of Balancing Services' section of the National Grid ESO website – <https://www.nationalgrideso.com/research-publications/future-balancing-services>

The Capacity Market

What Is the Capacity Market?

The Capacity Market is one of the main building blocks in the Government's Electricity Market Reform (EMR) programme. It aims to ensure that there is sufficient capacity of electricity to meet projected levels of future demand. To do that, it offers payments to generators and those on the demand side to guarantee they'll provide the additional capacity when it's needed and ensure supplies remain secure. Businesses can bid to provide capacity through auctions which are held one and four years ahead of delivery.

Routes into the Capacity Market

There are two possible routes to entering into the Capacity Market, the four year ahead auction (T-4) and the one year ahead auction (T-1).

T-4 auction

The main four-year ahead Capacity Market auction runs annually and secures capacity from providers which are then obliged to deliver in four years' time.

T-1 auction

The year ahead auction provides a top-up of capacity for the same delivery year as the T-4 auction.

Bidding into the Capacity Market

National Grid ESO is the delivery body for the Capacity Market. Parties looking to participate in this market will need to consider the following steps:

1. Registration

The first step for any business that wishes to participate in the Capacity Market

is to set up an account on the EMR Delivery Body Administration System at www.emrdeliverybody.com/CM/CompanyRegistration.aspx.

2. Prequalification

Before participating in a Capacity Auction, companies need to prequalify their generation or demand side resources for which they are seeking Capacity Agreements. The EMR Delivery Body uses the information submitted during Prequalification to verify that generation and demand side Capacity Market Units (CMUs) are eligible to participate in the auction and to establish the size of individual CMUs.

3. Pre-auction submission

A number of information exchanges between the delivery body and applicants occur in the period between Prequalification Results Day and the auction:

- As the delivery body, National Grid ESO will publish information confirming the Capacity Auction timing and auction parameters.
- CMUs that received Conditional Prequalification must submit the information required to confirm their eligibility to participate in the Capacity Auction.
- Depending on the CMU type, applicants can notify the delivery body whether and how they wish to participate in the Capacity Auction.

4. Auction

The Capacity Market auction is the competitive process to award Capacity Market Agreements to meet the target capacity for the relevant Delivery Year. Only Capacity Market Units (CMUs) which have successfully prequalified and where necessary confirmed entry, will be able to take part in the 'pay-as-clear' auction.

Chapter 3

Demand side flexibility opportunities

The auction price starts at the Auction Price Cap (as set out in the auction guidelines). The price is then reduced in each round by a set decrement. Bidders submit exit bids to retract a CMU from the auction at a particular price. The auction ends when a price is reached at which the total remaining capacity is equal to the capacity demanded, the 'clearing price'. Successful CMUs (those that have not submitted 'exit bids' above the clearing price) all receive a Capacity Agreement at the clearing price.

5. Post-auction submission

New build, refurbishing and unproven DSR CMUs may have to make further submissions to the delivery body if successful in the auction, before credit cover can be released.

6. Delivery

CMUs which have secured a Capacity Agreement at an auction must deliver against their capacity obligation at any time of system stress during the delivery year, or face a financial penalty.

Guidance documents available on the delivery body website (www.emrdeliverybody.com) provide further information on the auction process.

Contact

Contact the EMR team at emr@nationalgrideso.com for more information. Aggregators and Third Parties provide a route to market with all of the above capacity products for those businesses that don't want to manage their own bids.

In summary – The Capacity Market

What type of business is the Capacity Market best suited to?

Organisations that can commit to provide capacity through demand reduction or generation either one year or four years ahead of the delivery date.

Why would a business choose the Capacity Market over other services?

There's no reason why a business can't participate in the Capacity Market alongside other demand side services. If they feel able to take on the obligation of providing capacity alongside another service, then this can be beneficial to them.

DNO opportunities

Schemes from your local distribution network operator

The operation of distribution networks is changing significantly as Distribution Network Operators (DNOs) transition from operating traditionally passive networks to increasingly active ones. As part of this transition, DNOs are exploring more cost-effective solutions to traditional network reinforcement through their own flexibility services. Instead of building new assets such as transformers, overhead lines or underground cables, demand side response and other forms of flexibility offer an alternative method to managing flows on local networks. DNO requirements typically differ to those of National Grid ESO as they are inherently geographic in nature, and often require the relief of capacity on congested distribution networks caused by increasing volumes of renewable generation (wind and solar) connecting to the system at a distribution level that are necessary to meet net-zero targets.

Where there is spare capacity on the network then there is no DNO requirement. However, where networks are reaching their technical limits, flexibility services can help to free up

capacity and defer, or even remove the need for, costly network reinforcement altogether. These are likely to be similar to reserve products used for real power or voltage control (rather than fast acting products such as frequency control).

Services are also being developed to help manage system resilience. These consider how distributed energy resources (DER) can support planned distribution network equipment outages and also get customers back on supply more quickly in the event of unplanned events.

Most DNOs are now in the early stages of procuring flexibility from DER and demand side providers. A coordinated approach across network operators has helped to standardise products that will simplify access across the different licence areas.

The four standardised products, listed in Figure 3.2, have been developed by the DNOs to help resolve differing network needs:

The following sections of this chapter provide examples of the flexibility work and opportunities being carried out by each DNO.

Figure 3.2

Product	DNO requirement	Payment and dispatch structure
Sustain	To manage an ongoing requirement to reduce peak demand	Typically, dispatch is scheduled well in advance for a fixed fee
Secure	To manage peak demand on the network, usually weekday evenings	Predominantly paid based on utilisation, but with some use of availability payments also. Timing of dispatch varies by DNO (e.g. WPD dispatch one week ahead while UKPN dispatch in real time)
Dynamic	To support the network during fault conditions, often during maintenance work	Typically dispatched at short notice with low availability payments and high utilisation payments
Restore	To support the network during faults that occur as a result of equipment failure	Typically dispatched at short notice with low availability payments and high utilisation payments

Source: ENA Open Networks Project – DNO Flexibility Services Revenue Stacking, 30th July 2020



Electricity North West

Electricity North West's (ENW's) innovation portfolio contains a significant body of work, developing new markets through which customers can earn value while helping to solve network constraints. Work so far includes projects such as Capacity of Customers (C2C), a new form of demand response; and Respond, which is the UK's first commercial solution to fault level issues.

Offering customers genuine choice is a cornerstone of ENW's innovation strategy and it will continue to explore the opportunities provided by new and emerging markets.

ENW has now been promoting the use of flexibility services as an alternative to reinforcement for several years. This stemmed from the C2C project, in which it developed innovative commercial contracts to purchase demand or generation response from existing and new customers to manage network constraints. ENW has now rolled out the learning from this into business as usual, and issues flexibility tenders bi-annually as part of its investment programme.

When ENW's customers need more capacity, ENW will explore further flexible solution opportunities alongside other smart technologies and more traditional forms of reinforcement so that the best value solution is obtained.

To consistently deliver the best possible value for its customers ENW has developed and successfully introduced the 'real options' model. This is a very sophisticated financial model that significantly enhances its ability to undertake a robust economic assessment of comparator solutions. The model uniquely allows it to examine the value of each solution under all possible future demand scenarios ensuring its investments are future-proofed. This model is crucial to ensuring customers do not pay for capacity that will not be needed, and learning from this model is being used to inform industry wide evaluation methodologies for flexibility

Contact flexible.contracts@enlw.co.uk for more information.



Northern Ireland Electricity Networks

NIE Networks owns and maintains the transmission and distribution networks and operates the distribution network in Northern Ireland.

NIE Networks is progressing its FLEX project, focused on developing localised markets for demand side flexibility in Northern Ireland.

The project trial will seek to demonstrate that flexibility can offer a cost-effective alternative to traditional network reinforcement, income opportunities and savings for customers.

As part of its FLEX trial, NIE Networks plans to tender in late 2020 for demand side flexibility services to manage network constraints in specific geographic locations. Detailed service requirements will be announced ahead of the tender following engagement with stakeholders.

NIE Networks also plays a role in facilitating access for distribution connected customers to participate in markets and provide ancillary services such as reserve and ramping products to the TSO. NIE Networks issues Instruction Sets to individual customers which indicate when specific sites can participate in a coordinated demand side response as instructed by the TSO.

The Instruction Set assessment process considers local distribution network limits, and historical demand and generation. Ranging from zero to uninterrupted access across nine categories, they restrict delivery of demand side flexibility from sites to periods during which the distribution network is capable of handling such conditions safely. The TSO considers site Instruction Sets when offering contracts for ancillary services from demand side flexibility.

Going forward, NIE Networks plans to develop this process further to enhance access for distribution connected customers. A new dynamic network capacity allocation platform will consider network conditions closer to real time and forecast output from embedded generation, allocating available capacity to customers seeking to participate in markets and provide ancillary services.

For more information about NIE Networks innovation projects please visit www.nienetworks.co.uk/future-networks and for specific enquiries email flexibility@nienetworks.co.uk



Northern Powergrid

Back in November 2020, Northern Powergrid announced it was looking to procure flexibility for network resilience via a Dynamic Purchasing System and e-auction.

The scheme, named Restore Flexibility, was for the purpose of helping the operator manage the network on the rare occasions when it experiences network faults. Where it experiences such issues, customers may be able to support the system through providing flexibility – by shifting their energy consumption temporarily or flexing their generation assets after receiving an instruction from the DNO – and in return the customer would get paid a price/MWh, as set in the e-auction process.

The exercise looked across seven key locations in the region bid to be in a position to provide flexibility, with the aim of procuring up to 120MW of capacity across these locations. The locations were: St Andrews Road (Huddersfield), Staygate (West Yorkshire), Wold Newton (East Yorkshire), Featherstone (West Yorkshire), Greatham (County Durham), Denwick (Northumberland) and Guisborough (North Yorkshire).

Following the unfolding of the procurement process, Northern Powergrid announced that unfortunately, there had been no bidders to the e-auction, making it impossible to progress the process to the next phase. Fifty seven potential providers originally registered an interest in the pre-qualification documents, of which only three were confirmed and acceptable to progress to the e-auction stage for three of the seven locations, totalling c.30MW; but they did not convert into bids.

This outcome deprives the network of a flexibility solution to manage the risk in these seven locations, but even in its absence, the existing risk mitigation solution remains strong, so Northern Powergrid will take no further action with that matter.

Based on feedback sought from stakeholders, Northern Powergrid suggests that the energy industry may draw lessons from the outcome of this procurement event:

- A flexibility product with a utilisation payment on its own (i.e. not accompanied with availability payment) may not provide enough of an incentive to flexibility providers.
- The time window between the publication of documents and the e-auction should be sufficiently long to allow for interested parties to get comfortable with the all the legal aspects of the proposed trade.

In any future procurement, Northern Powergrid will learn from these lessons (and from lessons by other network operators), will continue to support an approach that favour efficiency of investment, and will seek to incorporate improvements that are championed by the Open Networks Project. This includes:

- Aligning timeline of signposting of requirements, publication of firm requirements and auction/tender rounds,
- Implementing a common collaboration agreement as agreed across all DNOs,
- Refinement of existing and development of future flexibility products,
- Work to deliver a modern, automated system to streamline the end to end process from signposting network requirements to the settlement of payments.

Looking forward, Northern Powergrid continues to be committed to delivering flexibility by adapting its processes, and its tools, and by creating transparency and trust. You can expect more on each of these three points in the next few months.

Contact flexibility@northernpowergrid.com for more information.



Scottish and Southern Electricity Network

Scottish and Southern Electricity Network (SSEN) manages the distribution networks in the north of Scotland and the south of England, delivering power to over 3.8m homes and businesses. Industry and internal forecasts predict a rise in electricity demand as the UK decarbonises, driven by the uptake of low carbon technologies. SSEN's objective is to make best use of our networks, data and emerging technology to deliver a smarter, flexible and secure energy system which can facilitate that uptake at maximum pace and minimal cost to customers.

To achieve this, SSEN identifies Constraint Managed Zones (CMZs) which are geographical areas where security of supply is achieved through 'flexibility first'. This means flexibility, provided by renewables, demand side response and energy storage, is prioritised over investment in traditional reinforcement. SSEN is technology agnostic and procures four flexible service products to tackle various network conditions:

- **Sustain**, managing cases where system planning studies have identified that forecasted load growth is expected to exceed the thermal rating of a network asset, for example during winter peaks.

- **Secure**, when flexibility can ensure security of supply as SSEN carries out planned maintenance work.
- **Dynamic and Respond**, which are used for unplanned outages, such as a fault during a planned outage (Dynamic) or to get the power flowing while fault repairs are being completed (Respond).

By June 2020, SSEN had 6MW of contracted flexible services, which had avoided the carbon equivalent of powering half a million homes for a week, while saving customers £230,000. But SSEN's CMZ portfolio pipeline dwarfs this, with 372MW in active procurement across Scottish and Southern networks and more being planned. This demonstrates SSEN's commitment to flexibility first: to adopt the lowest carbon, most economic approach to managing the network in the communities it serves.

Opportunities for service providers are announced on the SSEN website (www.ssen.co.uk/FlexibleConnections/), on Piclo Flex (<https://picloflex.com>), the independent marketplace for buying and selling smart grid flexibility services, and through social media.



ScottishPower Energy Networks

ScottishPower Energy Networks (SPEN) recognise that our energy landscape is continually changing and the needs of our customers and communities constantly evolving. To tackle the climate emergency and deliver Net Zero carbon targets, a significant proportion of transport and heating will be electrified. We are also going to see a further leap in renewable generation capacity as fossil fuel power stations close, and experience more dynamic and complex power flows as customers become increasingly active participants in the energy system.

To begin addressing the changes critical to the future, in October 2016 SPEN published a Distribution System Operation Vision. This described the whole system operating model best suited to address these changes, and the roles and responsibilities which it involves. Since then, the changes have increased, and the challenges intensified, and the magnitude of these changes means there is a clear need for a set of functions and activities to meet customers' evolving needs, deliver net zero, and ensure the continued safe, reliable and efficient operation of the distribution network and wider energy system for all customers.

Building on this vision, and the extensive work undertaken to date, SPEN has now created a DSO Strategy. This details the exact functions, activities and enablers seen as necessary from now through to the end of RIIO-ED2 (2028), to delivering this vital development for the GB electricity system. https://www.spenergynetworks.co.uk/pages/distribution_system_operator.aspx

Specific DSO activities that SPEN are undertaking include:

Flexibility tenders

To meet evolving customer needs, SPEN are developing smarter, more flexible network solutions to help mitigate the need for traditional reinforcement and reduce costs for customers.

Recognising that resources connected to its networks could provide services to assist in key areas that have specific challenges during periods of network constraint, SPEN is committed to exploring markets for flexibility with new and existing customers who are able and willing to control how much they generate or who can control their demand.

The benefits of procuring flexibility services include: Reducing the need in some areas for costly, traditional reinforcement; allowing consumers to capitalise on the opportunities arising from a transition to a smarter grid and participate in the low carbon future; and assisting the transition to DSOs allowing networks to be planned and operated more dynamically to meet changing customer needs.

In October 2019 SPEN issued a tender for 95MW of flexibility services for the periods 2020 to 2023. The Flexibility Services market is still in the early stages but an encouraging response allowed for bids to be accepted for a total of 81MW spread across the 3 years.

In 2020 SPEN will issued its biggest tender to date and look to procure flexibility services for the period 2023 to 2028.

<https://www.spenergynetworks.co.uk/pages/flexibility.aspx>

FUSION innovation project

SPEN's innovative FUSION project is trialling commoditised local demand side flexibility through a structured and competitive market, based on the Universal Smart Energy Framework (USEF).

FUSION will enable Distribution Network Operators and all market actors to unlock the value of local network flexibility in a competitive and transparent manner. This will be enabled by applying the functions and structure defined in the USEF.

<https://www.spenergynetworks.co.uk/pages/fusion.aspx>

Chapter 3

Demand side flexibility opportunities

Dumfries & Galloway ANM innovation project

Located within the SP Distribution licence area, Dumfries and Galloway has among the UK's highest proportion of connected renewable generation relative to its demand for energy. That can present difficulties when it comes to exporting renewable energy back to the electricity grid and connecting new projects. Currently, 90MW of distributed generation are connected in Dumfries and Galloway, while more than 200MW of additional distributed generation are contracted to connect in the future.

To manage and facilitate the requirements, SPEN is implementing a revolutionary, wide-scale integrated network management zone across the area. It's the first integrated

network management scheme of its kind in the UK and will span 11 grid supply points and interface with National Grid ESO.

The project will help manage transmission network constraints by using an active network management (ANM) system to monitor and manage exports from distributed generation on SPEN's network. As well as resulting in fewer constraints for existing distributed energy resources, the system will enable the connection of new ones.

https://www.spenergynetworks.co.uk/pages/dumfries_and_galloway_integrated_network_management.aspx

Contact flexibility@spenergynetworks.co.uk for more information.



UK Power Networks

UK Power Networks is the UK's largest Distribution Network Operator, safely and reliably supplying power to 8.3m homes and businesses across London, the South and South East of England. In 2017, it became one of the first electricity networks in the UK to set out the transition from Distribution Network Operator to Distribution System Operator, balancing an increasingly complex, interconnected and low-carbon electricity network while maintaining its focus on keeping the lights on. Its Futuresmart Strategy¹ lays out its approach.

Flexibility services

The company is creating an open, transparent and fair market for flexibility services after launching its industry-leading Flexibility Roadmap in 2018. This market is backed by a commitment to 'flexibility first' – to market test a flexibility solution to all significant investments in network capacity before committing to a traditional asset-based solution.

In just three years its flexibility market has grown from zero to awarding £14m worth of contracts for 123MW of flexible power. This was announced in June following the company's April 2020 Flexibility Tender. It included awards for 42 zones on its high voltage networks and 15 low voltage zones – a world first.

UK Power Networks' Flexibility Roadmap² sets out its guiding principles, including a commitment to engage with industry stakeholders to maximise cost-saving benefits for customers. UK Power Networks reached this milestone by working closely with the industry to co-design the products it is offering and make the market open and transparent.

It procures various flexibility products from a wide range of energy resources, including aggregators, commercial battery operators, heat pumps and 'virtual power stations' backed by spare capacity in domestic batteries and electric vehicles. In this way, flexibility services create new markets for low carbon 'distributed energy resources' (DER) while saving customers money on long-term investment decisions. The services offer 1-7 year contracts for flexibility providers with efficient costs across all of its zones.

The tender process

The company conducts two procurement events each year, one in autumn and one in spring, with its flexibility requirements published by zone on Piclo Flex³, the independent marketplace for energy flexibility services online. UK Power Networks publishes its zone requirements for visibility around six months before each tender (in the autumn ahead of the spring tender, for example). It also hosts two 'Flexibility Forum' events each year, which take place post-tender and post-zone publication. At the events, the Flexibility Services team takes attendees through the tender process and/or announces detailed results from previous tenders.

All of UK Power Networks' Flexibility Services documents – including tender invitations, zone revenue ranges and contract frameworks – are available to download from the document library on its online Flexibility Hub⁴.

To learn more, users can join UK Power Networks' mailing list or ask questions directly by emailing flexibility@ukpowernetworks.co.uk, or follow the company on LinkedIn or Twitter for news, updates and to register for its Flexibility Forums.

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1. UK Power Networks Futuresmart Strategy: <https://smartgrid.ukpowernetworks.co.uk/wp-content/uploads/2019/11/FutureSmart-Consultation-Report.pdf>
 2. UK Power Networks Flexibility Roadmap: <https://smartgrid.ukpowernetworks.co.uk/wp-content/uploads/2019/11/futuresmart-flexibility-roadmap.pdf>
 3. PicloFlex – <https://picloflex.com/>
 4. UK Power Networks Flexibility Hub – <https://smartgrid.ukpowernetworks.co.uk/flexibility-hub/>

Innovation Portfolio

Power Potential

Power Potential (formally known as TDI 2.0) is a world-first trial to maximise network capacity to address a barrier to connecting more renewable energy and storage technology in the South-East region. By working jointly together, UK Power Networks and National Grid ESO aim to open up new markets for distributed energy resources and generate additional capacity by alleviating transmission voltage constraints. The outcome will be more renewable energy connected to the network, savings for our customers and a new revenue stream for participating distributed energy resources (DER).

The project is creating a new opportunity for DERs by enabling them to participate in a regional power market and offer services to National Grid ESO, via UK Power Networks and its DER Management System platform (DERMS). The project successfully recruited trial participants, signed contracts with them, and worked with DER on laboratory testing of their DER controllers.

To keep up to date, visit the National Grid project website or UK Power Networks Innovation page.

Electric vehicles

UK Power Networks is undertaking a series of flagship projects designed to facilitate the electric vehicle revolution, based around its industry-leading EV Readiness Strategy. Its

Shift trial is taking a market-led approach, including entech supplier Octopus Energy, intelligent energy platform Kaluza and EV charging platform provider ev.energy. The trials are exploring the different market mechanisms to facilitate smart charging in a way which shifts the EV demand away from periods of peak use. Optimise Prime, the world's largest commercial EV trial, seeks to understand and minimise the impact that the electrification of commercial vehicles will have on distribution networks. It is developing technical and commercial solutions to save customer costs (estimated at £207m savings by 2030) and enable the faster transition. The insights from these and other key EV projects will help the company to explore new revenue streams for EV flexibility.

Other innovation projects

UK Power Networks is exploring a variety of other new revenue streams for distributed energy resources, including Energy Exchange, a £1m 'Market-Based Curtailment Management' project which will evaluate market-based solutions that could make it easier and more profitable for customers with flexible connections. In doing so it will allow UK Power Networks to maximise the incentives for flexible connections and continue to drive the low-carbon revolution.

Find out more by visiting [innovation.ukpowernetworks.co.uk](#) or [smartgrid.ukpowernetworks.co.uk](#)



Western Power Distribution

Western Power Distribution (WPD) has been at the forefront of distribution flexibility service procurement since launching an early NIA-funded innovation project, ENTIRE, in 2016.

Since 2017, WPD has been procuring demand side flexibility through Flexible Power⁵ to manage demand constraints on its network and avoid or defer the need for traditional reinforcement. It does this using three industry-standard DSO products: Secure, Dynamic and Restore. WPD operates a six monthly procurement cycle, commencing every January and July. Contracts for services are awarded for lengths between one and four years, at the choice of the provider.

WPD continues to procure significant amounts of flexibility across its network. The most recent procurement cycle in July 2020⁶ saw 45 constraint managed zones (CMZ) entering procurement, seeking over 300MW of services. It included both demand constraint services (generation turn up, demand turn down) as well as generation constraint services (generation turn down, demand turn up). This accounts for all of the load-related reinforcement remaining within ED1, delivering on WPD's "Flexibility First" commitment to seek non-wires alternatives ahead of investing in new assets.

Visibility of current requirements is downloadable from Flexible Power⁷, where you can find details on availability windows and likely utilisation volumes. The site also includes online tools such as a postcode checker⁸, value calculation tool⁹ and month ahead availability forecasts¹⁰. Future requirements for a five-year window are forecast, aligned to Distribution Future Energy Scenarios on WPD's network flexibility map¹¹.

A total of 218MW of service contracts have been awarded since Flexible Power's launch, with many CMZs still requiring more flexibility participation before further reinforcement can be avoided.

During winter 2019/20, WPD dispatched over 590MWh of demand side flexibility, which supported the deferment or avoidance of £26.4m in conventional reinforcement.

Participants seeking to provide demand side flexibility services to Western Power Distribution should register their intent on our dynamic purchasing system via <https://rfxwp.westernpower.co.uk/ECE>. More information can be found on www.flexiblepower.co.uk.

5. Western Power Distribution: Flexible Power – <http://www.flexiblepower.co.uk/>

6. Western Power Distribution: Flexible Power Procurement, July 2020 – <http://www.flexiblepower.co.uk/downloads/426>

7. Western Power Distribution: Flexible Power Requirements – <http://www.flexiblepower.co.uk/our-schemes>

8. Western Power Distribution: Postcode checker – <http://www.flexiblepower.co.uk/postcode-checker>

9. Western Power Distribution: Value Calculation Tool – <http://www.flexiblepower.co.uk/value-calculator>

10. Western Power Distribution: Month Ahead Availability Forecasts – <http://www.flexiblepower.co.uk/downloads/438>

11. Western Power Distribution: Flexibility Map – <http://www.westernpower.co.uk/network-flexibility-map>

Accessing the schemes

Businesses considering entering the demand side arena may not be sure what steps to take. This chapter explores access to the markets discussed previously, and looks into aid potential participants with an insight to the appropriate routes available to them.

Going direct or using an aggregator or supplier?

The main routes to enter the demand side market are either by providing services directly to National Grid ESO or by working with one of a growing number of demand aggregators and other third parties. Opportunities are also becoming available through electricity suppliers and the Distribution Network Operators (DNOs).

The route a business takes is largely dependent on whether it meets the energy (MW) requirements for the services that National Grid ESO procures and whether a business has capacity to manage the relationship. If providers have the commercial knowledge within their business to manage and implement the individual product requirements, they can go directly to National Grid ESO.

Alternatively, aggregators and suppliers offer services to providers that can simplify the introduction and participation in Balancing Services. There are a number of companies that operate in this space.

Aggregators and suppliers play an important role in building a stronger demand side market by helping businesses take advantage of the rewards that are available.

They also have the autonomy to provide tailored advice to businesses and recommend products that specifically suit an energy user. They can work closely with an energy user and show them how to maximise their assets in terms of the speed of response they could provide, capacity available, the amount of time that delivery could be sustained for – and the various prices available.

From the perspective of the System Operator (National Grid ESO), both routes of entry are beneficial to operating the electricity system as either avenue will drive growth in demand side markets. National Grid ESO fully supports and encourages the flexibility services provided by aggregators, other third parties, and suppliers.

All routes have their own merits. It's for the individual provider to decide which route is most suitable to their business. Details for working with National Grid ESO, aggregators or suppliers are highlighted below.

Working with National Grid ESO

As outlined in Chapter 3, National Grid ESO directly buys a range of services to help it deliver the delicate balancing act of electricity supply and demand.

If a business is able to meet the power (MW) requirement for these products, it may be able to contract directly with National Grid ESO.

Ways to get in touch with National Grid ESO regarding Balancing Services contracts:

Email: commercial.operation@nationalgrideso.com Tel: +44 (0)1926 654611

What are the main benefits of going direct to National Grid ESO?

1. Businesses get experience of direct contract management with National Grid ESO and have access to a dedicated Account Manager and Leads for each product & service.
2. No fees to pay to a third party, but a business will need to have the commercial expertise to manage and run the contract themselves.

Working with an aggregator or supplier

Businesses can choose to offer demand side services through an aggregator or supplier.

Appendix II provides a list of aggregators and suppliers as identified on the National Grid ESO website. However, National Grid ESO does not provide advice on which aggregator to choose, and neither can it make any recommendation about the performance of any of the companies listed. It is the responsibility of each potential provider to spend time researching and talking to the various aggregators in the market to establish which one best suits its requirements. To help deliver confidence

to customers in this area, the Association for Decentralised Energy (ADE) has, with input from the industry, developed a Code of Conduct for aggregators and suppliers to adhere to.

The list of aggregators and suppliers in Appendix II should not be treated as exhaustive.

Size is just one factor when a business makes its decision. National Grid ESO, aggregators and suppliers can provide different levels of information and support, and it's down to individual providers to decide which route works best for them.

What are the main benefits of going to an aggregator or supplier?

1. They provide support and flexibility to smaller loads. Businesses that choose this route can have more specific conversations about their own assets and what strategy might suit them best.
2. Businesses receive revenue without having to worry about the day-to-day management of the service.
3. They can simplify the offering to businesses so that demand side flexibility becomes a clear and interesting value proposition.

Chapter 4

Accessing the schemes

Bidding into the Capacity Market

National Grid ESO is the delivery body which administers the Capacity Market auctions, discussed in some detail in Chapter 3.

There are two ways in which parties can bid into the Capacity Market – The T-4 Auction and the T-1 Auction;

- The T-4 Auction runs each year and allows energy users to sell capacity that they are then committed to deliver in four years' time.
- The T-1 Auction is a top-up auction for each delivery year allowing providers to sell smaller amounts of capacity one year ahead of delivery.

The first step for any business that wishes to participate is to set up an account on the EMR (Energy Market Reform) Delivery Body Administration System at www.emrdeliverybody.com/CM/CompanyRegistration.aspx.

From there, they'll be walked through a pre-qualification process and introduced to the specific details of how to participate. Again, this process is discussed in more detail in Chapter 3.

Aggregators and suppliers can also provide a route into both the T-4 and the T-1 Capacity Market auctions on behalf of large energy

consumers who don't wish to manage their own bid.

For contacting the National Grid ESO Capacity Market team:

Email: emr@nationalgrideso.com
Tel: +44 (0)1926 655300

Getting started

Any business that is interested in joining this lucrative and fast-moving market shouldn't hesitate in reaching out and talking to an expert in the industry. They can seek further information directly from National Grid ESO or by talking to an aggregator or supplier.

The first step for connecting with National Grid ESO is via the email address commercial.operation@nationalgrideso.com.

Submit a question or comment and an Account Manager at National Grid ESO will respond. They'll be able to advise whether a business might be suited to take a direct contract or, if they may want to explore an alternative route.

Aggregators and suppliers are available to answer questions, provide tailored information and advice on the financial benefits of participating in this demand side revolution.

Chapter 5

Electricity storage for industrial and commercial energy users

This chapter has been written by the Energy Storage Network and provides an overview of the opportunities for large energy users to deploy energy storage systems, for example battery electricity storage, and gives insights on potential revenue streams and other benefits that can be realised by accessing this growing market.

The growing importance of grid-scale storage

Energy storage has in the past been challenging, expensive and subject to limitations which have meant that, for electrical grids, the rate at which electricity is consumed must be matched by the rate at which it is generated at all times. The rapid rise of large-scale battery storage has the potential to dramatically alter this picture.

As battery technologies have improved, materials have reduced in cost and as the benefits of scaled manufacture have begun to apply, large-scale and demand side battery storage has been gaining ground as an answer to a number of balancing issues increasingly facing electrical grids due to the increase in deployment of renewable technologies. As a result, commercial roll-out is now established both in the UK and internationally. Battery storage is being used for grid frequency response, which has proved an effective approach to smoothing out daily variations in demand and could be the key to unlocking the full potential of large-scale renewable generation.

Historical background

The value of grid-scale energy storage has long been recognised. At least 80 years ago,

the development of reversible hydroelectric turbines allowed for a form of pumped energy storage, filling reservoirs during times of low demand and generating electricity at times of peak demand.

There is now nearly 4GW storage capacity in the UK, with the vast majority of this being pumped hydro. However, further roll-out of pumped hydro is hampered by a need for very specific geography, high capex costs and efficiency losses inherent in the energy transitions involved (averaging no more than 70 to 85% round-trip efficiency). There are nearly 3GW of pumped storage schemes planned in Wales and Scotland.

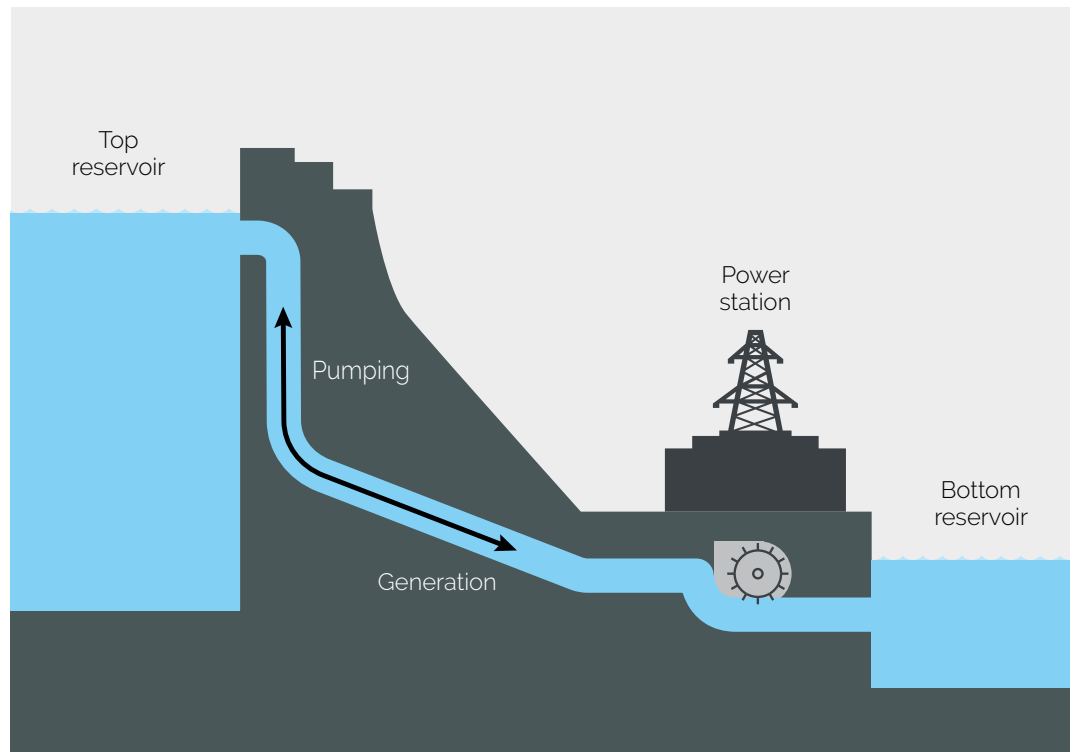
Several other methods of grid-scale storage are currently under development, including compressed air, liquid air (or 'cryo' storage), hydrogen electrolysis, gravity-based systems, the storage of heat in various forms, and several types of battery chemistry compositions.

Lithium-ion battery storage, benefitting from technology development and decreasing cost in the consumer and transport spheres, as well as higher efficiency (newer batteries achieving in excess of 90%), has rapidly emerged as a major grid-scale energy storage contender.

The development in the 1990s of energy-dense lithium-ion batteries, and their decrease in cost over subsequent years, has led to their growth in the consumer electronics and electric vehicle markets.

At this stage, it's clear that battery storage will play an important role in the near-future development of the UK electricity grid, however a range of the above named technologies will be required to facilitate a net zero electricity system.

Figure 5.1: Pumped hydro electricity storage



Source: meuc

Storage market growth

In this chapter, we focus primarily on how large consumers of electricity can utilise demand side battery storage. Large-scale battery storage capacity has grown from almost zero in 2015 to nearly 900MW of grid connected assets, with 5.5GW currently going through the planning system. While it is difficult to predict exactly how much storage will be needed to support a flexible system, estimates range from 13GW to 30GW by 2035. This high ambition and high need puts storage on a trajectory for growth over the next decade.

Types of battery technology

There are a number of complementing battery technologies which have seen significant adoption for grid-scale storage (with many more at an earlier development stage), each having characteristics that make them suited

for different applications in the grid-scale storage market.

Lead acid – a mature technology, lead-acid batteries account for as much as 50% of all battery use worldwide, primarily in the form of car batteries. While lead-acid batteries benefit from their low cost and reasonable safety characteristics, they contain toxic materials and historically have had low energy densities, although the recent innovations in lead-copper are starting to shift this. The advantage to a lead-based battery is ease of recycling and end-of-life decommissioning compared to other chemistries, such as lithium-ion.

Ultra-Battery – a new iteration of the lead-acid battery which addresses some of the chemistry's drawbacks, has seen considerable early uptake in both transportation and grid-storage applications.

Lithium-ion – the term lithium-ion refers to any one of a range of different lithium-anode-based rechargeable batteries, the

Chapter 5

Electricity storage for industrial and commercial energy users

first of which became widely commercially available in the early 1990s. Lithium-ion batteries have become increasingly commonplace due to their high energy densities and falling costs, and are now estimated to be cost-competitive with equivalent fossil fuel technologies with costs expected to continue to fall. Exact characteristics vary depending on the particular lithium-ion anode and cathode materials used, with some carrying explosion or overheating risks as a trade-off to increased performance, operating life or energy density.

Major electric vehicle industry figures, including Tesla and Nissan, have identified that the same lithium-ion battery technologies they use in their electric vehicles can be profitably utilised in other ways. This could be in consumer/commercial premises for demand side response and distributed-generation storage applications, as well as in grid-scale applications (when produced in a modular, scalable form). Nissan has taken this concept a step further, firstly utilising recycled electric vehicle batteries to provide a demand side storage solution. Secondly, they plan to connect vehicle-to-grid (V2G) charging units across the UK to allow parked electric vehicles to be used in a limited back-up balancing capacity on the grid. Several other car manufacturers are also investigating these opportunities or actively developing projects.

Nickel-metal hydride – developed in a similar time frame to lithium-ion batteries, nickel-metal hydride batteries built on the success of early nickel-cadmium rechargeable batteries. While lithium-ion batteries have much greater energy density and lower cost, the higher safety profile and excellent cycle life of nickel-metal hydride batteries has allowed them to dominate the first generation of hybrid vehicle applications such as the Toyota Prius.

Other contenders – other battery chemistries under development or already in use on a smaller scale include flow batteries, zinc-air and zinc bromide (either of which could prove a cheap option in the long-term due to zinc's abundance) and molten-salt sodium-sulphur, which, although in the early

stages of development, has seen several hundred megawatts of capacity deployed in Japan.

UK storage projects

In a report on smart power in March 2016, the National Infrastructure Commission (NIC) said that if costs continue to fall as anticipated, up to 15,000MWh of battery storage could feasibly be deployed in the UK by 2030. National Grid's Future Energy Scenario, Community Renewables, estimates 16,800MWh of battery storage installed by 2030. The NIC report further urged the UK Government to implement regulatory changes necessary to facilitate greater adoption of grid-scale battery storage as an essential building block of a smart grid for the UK.

The Department for Business, Energy and Industrial Strategy (BEIS) recognises the need for storage and is supportive of the growth of the industry. In 2017, BEIS and Ofgem released a Smart Systems and Flexibility Plan, which committed to a series of actions to improve the regulatory and market environment for storage.

National Grid ESO's system balancing

The need for electricity supply and demand to be actively balanced across a grid creates complex challenges. Battery storage has the potential to assist system operators in addressing system imbalance in a number of different scenarios: imbalance caused by changes in demand or in supply, and maintaining stable electrical frequency levels on the grid.

Frequency response

Historically, frequency response has been met by generators modifying their output and by consumers varying their demand. By contrast, battery storage can provide sub-second response times and is now the dominant technology in these markets. See page chapter 3 for more information on frequency response markets.

Figure 5.2: Lithium-ion battery installation



Source: UKPN Innovation

Responding to changes in demand

Balancing demand and supply has become more difficult with the growth in the renewable generation required to achieve a cleaner energy system. Some elements of electricity demand variation follow predictable patterns, such as summer to winter variations and daily peaks and troughs in usage. The difference between the lowest levels of daily electricity use (overnight) and peak electricity demand can equate to almost a doubling of demand, and a similar difference applies between the average summer and winter usage.

Baseload sources of electricity such as nuclear power provide a reliable and consistent supply over long periods of time, they cannot quickly or cost-effectively be brought on and off line. Similarly, whilst increasing volumes of intermittent generation (such as wind and solar) are helping to enable net-zero ambitions, by their nature, they are not always able to meet demand. The need for cyclical 'peaking' generation, therefore, has historically been met by generation sources able to increase and decrease their output when required, such as gas turbines and hydro power plants. Battery storage has begun making inroads into this market as a flexible, modular and cheaper alternative to traditional models.

Recent analysis from the Electricity Storage Network has shown that the levelised cost of storage is now cheaper than the equivalent fossil fuel peaking generation providing similar services¹². As costs continue to fall, battery storage is anticipated to be used to provide a replacement for peaking generation required to meet peak daily demand between 16:00 and 19:00 – aimed at bridging the peak electricity consumption hours without the need to build new gas peaking generation and therefore also supporting our decarbonisation efforts.

Responding to changes in supply

As well as swings in demand, the grid must be able to adapt to unexpected changes in supply. Generating plants suffer outages or reductions in output, and despite the associated benefits of a cleaner energy supply, electricity output from intermittent renewable energy sources cannot always deliver a firm output. Reacting to unpredicted changes in supply in a matter of minutes, or even milliseconds, requires electricity sources with very short start-up times – a role historically filled by gas turbine plants and, more recently, diesel generators.

However, if gas is principally used for supporting intermittent generation, it operates at a low load factor – this means

12. Electricity Storage: Pathways to a Net Zero Future, ESN, 2020co.uk/

Chapter 5 Electricity storage for industrial and commercial energy users

the output of a power plant is low compared to the maximum output it could produce. Therefore, it can prove difficult to make an economic case for investment in new plants of traditional fuel sources, with increasing numbers of localised climate emergencies it is also growing more difficult to acquire planning permission for such plants¹³. While commercial, grid-scale battery storage projects have used the frequency response market to launch in earnest in the UK, the role of battery storage will extend beyond this. The potential to support peak shaving, create flexibility in constrained areas of the grid, and provide reserves to complement the UK's increasing use of renewable generation will play an important role in building the business case for storage and supporting the decarbonisation of the electricity system.

Storage in frequency response markets

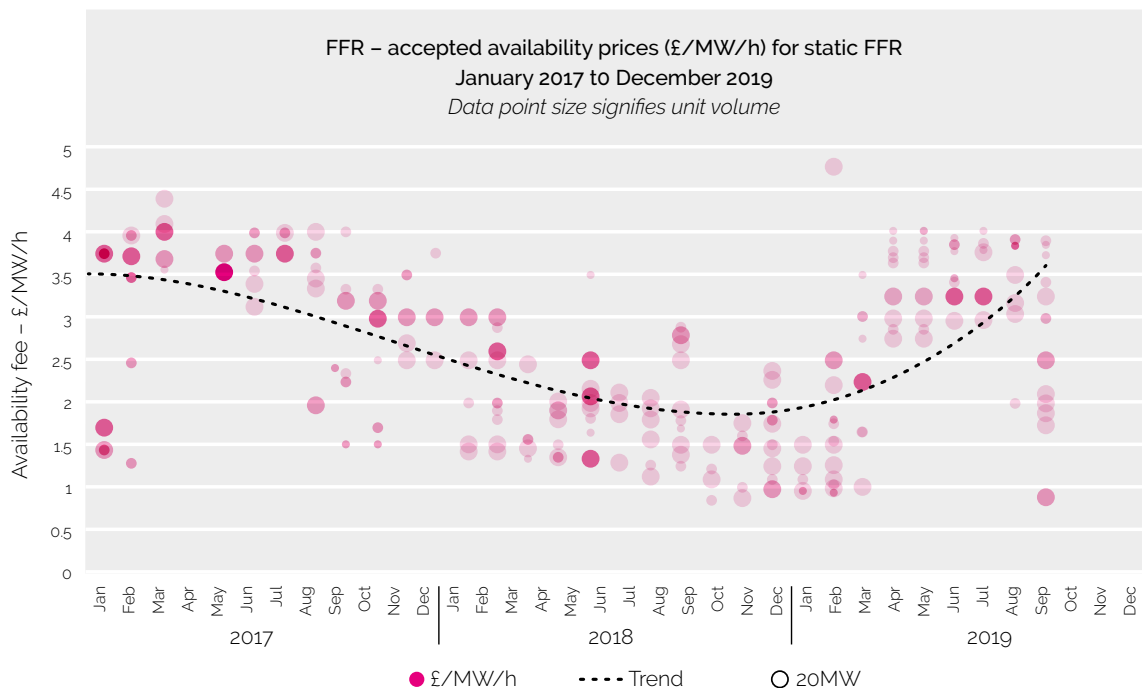
Since 2016, National Grid ESO have procured frequency response services through

several auctions and markets. The Enhanced Frequency Response (EFR) market and the Firm Frequency Response (FFR) markets have proved lucrative for storage and enabled much of the deployment since 2016. However, increased competition has saturated these markets, driving prices down.

Control of frequency has become increasingly difficult as the rate of change of frequency becomes more variable. National Grid ESO has recognised the need for more markets to address this issue and is therefore introducing a suite of frequency response products: Dynamic Containment, Regulation, and Moderation. These operate pre- and post-fault in order to control frequency as close to real time as possible.

The change in prices in the FFR market from 2017-2019 can be seen in the figure 5.3.

Figure 5.3 Firm frequency response prices



Source: Power Responsive Annual Report 2019

13. <https://environment-analyst.com/uk/82026/landmark-rejection-for-devon-peaking-plant>

Chapter 5

Electricity storage for industrial and commercial energy users

Other ancillary services

Alongside voltage control, storage provides a host of other ancillary services such as real and synthetic inertia, constraint management and flexibility to DNOs at a local level (local flexibility markets). With the energy system growing more complicated, National Grid's Network Development Roadmap sets out more products that could solve upcoming grid issues. Examples include its Constraint Management Pathfinder and Stability Pathfinder. Distribution Network Operators are also starting to take greater advantage of flexibility with large flexibility tenders such as UKPN's 123MW, £14m flexibility tender¹⁴.

Storage in the Capacity Market

Both storage and DSR can participate in the Capacity Market (CM) – a market driven by Government and delivered by National Grid ESO with the aim to secure capacity for winter peaks. Participation is in the form of auctions with payments for availability over given periods. This market offers an opportunity for longer duration revenue opportunities. Although the CM allows for slower response times, storage obtained 2,710MW in the T-1 Capacity Market Auction for 2017/18.

In recent years, this has reduced to only 3.7MW in the T-1 Capacity Market Auction for 20/21. The most recent T-4 CM auction, in March 2020, cleared at £15.97/kW, securing 43.7GW of capacity from 2020 at a cost of around £1bn. 117MW of battery storage projects were awarded contracts.

There have been several factors leading to a reduction in storage in the Capacity Market in recent years. In 2018, storage de-rating calculations had a duration factor applied to them, meaning the most common short-duration storage assets had their derating factor reduced to around 30% compared to DSR at 86%. This has led

to some storage assets entering as DSR; however the rules are expected to change to prohibit this soon. There has also been a string of low clearing prices for the auction across 2019 and 2020 with the June 2019 T-1 clearing at only £0.77/kW and the February 2020 T-1 still at only £1/kW. With the added administrative burden of the Capacity Market auction process, this has reduced the viability of the Capacity Market as a revenue stream for storage projects.

Joint location of renewable generation and storage

Co-locating onsite battery storage with renewable generation assets has the potential to offer a number of obvious benefits. In this case storage can provide reserve and time-shift directly to the generator, which is becoming more important as renewable plants are beginning to be curtailed.

However, currently generators are paid by the ESO to 'turn down' at times of high generation and low demand and storage may be underutilised if only used for this purpose. In the current market, storage may also need to provide other services in order to make full use of the asset. There are several co-located storage sites in the electricity system, but most of these are simply sharing a grid connection rather than an operating model.

Those with behind the meter generation, will not be bound by the same business models as grid-connected generation and therefore co-located storage could provide a greater benefit in this instance.

In addition, developers must also consider the risk of how changes to a project may impact its entitlement to renewable benefits.

14. <https://www.ukpowernetworks.co.uk/internet/en/news-and-press/press-releases/World-first-for-Flexibility-markets-as-UK-Power-Networks-reveals-biggest-ever-tender.html#art-top>

Aggregation of demand-side response with storage

Demand side response aggregators, who seek to respond to National Grid ESO's balancing needs by securing commitments from portfolios of diverse businesses across the country to reduce their power usage on demand, can be limited by the slow response times these approaches often have. Adding a relatively small amount of battery storage to an aggregation set-up can bridge the gap in response time for a much larger portfolio. National Grid ESO has expressed an ambition of a greatly increased role for demand side response measures in balancing, meaning this area will likely see considerable development going forward. Demand side response is an area where the UK is leading the field internationally, with a robust regulatory framework already in place.

National Grid ESO has been conducting work to make the Balancing Mechanism accessible to such providers through its Wider Access to the Balancing Mechanism project. This project aims to increase access to the Balancing Mechanism by removing barriers to entry such as by improving existing routes to markets, developing new, cost-effective routes to market, and enhancing IT systems. One aspect of this project was the introduction of Virtual Lead Parties, which allowed aggregators access to the Balancing Mechanism, ancillary services and the Trans European Replacement Reserves Exchange (TERRE) without the need for a supply licence.

In June 2020 Flexitricity reported that the introduction of National Grid ESO's Optional Downward Flexibility Management footroom service allowed it to pass the 500MW milestone for its virtual power plant. Between 2019 and 2020 Flexitricity added significant volumes of storage to its portfolio including 70MW from Gresham House and 19,5MW via Anesco¹⁵.

Potential revenue streams

There is a significant market opportunity for industrial and commercial (I&C) energy users to use electricity storage, especially as behind-the-meter applications offer additional options for optimising the use of any existing DSR capability.

The main market drivers for storage deployment will be:

1. Improvements in the real-time trading model
2. Increasing need for flexibility and increasing value of ancillary service markets
3. Falling energy storage system costs
4. Fewer barriers to market participation
5. Greater recognition of the value of behind-the-meter services
6. Growing customer awareness and confidence

Combining DSR capability with electricity storage could unlock a number of benefits, including:

- Reducing the cost of electricity purchases by storing cheaper energy in order to meet demand at another time
- Maximising the value of onsite renewable generation by storing excess output for use at another time, rather than selling at a discount, thereby maximising 'self-consumption'
- Bringing flexibility to I&C users with inflexible processes
- Providing services to the grid to help balance the electricity system

These benefits mean there are a number of potential sources of revenue or cost avoidance that DSR providers could harness by utilising electricity storage applications.

15. <https://theenergyst.com/flexitricity-vpp-hits-half-a-gigawatt-predicts-dramatic-growth-for-dsr/>

Chapter 5

Electricity storage for industrial and commercial energy users

Through storing electricity, either from onsite generation or importing from the grid, I&C users could unlock the potential of their inflexible processes or similar to DSR, behind-the-meter storage can offer significant cost saving opportunities by supporting I&C users' ability to respond to price signals they receive from their supplier. These consist of the wholesale energy market prices and the transmission and distribution network charges (discussed in more detail in chapter 2). Users, with help from their supplier, can identify high cost times of day. This approach of shifting energy usage to avoid high wholesale energy market prices or high network charges is known as peak shaving and is often the simplest opportunity to participate in.

The opportunity to avoid high network charges is becoming less certain however. The Targeted Charging Review, which was concluded by Ofgem at the end of 2019, has been structured in a way to ensure that large I&C demand customers can no longer avoid network costs as they do through Triad avoidance during peak winter periods (Triads being the three highest demand periods of the winter, identified in retrospect by National Grid). Red-band distribution use of system (DUoS) charges are also reducing, meaning the opportunity for increase revenue for charge avoidance is more difficult.

As well as enabling the storage of off-peak electricity, storage applications could be combined with renewable generation technologies, such as onsite wind or solar generation. This would enable I&C users to store energy which isn't consumed immediately and instead use it to support processes at a later point in time or when energy prices are higher.

Behind the meter assets also have the opportunity to provide the ancillary services mentioned above. By providing grid benefits this way, they can also gain additional revenue and ensure the asset is used to its full extent. For example, Arsenal Football Club installed a 2MW battery to power its Emirates Stadium

during matches. When the battery is not in use on site, it participates in grid services to provide flexibility to the system, while earning revenue for Arsenal and the project partners.

The potential value of commercial & industrial storage for power supply stability/integrity

Some I&C energy users are very sensitive to power supply interruptions and power quality issues, potentially needing to fully restart sites/processes after short supply interruptions or other power quality disturbances. Co-locating electricity storage assets with industrial sites will likely continue to be primarily designed around parallel operation to the network. However, with detailed connection arrangement design and sizing there could be some parallel benefits that could be exploited for storage assets to provide power supply integrity support for certain I&C sectors.

This could be at either operational site level, individual process level, or potentially to support specific strategic pieces of plant. The business model for I&C storage is potentially complicated and challenging moving forward, with network charging reforms and competitive commercial flexibility markets causing a robust set of revenue streams to be difficult to pin down; therefore under this environment justification for storage project capital costs becomes different for I&C businesses. Exploring the potential parallel/secondary benefits that storage could bring to supply stability, potentially reducing downtime, lost productivity or other incentives linked to maximising process 'up-time', may be worth exploring and evaluating. Profiting from the I&C storage business models may need to go beyond targeting commercial flexibility and network peak charge avoidance income streams if business cases are to be justified and project capital spend proposals are to be approved.

Hedging of power

Beyond the wholesale markets, the balancing markets are inherently volatile – National Grid ESO uses these markets to balance the system close to real-time, and prices

fluctuate according to the variation between spikes in demand and generation. The quick response times and agility that storage offers mean it is well placed to take advantage of these price spikes. As access to these markets opens up to storage, trading is becoming an increasingly viable revenue stream. While this may provide the potential for a significant upside to the project, careful thought will need to be given to appropriate restrictions, thresholds and tolerances if this is not to create unbankable risks.

Business rates

Under the current tax regime, assets that are classed as 'behind-the-meter' and not connected directly to the grid don't receive the same exemption for business rates as front-of-the-meter storage assets that are solely providing grid benefits. For example, a grid connected battery site could be expected to pay around £26,000 for an average 10MW site, whilst behind the meter this increases to £139,000.

The Electricity Storage Network (ESN) has been working with the Valuation Office Agency to improve the rates calculation for storage and are also pushing for the Government to reduce business rates for behind-the-meter assets. For more detailed information on the business rates calculation and how it might affect an asset, you can read the following note developed by Roadnight Taylor and the ESN.

Storage for I&C energy users

Onsite storage could offer opportunities for a range of I&C energy users, both those with a low DSR potential where it can bring in valuable flexibility and those with high DSR potential where it enhances the existing potential, for example chemicals, cold storage, steel, water & waste treatment, paper industries.

There is no 'one-size-fits-all' proposition, due to the nature of each industry, energy user and service. When assessing the suitability of storage applications, energy users should consider which markets they wish to access and which storage option is best placed to enable this, alongside existing assets.

It is possible to explore the opportunities of onsite generation independently, however aggregators may be able to support with deployment, including the smart software required. The routes to market are discussed in chapter 4 of this guide.

Finally, we are in the midst of a period of great change in the energy market, with significant developments in battery storage technologies and a shifting regulatory and revenue-support landscape. There are multiple opportunities for consumers, battery storage investors, developers and lenders to cooperate in the future.

Case studies of demand side response and storage schemes



Saint-Gobain, a manufacturing company

An awareness campaign on energy charges at one of the UK and Ireland's largest manufacturing firms has reaped significant savings and also helped it play a part in ensuring the nation's electricity network is able to meet demand. Michael Dickinson, Engineering Manager Glass Industry UK & Ireland for Saint-Gobain, explains more.

"The workings of the Triad system was probably something of a mystery to many of our site managers and energy champions.

The Triad charging methodology encourages large energy users to reduce consumption at peak periods in winter by levying a charge based on their electricity use over the three half-hours of highest demand on the grid each winter. As these Triad periods are not known in advance, efforts by major energy users to try and avoid them has the effect of reducing demand across the system. Triad charges can be a sizeable proportion of energy bills at Saint-Gobain, a fact highlighted by an energy presentation to our managing directors.

We looked to try and help our site managers and energy champions better understand the Triad system and how to minimise costs by reducing demand around peak periods. This was followed by a joint webinar for staff from our 20 or so sites around the country ahead of last winter.

The response exceeded expectations with a number of sites really taking the issue on board and developing detailed plans of action for when a Triad period looked likely. Although the timing of the Triad periods isn't known in advance, we subscribe to our supplier's Triad alerting service which assesses a range of factors including historic trends and temperature to determine when they are likely.

By switching machinery off or otherwise reducing demand for a short period of time from around the peak time for Triads some sites have been able to achieve dramatic savings. Our overall demand across the three Triad periods showed an 11% fall and led to a total saving of £165,000.

At one site alone the saving achieved was the equivalent of more than a whole month's energy costs. The site's success saw it recently presented with the first Saint-Gobain UK & Ireland Energy Management Award with our supplier also making a donation to charity to mark the achievement."



Marriott International Hotels – Europe

"After successful trials, Marriott International Europe has embraced Demand Side Response. Here, Marriot International Europe tell us why the chain rolled out the red carpet for DSR."

At Marriott International the benefits of DSR initially seemed to make little sense – it's 6pm, it's been a hot day, the hotel is full of people getting ready for the evening and we are being asked to reduce our demand for electricity. Really?

Once we came to understand the concept however, we wanted to be involved. From a small beginning with a pilot in just four of our hotels, we expanded our participation in DSR to 29 hotels in the UK over a period of four years.

The concept is that small reductions in demand from our hotels, and the other businesses that we are aggregated with by KiWi Power, add up to a significant overall reduction allowing National Grid ESO to keep the system in balance during times of high demand. For Marriott International Europe the initial focus was on large pieces of electrical equipment such as the chillers that we use for air conditioning and refrigeration. Shutting these down for short periods of time within agreed parameters can be done with little or no effect on our operations, certainly as far as our guests are concerned.

Over the period we've been providing a demand response service we've never had any adverse reaction from our guests.

Once we became aware there was a market opportunity in the UK we started to look at how we could unlock it.

Initially we were wary as KiWi Power is a relatively small company with a flat hierarchy where decisions are made very quickly, whereas with a large corporation like ours we sometimes need longer to ensure the concept is fully tested. However, it's turned out to be a very good fit.

Typically, a hotel is contacted by the aggregator and given a couple of hours' notice of a turn-off lasting for around an hour. The relevant equipment has controls fitted which allow the aggregator to turn it off and on remotely. All our hotels have separate contracts with KiWi Power so they agree at a local level how much capacity they are committing to provide. Once the system is up and running it's almost effortless on our part.

We continued to work with the aggregator to bring more pieces of equipment within the scheme, right down to things like ice machines, so we can maximise the potential of our assets.

However, a major benefit for us is that it underlines our credibility as a business committed to sustainable energy use and it has resulted in some very positive media coverage.

M&S

EST. 1884

Marks & Spencer

High Street retailer Marks & Spencer seized the opportunity to offer through demand side response (DSR). Marks & Spencer explains why getting involved in the Short-Term Operating Reserve (STOR) scheme and the Capacity Market, on top of Triad avoidance, is the right fit for the business.

"Our business requires a large amount of energy to operate – covering our distribution centres and offices as well as hundreds of stores across the UK. We need that energy to keep our stores lit, food lines refrigerated and our customers and employees comfortable with adequate heating, ventilation and air conditioning (HVAC)."

Working with E.ON as our aggregator, they have managed our participation in STOR and the Capacity Market – plus Triad avoidance.

The potential benefits of DSR are really attractive. As well as contributing to security of supply and generating additional revenue we are also supporting our Plan A targets. Meanwhile, through our Capacity Market obligation, we have made a long-term commitment to supply an agreed level of capacity to the system.

So how are we delivering this capacity and helping to balance the system?

First of all, we have set up automatic and remote switching of our non-critical loads, specifically HVAC, when the grid requires additional capacity during peak demand periods. And secondly, we are using the generator assets we already have in our stores – usually only used to power our business in a power cut – to generate additional electricity during periods of peak demand.

Getting the business ready to participate in this scheme required extra work and investment. We use a central energy management platform to help control energy use across our sites. At the beginning of this project, all of our lighting and many HVAC assets were already connected and controlled, but our generators were not.

With the help of our suppliers, we connected all our additional assets to this central platform so they could be remotely controlled to deliver the services when needed.

Another key part of getting up and running was liaising with the relevant Distribution Network Operators (DNOs) to ensure that our generators could run in parallel with the grid safely, and in some cases, that power we generated could be exported to the network. With all the work complete we have HVAC assets in 25 stores available and online, so we can control and shift loads as required. In addition, 13 of our sites – with many more planned – have had their generators upgraded to supply power to the grid when called upon.

All participating sites successfully went through Capacity Market testing in August 2016 and STOR delivery kicked off in September that year.

One unexpected benefit is that by keeping our generators online for providing flexibility to National Grid ESO, we are more confident they will run successfully if a power cut did occur.

Chapter 6

Case studies of demand side response and storage schemes



Colchester Hospital University NHS Trust

The Trust was one of the first Trusts to see the potential of demand side response (DSR) for generating revenue while helping balance supply and demand across the grid.

Colchester Hospital University NHS Foundation Trust has two main sites, Colchester General Hospital and Essex County Hospital. Having access to a constant power supply is literally a matter of life and death for the UK's NHS hospitals, which is why they all have emergency back-up electricity generators.

With NHS finances under constant pressure, the more forward-thinking NHS hospitals are working with demand response aggregators and National Grid ESO to use these generators to help balance the system and create a new revenue stream.

Colchester Hospital University NHS Foundation Trust was approached by demand response aggregator KiWi Power who proposed a scheme to install hardware and software that would help us realise the full potential of our generators and provide demand response for National Grid ESO to call upon.

Before DSR we routinely ran our generators to test them for a set 10 hours a month. Our base load was 1.6MW and we had the potential to generate 3.6MW, giving us an export capacity of 2MW. Under DSR, we now switch to our own generators at times when the system requires it, which helps prove the resilience of our generators.

For this system to work you do need to have well-maintained generators as they have to be able to react within a short period. You also need to have the right hardware and software to ensure a seamless switchover when a generator is called on because the hospital cannot afford to have any downtime.

We benefit from National Grid ESO's STOR (Short-Term Operating Reserve) programme and it allows us to realise a key objective: to upgrade and improve the resilience of the hospitals' generators.

The system allows the generators to be remotely controlled when National Grid ESO activates a demand response event. The diesel generators synchronise to the mains and export spare capacity back to the Grid. A further benefit provided by KiWi Power is to remotely manage the Trusts Triad Avoidance scheme. Triad periods help National Grid ESO recover the cost of maintaining the transmission network through charges applied at three peak half hours between November and February. KiWi Power predict when the Triad periods are expected to occur and dispatch the generators accordingly through their automated dispatch process – something we used to have to do manually. This safeguarded an important money saving scheme for Colchester. The Triad process is a simple one, and one that many hospitals could participate in..



The University of East Anglia

The University of East Anglia has around 15,000 students and 4,000 staff, spread over a campus of 320 acres just outside Norwich. This centre of higher education has found that the benefits of Demand Side Response (DSR) are, well... elementary. Richard Bettle, Energy & Utilities Manager, explains why.

"Our site has a power consumption rate of some 5.5MW during the day, dropping to 2.8MW at night. In winter, it's about 6MW and 3.2MW respectively. Back in 1999, we put in a Combined Heat and Power system and we generate about 60% of our power onsite with gas engines."

We have three 1MW engines installed in 1999, plus a 1.7MW unit included in 2008 that provide us with 6MW of heat if all are running. It's much more economical for us to buy gas at 2p a kilowatt and generate electricity at 6 to 7p/kWh rather than buy it in at 10 to 11p a kilowatt and offset running gas boilers for heat. It is right both from an economical and environmental perspective, because it reduces our carbon signature considerably.

Open Energi came to us about DSR and although we can't vary the load greatly – a few minutes would be fine but a long period of 30 minutes would be difficult – we gave serious consideration to what we could do across campus.

For example, we have a permanent air extraction system ventilating our student residence buildings taking air out of shower

pods. It was a case of 'Does it really matter if it goes off for a few minutes? No, not really.' Similarly, we have an art gallery onsite that has around 30 air handling units. Does it really matter if they stop ventilating for a few minutes? Again, the answer is no.

The question we kept asking ourselves is 'Would the customer really be affected?' There are many benefits from our point of view. We realised that we can earn an income from operating our equipment slightly differently, the system is still under our control and we don't have any expenditure in putting in the new system. Altogether we're making around 700kW available from a combination of air handling units and chillers.

It's completely automatic. The Open Energi box measures the local frequency of the mains. It senses it's going down and says 'That's a bit too low', and will then shed some of our load within two seconds. If frequency goes too high, then it puts on a bit of load.

The system has an accurate electricity meter that's measuring everything so it can prove to National Grid ESO that the event is really happening.

We are now actually generating an income, just for operating our utilities slightly differently. It's helping the country, the environment in terms of carbon emissions, we're getting some money for it, and can disable it if we have to. So, for UEA it has been a case of 'Why not?'"



Ardagh Glass

Ardagh Glass is the leading global supplier of value-added, infinitely recyclable packaging solutions for the world's leading brands. Ardagh has 108 metal and glass manufacturing facilities in 22 countries, employing approximately 23,300 people, with sustainability and energy efficiency being two of its core values.

Ardagh started working with GridBeyond in August 2016, in order to deliver the best returns through energy savings and placement in the relevant energy markets, whilst enhancing the overall energy strategy and boosting sustainability.

GridBeyond conducted audits across several sites to identify the flexible and inflexible assets, which were then presented to Ardagh before deciding that several blast furnaces across four production sites would participate in demand response.

By selecting GridBeyond, Ardagh was able to seamlessly stack and switch between demand side response programmes and energy services.

When Dynamic Frequency Response (DFR) became available as a balancing service from National Grid ESO, GridBeyond's technology was able to facilitate continual fast acting responses to both high and low frequency events in under 0.1 seconds, without impacting on Ardagh's operations. This rapid response is a reaction to the small fluctuations in the grid frequency caused by the intermittency of renewable generation, which is required to help meet net-zero ambitions. The faster the response, the more the National Grid ESO can rely on renewable sources.

At the end of 2017 Ardagh was looking to enhance its flexibility and take their energy

resilience to the next level with an onsite commercial battery.

By this point, GridBeyond had fully developed the technology to create the Hybrid Battery and Demand Network, which promised to unlock more energy flexibility, and in turn could boost Ardagh's sustainability strategy. In addition, GridBeyond's partnership with battery installers and financiers meant Ardagh was easily able to access a 2MW commercial battery for its Irvine site.

As sustainability pioneers in the manufacturing industry, Ardagh Group, was the first to install a behind-the-meter battery on the network at the end of 2017.

Now with 12MW of flexibility across 4 sites, combining control of large demand assets with the control of the highly flexible battery assets, GridBeyond has allowed Ardagh to maximise its demand side value through participation in Firm Frequency Response (Low Frequency Static (LFS) and Dynamic Firm Frequency Response (DFFR)), peak avoidance (Triads & DUoS), and the Capacity Market.

"We are committed to environmental responsibility and sustainable manufacturing processes and had been exploring battery storage solutions to help us effectively meet these commitments. When GridBeyond approached us with its hybrid battery and DSR offering, we felt confident that this would provide the efficient and cost effective solution we were looking for, which it has now successfully delivered."

Annelene Fisser
Group CSR & Sustainability Manager,
Ardagh Group



Norish was established in Ireland in 1975 and provides cold storage facilities to partners throughout the UK. It has 60,000 pallet storage spaces across the country and consumes an average of 21GW of electricity per year.

At times of high national electricity demand, or if a major power station fails, Flexitricity turns down Norish's cooling plant for short periods to reduce the stress on the electricity network.

Critical temperatures are monitored to ensure the integrity of the stored product. This allows Norish to earn extra revenue without disrupting its normal business operations.

Norish engineers monitor the plant at all times but the whole demand side response participation process is automated and managed by aggregator Flexitricity.

Energy is the second biggest overhead for the company, and its operating costs have more than doubled over the last 10 years. Demand side response participation has transformed efficiency across the plants and enabled Norish to reduce energy costs, drive sustainable revenue and re-invest to improve operations.

There has also been a significant environmental impact. Every megawatt of capacity connected to a virtual power plant is a megawatt that does not have to be held in reserve elsewhere – reducing emissions by between 300 to 750 tonnes of CO₂ per megawatt per annum.

In addition, the flexibility provided by Norish is vital in helping National Grid ESO manage the increased renewable generation in the system. Whilst the flexible capacity that Norish can provide is too small to meet the requirements of National Grid ESO services, Flexitricity has been able to pool the 0.9MW of capacity that Norish can provide into a larger portfolio. As a result, Norish has been able to take advantage of revenue opportunities from both STOR and the Capacity Market, earning on average £19,000 annually. Currently, Norish is exploring new on-site generation and storage opportunities to respond to the growing demand for flexible energy. It is also interested in Balancing Mechanism participation which is now open to a wider range of participants thanks to the new Virtual Lead Party route.

**Stuart Lloyd, Chief Engineer,
Norish Cold Storage**

"Demand side response participation through Flexitricity has had a huge impact on our business and has enabled us to drive savings and revenue from an area that has always represented a significant overhead for us. The partnership has not only given us more control and business intelligence, but we are also able to support National Grid as we move towards a low carbon economy."



Philip Dennis Foodservice

National Grid ESO and ELEXON opened up the balancing mechanism (BM), the most important tool for balancing the energy system in real time, to a wider range of flexibility providers in December 2019.

A family-owned wholesale food business partnered with Flexitricity to become the first company to trade with National Grid ESO using this new route to market.

Roisin Quinn, Head of National Control at National Grid ESO, said:

"This transformation is central to the way we balance the system today – particularly as we work to meet some of the challenges associated with balancing the system – and forms an important part of being able to operate carbon free by 2025."

In an industry first, Flexitricity aggregated two batteries owned by Philip Dennis Foodservice and dispatched them in response to a call for energy received from National Grid ESO using the newly-launched balancing mechanism wider access arrangements.

Philip Dennis Foodservice is a family-owned regional catering wholesaler based in Devon supplying customers with a range of frozen, ambient and chilled foods.

The company has a Tesla energy storage system at its site in Mullacott, and a BYD battery adjacent to another of its sites at Roundswell. Both batteries are connected to Flexitricity's virtual power plant and are managed round the clock by Flexitricity's 24/7 control room in Edinburgh.

Philip Dennis Foodservice became the first of a new wave of participants to trade in the balancing mechanism after National Grid ESO removed barriers to entry to this market at the tail end of 2019.

The transaction marks an important milestone for the GB energy market and highlights National Grid ESO's focus on boosting real-time flexibility in the system and improving equality of access. Balancing mechanism wider access presents a huge opportunity for a range of flexible energy users, including EV users, domestic heating and energy storage, district heating, renewables and community energy projects, and industrial and commercial flexibility such as refrigeration, HVAC and lighting.

Historically the balancing mechanism has been dominated by large energy suppliers, formerly known as the 'Big Six'. Now, as the country moves towards its 2050 net zero carbon targets, National Grid ESO and ELEXON have made changes to encourage smaller, more agile energy assets to contribute.

This change will improve system flexibility, which will facilitate renewable energy deployment and bring better value to consumers. New entrants to the market – like Philip Dennis Foodservice – will be able to reduce their environmental impact whilst creating additional revenue streams without disrupting day-to-day operations.

Flexitricity monitors the balancing mechanism and remotely alters the charge and discharge profile of Philip Dennis Foodservice's batteries onsite, in response to National Grid ESO's requirements to balance supply and demand in real time.

The balancing mechanism is one of the main tools National Grid ESO uses to balance supply and demand on the electricity system in real-time. Through the BM, providers can offer to increase or decrease their generation or demand to help balance the system.

Chapter 6

Case studies of demand side response and storage schemes

Roisin Quinn, Head of National Control at National Grid ESO, said:

"We're excited to see the first example of wider access to our balancing mechanism as a virtual lead party in action with Philip Dennis Foodservice and Flexitricity. Wider access opens up opportunities for new providers and technologies to become part of the electricity market, making it smarter and more flexible as we shift away from traditional large thermal power generation to cleaner, decentralised power."

Andy Lowe, Director at Flexitricity, said:

"We are delighted to be the first to complete a trade in the balancing mechanism utilising this new route to market and are fully committed to helping more businesses like Philip Dennis Foodservice to access this revenue source."

We have been working with businesses for over 11 years to maximise the value of their energy assets and now we can provide this service to thousands more businesses.

Our focus has always been to build a decentralised, greener and fairer energy system where all energy users benefit – not just the big suppliers. It's hugely rewarding to see that

that's now becoming a reality. Philip Dennis Foodservice – a small, family-owned business – is traded as part of our virtual power plant in the same, lucrative market the 'Big Six' are trading in. It's a perfect example of the progress we've made as an industry over the last few years.

Now as at any other time, our energy system needs customer-side flexibility to be both secure and green which is why it was important to us to be able to reach this milestone."

Peter Dennis, Director at Philip Dennis Foodservice, said:

"Sustainability is at the heart of everything we do, and we're delighted that working with Flexitricity is enabling us to 'green up the grid'. We're extremely proud that our batteries were the first ever assets traded in the balancing mechanism through this new route to market."

Energy used to be purely a cost for us and something that we didn't have much control over. Now, by slightly altering our generation and consumption profile in response to National Grid ESO's requirement, we're able to earn additional revenue that can be invested back into the business and gives us a competitive advantage."



Demma

Demand Side Response – money saving for the big and powerful or a genuine route to meet NetZero 2050 target?

When Demand Side Response (DSR) emerged just over eight years ago, many believed it was a game-changing moment for the energy industry, potentially solving the problem of energy shortages at peak demand. To a large extent it has delivered on its promise by offering building owners the opportunity to reduce energy costs and carbon footprint while generating a new revenue stream. National Grid's most recent 'Future Energy Scenarios (FES)' modelling suggests the volume of 'pure' DSR could double within two to three years as the value of flexibility sharply increases. This is great news. However, when you take a look at the current addressable market for DSR and where we are heading, it is unclear if it can make a meaningful difference in its current form as we ask... Just how many buildings are there with peak loads north of 1MWh to achieve an expected load shift of 100-200kW?

BMS and Energy Management company, Demma, a customer of Pearlstone, was quick to identify the opportunities presented to it if it entered into the DSR. Under the terms of the Energy Services Agreement with Pearlstone, Demma is able to bring single-property facilities under its management (which usually fall far below the traditional criteria for DSR) together under one energy savings contract.

Demma works with its building operators to identify electrical assets in its facilities, such as Heating Ventilation and Air Conditioning (HVAC) as well as many others, so that they can turn them down or off for short periods to provide demand side flexibility. This flexibility can be used to reduce financial exposure to system demand charges such as DUoS and Triad and achieve savings for its aggregated

pool of managed buildings. This flexibility can also realise customer value in terms of new revenues by providing DSR services such as short-term operating reserve (STOR) as well as other ancillary and balancing services to National Grid.

In short, Demma as well as its customers will now take advantage of the many benefits of DSR including cutting charge costs, reducing energy costs, and realise new revenue streams. There can be other gains, such as improving the resilience of existing systems, as well as improved energy management through real-time monitoring and supporting positive environmental change and strategic 'net zero' ambitions.

This offering is possible due to the innovations by Pearlstone Energy, a recognised commercial aggregator and a leading UK innovator in Demand Side Flexibility (DSR). DEMMA became a customer of Pearlstone after it announced its Virtual Integrated Building™ (ViB™), designed and created for owners of multi-site environments, previously considered 'not big enough' for DSR. The ViB allows a single host site server (in this case DEMMA) to consolidate data from multiple remote building management systems (its customers). The dedicated cloud server is then able to execute multiple remote demand response protocols, designated by the customer's unique energy saving strategy. See diagram overleaf.

A key element for of the proposition is that it has a positive impact on the customer's balance sheet from day one. The solution is installed at no cost to the customer, and fees are only due once a customer has benefited from reduced costs or revenue payments from the National Grid.

David Stretch, Director of Demma commented about the opportunities facing

Chapter 6

Case studies of demand side response and storage schemes

DSR today: "The Energy Services Agreement created in collaboration with Pearlstone is fast becoming a cornerstone of our energy savings offering. It is hard to quantify just how much this innovation has opened up the market but it is significant, and I find myself talking to new customers about the opportunities of DSR daily."

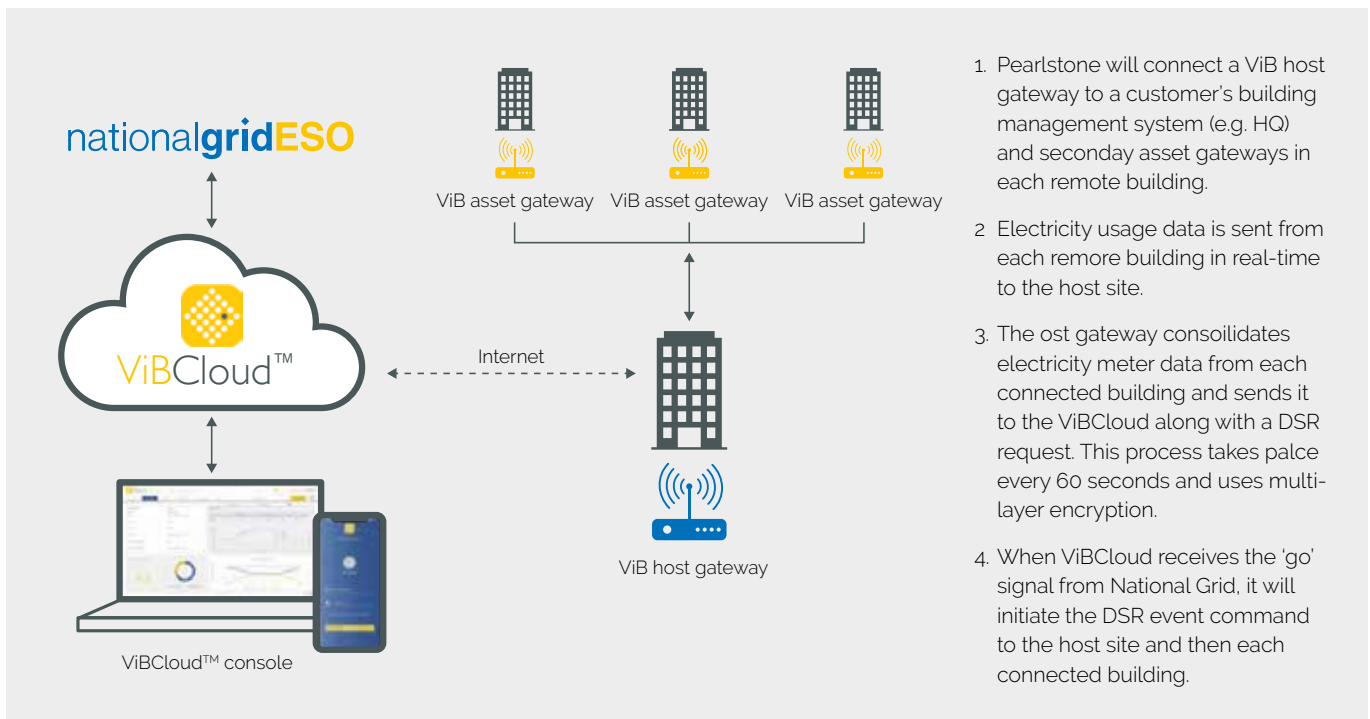
Dr Azad Camyab, Pearlstone CEO, said:

"Facilities use electricity for different purposes, but they don't need to consume it at full capacity all of the time. We're teaming up with the right partners such as Demma and use our open-source smart grid technology to tap into buildings' flexible energy needs to offer additional sources of grid stability along with savings and potential new revenue for participants."

Through innovation and collaboration, the outlook for DSR has now radically changed.

It has, in effect, been democratised, making it available to not just for the top 1% of energy users, but open to a far more diverse group of organisations and customer profiles. Today, single property customers with peak loads of just 200kW (expected load shift of up to 40kW) can profit from grid balancing schemes, recognise additional revenues, reduced energy costs and lower CO₂ emissions. This is also significant news for the NG ESO. As the addressable market grows, Demand Side Flexibility will increase in line, creating a more resilient and a future-proofed energy eco-system and will allow for the development of additional renewable technologies.

Make no mistake, this is an important development in the DSR space. The playing field has been levelled and hopefully we can all take advantage of the benefits this approach brings, whether great or small.



Appendix I

Power responsive programme from National Grid ESO



Power Responsive is a stakeholder-led programme, facilitated by National Grid ESO, to stimulate increased participation in different forms of flexible technology such as demand side response (DSR), small-scale generation and storage. Together we class these solutions as demand side flexibility (DSF).

The programme brings industry and energy users together, to work in a coordinated and collaborative way. A key priority is to grow participation in DSF, making it easier for industrial and commercial businesses to get involved and realise financial and carbon-cutting benefits.

Since the creation of Power Responsive in 2015, there has been an increasing awareness and focus on demand side flexibility. Power Responsive has been considered mould-breaking: being collaborative in approach, looking across the DSF landscape, steering a concerted programme to deliver greater awareness and market developments. Power Responsive has played a significant role in transitioning demand side flexibility and the provision of balancing services into becoming a mainstream proposition.

In recent years, a number of new forums and programmes have appeared which have focused wholly or partially on demand side providers; Distribution Network Operators (DNOs) are now starting to procure demand side flexibility directly to manage issues on their own networks, and there are a number of local energy market platforms being developed to trade or sell flexibility across distribution and transmission.

In this landscape, it is challenging for DSF providers to fully engage with all developments, and it is also challenging for policy-makers to ensure that they are listening to and taking on board the views of the demand side flexibility community. Power Responsive brings customers and industry parties together with policy-makers and regulators on a regular basis to discuss issues that cut across multiple areas of DSF.

How to get involved

National Grid ESO believes the best way to shape and share the possibilities created by demand side solutions is for as many stakeholders as possible to be part of the discussion.

There are a number of ways in which you can stay involved with Power Responsive:

- **Mailing List** – You can register to receive updates and read the latest industry developments on the Power Responsive website – www.powerresponsive.com
- **Working Group** – Attend the Flexibility Forum that provides a platform from which to hear & discuss the latest industry updates, ask the questions you need answers to, and feed back your thoughts, concerns, and ideas to industry parties.
- **LinkedIn Group** – You can join our LinkedIn Group to post questions, thoughts, and discussions with peers.
- **Email** – email powerresponsive@nationalgrid.com

Businesses that are interested in participating in demand side flexibility services should visit National Grid ESO's Balancing Services webpages or contact the National Grid ESO Business & Revenue team via the details below:

URL – <https://www.nationalgrideso.com/industry-information/balancing-services>

Email – commercial.operation@nationalgrideso.com

Telephone – +44 (0)1926 654611

Appendix II

Commercial aggregation service providers

As described in Chapter 4, energy users can choose to enter the demand side market by working with Demand Aggregators, Suppliers or other Third Parties.

Below is a list of organisations, although not exhaustive, that may be able to offer commercial aggregation services to providers.

Company	Telephone	E-Mail
Actility	0032 472 89 73 25	www.actility.com/contact/
Ameresco Limited	07814 618737	enquiries@ameresco.com
EDF Energy	07713 860663	DemandSideResponse@edfenergy.com
Endeco Technologies	01923 431 638	service@endeco-technologies.com
Energy Pool/Schneider Electric	07880 207431	contact.uk@energy-pool.eu
EnerNOC UK Ltd	020 71 83 23 87	www.enernoc.com/contact-sales
E.ON Connecting Energies	0800 066 5814	solutionsalesupport@eonenergy.com
Flexitricity	01312 218102	www.flexitricity.com/en-gb/contact/
Engie (previously GDF SUEZ)	01133 062100	home.engie.co.uk/contact-us/
KiWi Power Ltd	08455 194054	info@kiwipowered.com
Limejump Ltd	02071 275308	info@limejump.com
Npower Ltd	07989 481144	www.npower.com/business/
Open Energi	07939 462000	http://www.openenergi.com/contact-us/
Origami Energy Limited	07884 650816	origamienergy.com/contact/
Pearlstone Energy Limited	07843 452811	http://www.pearlstoneenergy.com/contact-us/
Reactive Technologies	07771 706457	www.reactive-technologies.com/about/
REstore	07890 266261	www.restore.eu/en/about-us/contact
Stor Generation Ltd	02031 792100	AFerro@questjfminvestments.com
UK Power Reserve Ltd	01217 121975	ukpowerreserve.com/contact/
Upside Energy Ltd	07546 519518	upsideenergy.co.uk/contact/

Legal notice

National Grid ESO makes no warranty as to the performance of any of the aggregators listed here. Your dealings with any aggregator or third party, through the website, and any terms, conditions, warranties or representations with such aggregators, are solely between you and such aggregators.

National Grid ESO makes no recommendations whatsoever to you or any third party as to the aggregators listed. The list of aggregators contained here is not to be treated as being exhaustive in any way.

If you have any queries on the above list please contact:
commercial.operations@nationalgrid.com

Appendix III

Flex assure – compliance scheme for DSR aggregators

Flex Assure, a voluntary code of conduct and compliance scheme, sets standards for demand side response (DSR) aggregators, providing assurance to business customers using their services. Aggregators who have achieved Flex Assure membership are committed to abiding by the industry-leading standards defined in the Code of Conduct.

The Code of Conduct, developed by the ADE and supported by Government, the Major Energy Users Council and Make UK, sets standards around sales and marketing, proposals, contracts and complaints. Visit the Flex Assure website (www.flexassure.org) for further information.

Flex Assure membership is open to all aggregators and licensed suppliers offering DSR services to business customers. Up-to-date information of aggregators signed up to the Flex Assure Scheme can be found on the scheme website and on National Grid ESO's list of DSR aggregators¹⁸.

Background

In a rapidly-changing and growing market for flexible energy services, the mission of Flex Assure is to facilitate trust in the sector by setting minimum standards and promoting industry best practice.

While a rapidly growing market, demand side response (DSR) is not new. Long before current energy management technologies were available, utilities and large commercial and industrial consumers were working together to reduce demand at times of energy system peak demand and help balance the network.

Today's DSR market is seeing an increasing number of new market entrants who are developing the technologies, aggregation models, and products that serve a wider number of customers.

As energy is not their primary business, commercial and industrial sites that want to take advantage of these savings can choose to rely on DSR Aggregators, who specialise in coordinating or aggregating demand response from individual consumers to better deliver power system services. Aggregators have technical and policy expertise which can help sites fully capture the benefits of DSR, providing a route to market for those businesses which do not want to invest time and capital into energy specialisation.

With many energy users new to demand response, it is important they feel confident about the service they will receive from these aggregators. Trust in how aggregators communicate with, and deliver solutions, to customers is essential.

To achieve this trust, customers need to have a common set of standards by which to compare aggregators and their claims. With a growing marketplace and increasing numbers of new entrants, it is equally important that customers are able to quickly understand which providers meet those standards. The ADE DSR Code of Conduct is designed to achieve those standards and enable customers to trust the DSR Aggregator sector.

Building assurance in the market

The DSR Code of Conduct provides this assurance through a voluntary scheme where aggregators commit to working with customers in an honest and transparent manner, while providing evidence of service benefits and fair contracts.

The DSR Code of Conduct is open to all aggregators and licensed suppliers who facilitate energy users' participation in different energy markets, including the Capacity Market and Balancing Services.

18. Commercial Aggregators – <https://www.nationalgrideso.com/industry-information/balancing-services>

Appendix III

Flex assure – compliance scheme for DSR aggregators

Creating a baseline standard for sales methodology and customer service practices ultimately serves all DSR aggregators and helps market forces decide which services and technologies best fit different customers.

The Code currently applies to commercial, industrial and public sector energy users only, as the household DSR market remains embryonic. The Association for Decentralised Energy (ADE) is monitoring development of the domestic DSR market and may consider the creation of a separate domestic DSR Code of Conduct under the umbrella of Flex Assure, if the Board of Directors and Scheme Committee consider it appropriate. It is possible, however, that other actors may be better placed for providing assurance in the domestic flexibility market.

The Code aims to deliver the following outcomes across the specific areas in the market, including:

- **Sales and marketing**

A relationship between aggregators and customers must be initiated in an honest and technically proficient manner. Accordingly, sales materials must be accurate, and sales representatives must behave with honesty and integrity.

The Code requires sales staff to be properly trained to communicate technicalities to customers and provide honest data to back up product claims. Additionally, staff must behave in a manner that does not deceive, pressure, or harass potential customers. To assure that these rules are followed, aggregators must keep records of customer communications.

These minimum requirements help ensure that sales materials and representatives enable customers to make decisions based on accurate information, thereby driving high performance throughout the industry.

- **Technical due diligence and site visit**

Cybercrime is a significant threat to the security of the electricity grid and energy supply. The Code ensures that best practices to protect electronic data and assets are considered as systems are implemented. Similarly, protection of customer data is one of the most important aspects of a business-to-business relationship. Code members must strictly adhere to rules and regulations relevant to the handling and protection of customer data.

Additionally, the Code sets standards to help members prevent electronic invasion or theft of data, as well as procedures to react and strengthen systems in the event of a cyberattack. These standards ensure that members are able to plan ahead of, and react to, the rapidly changing needs of cybersecurity.

Equally important, the Code requires that member installations are built to ensure protection of their employees and liability coverage is provided in the unlikely event of an accident.

- **Proposals and contracts**

The marketing period leading up to final agreement is a critical time for customers to weigh the benefits and value of proposals. Accordingly, the Code places emphasis on the development of tenders that are fair and accurate and do not deceive customers into signing up for services that they do not want or need.

The Code, therefore, requires that all relevant benefits are clearly laid out, any fees are clear and thoroughly explained and the requirements of operating within various Government schemes are clearly presented to customers.

Once this data is processed, a contract must be presented that clearly states its terms

Appendix III

Flex assure – compliance scheme for DSR aggregators

and makes the customer aware of their risks, liabilities, and obligations. This ensures that aggregators and customers enter into agreements that are mutually beneficial.

- **Complaints**

Finally, Flex Assure members are required to provide customers with continued support after a contract has been agreed to. While Flex Assure does not include any dispute resolution mechanism, it requires members to have appropriate complaints and dispute resolution mechanisms in place and to clearly inform their customers of these.

Flex Assure includes a complaints mechanism, by which an eligible customer can raise a complaint against a scheme member, if they believe said scheme member has breached the Code of Conduct. If the complaint is upheld by the scheme committee, and a compliance panel finds the scheme member to be non-compliant, the scheme member's membership status will be revised.

Continued adherence to the standards of the Code helps to ensure that it remains a foundational part of members' customer business operations.

Development of the code and compliance scheme

The Association for Decentralised Energy (ADE) developed the Flex Assure Code of Conduct in recognition of a need for standards of practice in a rapidly growing flexibility market.

Development of the Code of Conduct commenced in 2016 through a steering committee made up of aggregators, suppliers, and industrial customers and their representatives, including representatives from the Major Energy Users Council and National Grid ESO Power Responsive. Ofgem and BEIS attended steering committee meetings as observers. Following consultation of the Code text, all responses were considered by the steering committee and the Code text revised as appropriate. The Code of Conduct was published in November 2018.

Recognising the importance of enforcement to provide customer assurance that an aggregator or supplier is meeting the Code standards when they are advertised as a member of the Code, the Flex Assure compliance scheme was set up to enforce the Code of Conduct. The Flex Assure compliance scheme was launched by the ADE in May 2019.

For more information and contact details for the Code of Conduct can be found on the on the Flex Assure website¹⁹.

19. ADE Code of Conduct website – <https://www.flexassure.org/dsr/>

Appendix IV Distribution network charges

In Chapter 2 we showed how significantly delivery charges varied across the day and week as levied by the Distribution Network Operators. Here is the full list of DNO areas with their 2020/21 charges. A map of the DNO areas is shown in Figure 2.3.

Electricity North West

Time bands for half hourly metered properties			
Time periods	Red time band	Amber time band	Green time band
Monday to Friday (including bank holidays) all year	16:00 – 19:00	09:00 – 16:00 19:00 – 20:30	00:00 – 09:00 20:30 – 24:00
Saturday and Sunday all year		16:00 – 19:00	00:00 – 16:00 19:00 – 24:00
LV HH metered	7,432	1,500	0,607
LV Sub HH metered	5,924	1,218	0,572
HV HH metered	4,219	0,914	0,534

SP Energy Networks (Scottish Power Distribution plc & MANWEB plc)

Time bands for half hourly metered properties			
Time periods	Red time band	Amber time band	Green time band
Monday to Friday (including bank holidays) all year	16:30 – 19:30	08:00 – 16:30 19:30 – 22:30	00:00 – 08:00 22:30 – 00:00
Saturday and Sunday all year		16:00 – 20:00	00:00 – 16:00 20:00 – 00:00
LV HH metered	7,457	1,902	1,301
LV Sub HH metered	5,054	1,618	1,289
HV HH metered	3,952	1,503	1,285

Northern Powergrid (North East)

Time bands for half hourly metered properties			
Time periods	Red time band	Amber time band	Green time band
Monday to Friday (including bank holidays) all year	16:00 – 19:30	08:00 – 16:00 19:30 – 22:00	00:00 – 08:00 22:00 – 24:00
Saturday and Sunday all year			00:00 – 24:00
LV HH metered	5,254	1,575	1,093
LV Sub HH metered	4,323	1,435	1,088
HV HH metered	3,539	1,325	1,083

Appendix IV Distribution network charges

Northern Powergrid (Yorkshire)

Time bands for half hourly metered properties			
Time periods	Red time band	Amber time band	Green time band
Monday to Friday (including bank holidays) all year	16:00 – 19:30	08:00 – 16:00 19:30 – 22:00	00:00 – 08:00 22:00 – 24:00
Saturday and Sunday all year			00:00 – 24:00
LV HH metered	4.197	1.565	1.006
LV Sub HH metered	3.533	1.405	0.990
HV HH metered	2.840	1.247	0.975

Scottish and Southern Energy (Scottish Hydro Power Distribution)

Time bands for half hourly metered properties			
Time periods	Red time band	Amber time band	Green time band
Monday to Friday (including bank holidays) all year	16:30 – 19:30	08:00 – 16:30 19:30 – 22:30	00:00 – 08:00 22:30 – 24:00
Saturday and Sunday all year		16:00 – 20:00	00:00 – 16:00 20:00 – 24:00
LV HH metered	7.457	1.902	1.301
LV Sub HH metered	5.054	1.618	1.289
HV HH metered	3.952	1.503	1.285

Scottish and Southern Energy (Southern Electric Power Distribution)

Time bands for half hourly metered properties			
Time periods	Red time band	Amber time band	Green time band
Monday to Friday (including bank holidays) all year	16:30 – 19:30	08:00 – 16:30 19:30 – 22:00	00:00 – 07:00 22:00 – 24:00
Saturday and Sunday all year		09:30 – 21:30	00:00 – 09:30 21:30 – 24:00
LV HH metered	6.270	0.866	0.365
LV Sub HH metered	4.864	0.605	0.347
HV HH metered	3.544	0.498	0.342

Appendix IV Distribution network charges

UKPN (London Power Networks)

Time bands for half hourly metered properties			
Time periods	Red time band	Amber time band	Green time band
Monday to Friday (including bank holidays) all year	11:00 – 14:00 16:00 – 19:00	07:00 – 11:00 14:00 – 16:00 19:00 – 23:00	00:00 – 07:00 23:00 – 24:00
Saturday and Sunday all year			00:00 – 24:00
LV HH metered	4.799	0.189	0.000
LV Sub HH metered	3.098	0.000	0.000
HV HH metered	2.402	0.000	0.000

UKPN (South Eastern Power Network)

Time bands for half hourly metered properties			
Time periods	Red time band	Amber time band	Green time band
Monday to Friday (including bank holidays) all year	16:00 – 19:00	07:00 – 16:00 19:00 – 23:00	00:00 – 07:00 23:00 – 24:00
Saturday and Sunday all year			00:00 – 24:00
LV HH metered	9.080	0.739	0.478
LV Sub HH metered	5.281	0.581	0.455
HV HH metered	5.363	0.570	0.452

UKPN (Eastern Power Network)

Time bands for half hourly metered properties			
Time periods	Red time band	Amber time band	Green time band
Monday to Friday (Including Bank Holidays) all year	16:00 – 19:00	07:00 – 16:00 19:00 – 23:00	00:00 – 07:00 23:00 – 24:00
Saturday and Sunday all year			00:00 – 24:00
LV HH metered	9.800	0.314	0.110
LV Sub HH metered	7.104	0.215	0.096
HV HH metered	5.765	0.174	0.090

Appendix IV Distribution network charges

Western Power Networks (East Midlands)

Time bands for half hourly metered properties			
Time periods	Red time band	Amber time band	Green time band
Monday to Friday (Including Bank Holidays) all year	16:00 – 19:00	07:30 – 16:00 19:00 – 21:00	00:00 – 07:30 21:00 – 24:00
Saturday and Sunday all year			00:00 – 24:00
LV HH metered	5.719	1.310	0.813
LV Sub HH metered	4.321	1.217	0.800
HV HH metered	2.908	0.955	0.789

Western Power Networks (West Midlands)

Time bands for half hourly metered properties			
Time periods	Red time band	Amber time band	Green time band
Monday to Friday (Including Bank Holidays) all year	16:00 – 19:00	07:30 – 16:00 19:00 – 21:00	00:00 – 07:30 21:00 – 24:00
Saturday and Sunday all year			00:00 – 24:00
LV HH metered	5.711	1.433	0.978
LV Sub HH metered	4.085	1.290	0.949
HV HH metered	2.418	1.102	0.932

Western Power Network (South Wales)

Time bands for half hourly metered properties			
Time periods	Red time band	Amber time band	Green time band
Monday to Friday (Including Bank Holidays) all year	16:00 – 19:30	07:30 – 17:00 19:30 – 22:00	00:00 – 07:30 22:00 – 24:00
Saturday and Sunday all year		12:00 to 13:00 16:00 to 21:00	00:00 to 12:00 13:00 to 16:00 21:00 to 24:00
LV HH metered	8.079	1.774	1.427
LV Sub HH metered	6.206	1.617	1.400
HV HH metered	5.099	1.526	1.373

Appendix IV Distribution network charges

Western Power Network (South West)

Time bands for half hourly metered properties			
Time periods	Red time band	Amber time band	Green time band
Monday to Friday (including bank holidays) all year	17:00 – 19:00	07:30 – 17:00 19:00 – 21:30	00:00 – 07:30 21:30 – 24:00
Saturday and Sunday all year		16:30 – 19:30	00:00 – 16:30 19:30 – 24:00
LV HH metered	9,219	1,650	1,381
LV Sub HH metered	7,475	1,544	1,360
HV HH metered	5,968	1,452	1,345

Full 2020/21 tables for each Distribution Network Operator can be found at:

Electricity North West – <https://www.enwl.co.uk/about-us/regulatory-information/use-of-system-charges/current-charging-information/>

SP Energy Networks (SPD plc & MANWEB plc) – http://www.scottishpower.com/pages/connections_use_of_system_and_metering_services.aspx

Northern Powergrid (NE& Yorkshire) – <https://www.northernpowergrid.com/document-library/charges/charges-use-of-system-charges-2020-21>

Scottish and Southern Energy (SHPD & SEPD) – <https://www.ssepd.co.uk/Library/ChargingStatements/>

UKPN (LPN & EPN & SEPN) – <https://www.ukpowernetworks.co.uk/internet/en/about-us/duos/>

Western Power Distribution – <http://www.westernpower.co.uk/About-us/Our-system/Use-of-System-Charges.aspx>

About the author



Eddie Proffitt

Eddie Proffitt is Technical Director of the Major Energy Users' Council, an independent body representing leading companies in the industrial, commercial, retail and public sectors of the market, for whom energy is a major cost. The electricity consumption of MEUC members is over 25% of the UK's non-domestic total demand.

Eddie had a career in industry mainly with Pilkington Glass where he spent over 30 years. His roles with them were varied before ending as their Head of Procurement for their 60 sites in the UK, where energy was a crucial factor.

In addition to his industrial background Eddie has also served as a non-executive director of an NHS Trust, where as Chair of the Audit committee he had first-hand knowledge of the impact of energy costs on the public sector.