Profiting from Demand Side Response

Eddie Proffitt

The Major Energy Users’ Council in association with National Grid
Profiting from Demand Side Response
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Director of UK System Operator, National Grid

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Foreword

Cordi O’Hara
Director of UK System Operator
National Grid

Welcome to this guide that aims to provide MEUC members and large demand users with all the information they need to profit from opportunities in Demand Side Response (DSR).

As electricity System Operator, National Grid is responsible for the minute-by-minute, second-by-second balancing of the supply and demand of electricity. This gives us a unique perspective of how the electricity systems that power our world are changing.

It’s a rapidly changing landscape, with more and more renewables coming on line, and advances in technology meaning we’re reducing our reliance on traditional power stations.

While these powerful winds of change create new challenges for National Grid and the broader industry, they also present exciting opportunities for large commercial and industrial energy users.

Critical Crossroads

As we stand at a critical crossroads, National Grid believes that DSR has a vital role to play. But we need it to grow.

There are already a number of ways businesses can get involved in DSR and earn revenue simply by using energy more intelligently and flexibly.

There does remain a relatively low level of participation across our services. It’s imperative this grows, so that National Grid continues to have all the tools it needs to balance the system economically and efficiently.

The key to growing any service is properly selling its benefits, removing barriers to participation and making sure we have the right customer-led products that compel businesses to participate.

That’s why we launched a campaign called Power Responsive, which aims to deliver these goals and drive rapid growth in DSR in the UK by 2020.
Foreword

Teaming Up to Grow the Market

We don’t have all the answers about how we grow DSR to scale and the Power Responsive campaign is about addressing this collaboratively. It brings businesses, suppliers, policy makers and other stakeholders together to address barriers, maximise opportunities and shape the growth of the market.

Our focus is firmly on large industrial and commercial consumers, because they’re the group that uses two thirds of the electricity on our networks. We believe that we can achieve a natural growth to scale if we can normalise the use of DSR with these businesses.

But we’ll only achieve that if we continue to drive home the benefits of DSR – namely, earning revenue that offsets your overall energy bills and reducing your carbon footprint by supporting a market that enables greater penetration of renewable generation sources.

Businesses Are Already Benefiting

Many businesses, including Sainsbury’s, United Utilities and Transport for London, are already benefiting from demand side opportunities, but we need more large businesses to join us on our journey into tomorrow’s world, where DSR will play a much bigger role in balancing the system.

This guide is your handbook for taking the right steps towards reaping the benefits of DSR. We hope it gives your business the information and motivation to participate in our existing services – and to be a part of the debate that shapes a cleaner, safer and more affordable energy system for the future.
Making Money and Avoiding Penalty Charges

Why the Demand Side Is Becoming More Important
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Rarely does a review of the energy scene start with the proposition that business customers have increasing opportunity to benefit financially from their power charges without significant expenditure. Looking carefully at when electricity is used and adjusting demand to the large variations in delivered prices which occur over the day and over the week is now bringing welcome relief to many organisations’ energy costs. You could also be paid if you have your own generation and can make it available when needed to help keep the lights on.

Demand Side Response (DSR) is the generic title given to a range of options customers have to reduce their electricity costs by changing their pattern of consumption. Of course the cheapest unit of energy is the one you no longer need to use and improving energy efficiency lies at the heart of the matter. But you can also make substantial cost savings by moving consumption away from high priced times and even be paid to use it when supply onto the system is higher than demand.

Electricity cannot be stored economically, so at any moment in time, electricity demand and supply must be equal. Every second of every minute of every hour, National Grid must maintain this vital balance; too much electricity, and equipment could fail, too little, and there is a risk of blackouts.

Demand response technologies help National Grid to manage the peaks and troughs in electricity demand and supply – for example when everyone turns their kettles on at the end of a popular television programme or when a power station fails. If you can help by turning down or providing additional power to the grid you will be rewarded by lower bills and may even receive payments from National Grid.

**Figure 1.1: Balancing Electricity Supply and Demand**

- National Grid has a statutory mandate to keep power balanced between 49.50 – 50.50 Hz
- Power supply would fail without grid balancing services
Making Money and Avoiding Penalty Charges

Why the Demand Side Is Becoming More Important

The challenge to maintain the national network in balance and keep the lights on has been changing fundamentally in recent years. Not so long ago National Grid had a hierarchy of large generation plants they could call upon or stand down as national demand rose and fell. Only the nuclear stations and very large coal-fired plant were deemed to “must run” as the cost and disruption caused by turning them off would prove prohibitive.

Today the situation is very different. Increasing contributions from the renewables sectors, notably from wind and solar, are both unpredictable and fragmented, spread out across the country. To maximise carbon savings National Grid needs to make the most of clean sources like these but must also take compensatory actions when they are not available. Expensive stand-by plant has to be called upon when the wind doesn’t blow or the sun doesn’t shine. Additional power must be either taken onto the grid or demand reduced. Large users in industry are increasingly being encouraged to “turn down” and delay their demand until such time as available capacity improves.

The rigours of the market have also played their part. Before privatisation the CEGB, the nationalised generating business, could keep a substantial reserve in hand to meet fluctuating demand and cover contingencies. The comfort zone or “planning margin” between available capacity and maximum system demand has evaporated since then from around 20 per cent to a little over one per cent today.

Against this unwelcome background National Grid needs all its tools in its tool box to keep the lights on. It is the benefits awaiting your organisation from demand turn down and supplementary generation that this book addresses but let’s look first at some basic principles of the power market.

Why Power Prices Fluctuate

Generators have traditionally faced two main drivers for their operating costs. Obviously the cost of the fuels they use has a direct effect as has the conversion efficiency of the power plant. The frequency generating stations are called on to run, known as the load factor, is also key to the unit cost of output. Clearly a plant running 24/7 at base load should deliver power at a much lower unit rate than power from peaking plant which may run for just a few hours a year when demand is at its highest. As the system operator calls on more expensive plant to meet increasing demand so the unit cost of the power delivered into the system rises.
Today, modern electricity systems are evolving towards a generation mix that is more reliant on wind and solar to meet environmental targets. While renewable energy sources support these targets they also tend to be decentralised, less predictable and less flexible, while some are not available (solar PV) to meet the winter peak demand. This increases the requirement for demand side balancing services, known as Demand Side Response (DSR). These services help the system operator, National Grid, to balance supply and demand at times of system stress, vital to maintaining the UK’s power supplies.

**Figure 1.2: The Changing Face of Power Supply**

Until recently the electricity industry followed a rigid path from generating source to customer

Today the challenge is far more complex and demanding

Source: Open Energi
Fortunately DSR technologies have become increasingly feasible due to the integration of information and communications technology and the power system, resulting in a new term: Smart Grids. The grids of the future will not only deliver power as instructed but help balance the system by automatically switching customers on and off and drawing supply back from them. Bi-directional smart grids enable energy export and import to create the demand side balancing market.

Other influences on power prices include plant outages caused by unexpected plant failures and planned maintenance, fluctuations in generating fuel costs notably for gas and coal, and the availability and contributions made from intermittent renewable sources. High wind output at times of low demand in the early hours has even led to negative pricing and DSR can also work to encourage customers to use power at these times as well as to reduce consumption during peak periods.

The situation has become more complicated recently although these basic principles still hold. To boost confidence in bringing forward the scale of funds necessary for new generating plant, investors are now insulated from fluctuating and uncertain market prices by gaining guaranteed prices from a government agency which will either top up payments when prices are low or receive back money when prices are high. These arrangements work around an agreed strike price and are referred to as contracts for difference (CFDs). Likewise customers can insulate themselves by taking hedged prices for days, months and seasons ahead.
What the Future Holds

Replacing the command and control of a nationalised power industry with a market made up of a multitude of privately owned generators and suppliers, all with their own plans and aspirations, makes forecasting the future much harder. Add in Electricity Market Reform (EMR), the recent reshaping of the market to take us to a low carbon future, the growing impact of environmental legislation, increasing uptake in energy efficiency together with our changing economic prospects and you can see the heady mix of uncertainties which need to be addressed to arrive at a sensible assessment of the future energy landscape.

Figure 1.4: Fluctuating Demand across the Day is a Key Driver to Wholesale Prices

Increasing demands from homes coincides with high business use between 16:00 and 18:30

Peak demand times in the winter require the most costly plants to operate

As system operator, National Grid maintains a rolling annual programme to show the way to government, the energy suppliers and other stakeholders. To do this National Grid has established four main Future Energy Scenarios. These represent transparent, holistic paths through this uncertain landscape. The scenarios are not forecasts, they are predictions of the future that seek to discover plausible and credible conclusions. They also enable National Grid to identify strategic gas and electricity network investment requirements for the future.
Making Money and Avoiding Penalty Charges

The scenarios are based on varying importance given to the three objectives within the “energy trilemma” namely security of supply, affordability and sustainability. The government has set a standard for electricity security of supply and through Electricity Market Reform put in place the framework to deliver to this standard. The scenarios flex the two variables of prosperity and green ambition.

No one can be certain how the energy future will evolve and this uncertainty is likely to remain with us for the foreseeable future. National Grid’s Future Energy Scenarios (FES) represent transparent, holistic paths through that uncertain landscape to help Government, National Grid’s customers and other stakeholders make informed decisions. The four scenarios in the report are based on:

- **Consumer Power**: A world of relative wealth, fast-paced R&D and consumer spending. Innovation is focused on meeting the needs of consumers who are focused on improving their quality of life.

- **Gone Green**: A world where green ambition is not restrained by financial limitations. New technologies are introduced and embraced, enabling all carbon and renewable targets to be met.

- **No Progression**: A world focused on achieving security of supply at the lowest possible cost. Low economic growth and little innovation means traditional sources of gas and electricity dominate.

- **Slow Progression**: A world where slower economic growth restricts market conditions. Available money is spent focusing on low-cost long-term solutions to achieve environmental targets, albeit later than the target dates.

How Customers Can Benefit from Demand Side Response

To benefit financially you need to start by gaining a working knowledge of where, when and why your organisation draws power from the public supply system. You also need to identify the capacity and availability in practice of any on-site generating plant.

If you have half hourly (HH) metering installed your supplier can provide you with a print out over the day, week and billing period of how the demand changes from half hour to half hour. This load profile is valuable in determining your overall load shape and sub meters can then break this down to specific processes and requirements if a greater level of detail is required to understand requirements better.
Table 1.5: National Grid’s Future Energy Scenarios

The assumptions adopted for the four scenarios are updated annually.

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Economic</th>
<th>Political</th>
<th>Technological</th>
<th>Social</th>
<th>Environmental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer Power</td>
<td>moderate growth</td>
<td>government policies focus on indigenous security of supply and carbon reduction</td>
<td>high innovation focused on market and consumer needs, high levels of local generation and a mixture of generation types at national level</td>
<td>consumerism and quality of life drives behaviour and desire for 'going green', not a conscious decision</td>
<td>long-term UK carbon and renewable ambition becomes more relaxed</td>
</tr>
<tr>
<td>Gone Green</td>
<td>moderate growth</td>
<td>European harmonisation and long-term environmental energy policy certainty</td>
<td>renewable and low carbon generation high, increased focus on green innovation</td>
<td>society actively engaged in 'going green'</td>
<td>new policy intervention ensuring all carbon and renewable targets are achieved</td>
</tr>
<tr>
<td>No Progression</td>
<td>slower growth</td>
<td>inconsistent political statements and lack of focus on environmental energy policies</td>
<td>little innovation occurs in the energy sector with gas as the preferred choice for generation over low carbon</td>
<td>society is cost conscious and focused on the here and now</td>
<td>new policy interventions constrained by affordability</td>
</tr>
<tr>
<td>Slow Progression</td>
<td>slower growth</td>
<td>European harmonisation, focus on low cost environmental energy policies</td>
<td>medium levels of innovation lead to a focus on a mixture of renewable and low carbon technologies</td>
<td>society is engaged in 'going green', but choices are limited by cost</td>
<td></td>
</tr>
<tr>
<td>Green Ambition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Future Power Demand for Each Scenario

DSR Required for Each Scenario

- Historic
- Gone Green
- No Progression
- Consumer Power
- Slow Progression
- Consumer Power and Slow Progression
Overlaying this information with pricing data will then show you when it will be beneficial to turn down and delay consumption to lower cost times. It is important in this exercise to remember that the price you pay for your power is made up of more than the wholesale market price and that delivery charges can have a major impact on the bill.

Delivery charges come from two sources: National Grid for transmission taking power from the generating stations across the country to regional distribution centres where ownership and charging transfers to the Local Distribution Company at grid supply points. With a few exceptions of very large industrial sites, it is the distribution company which delivers onto your site.

Both transmission and distribution charges acknowledge the costs of providing and maintaining the maximum capacity in the wires necessary to meet national demand at peak times and their tariff pricing structures are based on this principle. We will look in more detail on how these charges are calculated in the next chapter. Suffice it so say that major savings in business power bills can be achieved by moving consumption away from peak times.

National Grid also looks to larger customers to keep the system in balance in three generic ways:

a. By providing frequency response, reducing demand within 30 seconds
b. By providing reserve, reducing demand within up to 20 minutes response time, and
c. By providing contingency capacity which can be called on to supplement grid supplies.

We will see in Chapter 3 that if you can assist, National Grid has a number of tailored products which in broad terms appeal to customers who (a) can automatically trigger demand reductions instantaneously, (b) can provide a more measured response within a period up to 20 minutes, or (c) make available supplies to National Grid from on-site generation plant when the national grid is under pressure.

Knowing your consumption profile and the ability to be flexible will also pay dividends when you come to negotiating your power supply contract. Suppliers are keen to limit their risk and will prefer to contract with clued up customers prepared to manage their consumption accordingly, rather than take on those whose consumption may turn out to be very different from what was expected at the onset of the contract.

**National Grid’s Power Responsive Initiative**

In June 2015, National Grid launched the Power Responsive campaign to promote the delivery of Demand Side Response (DSR) in GB electricity markets and reduce barriers to participation, particularly for industrial
Making Money and Avoiding Penalty Charges

and commercial (I&C) customers. The launch attracted a wide range of stakeholders, exploring opportunities and challenges for scaling up DSR delivery, and identifying the critical areas where further work is needed.

National Grid has begun to work collaboratively with stakeholders across the energy and I&C sectors to take this work forward by establishing a high-level group to drive and steer progress. The MEUC is represented on this steering group along with a number of members and our approach is that this should be seen not as an industry problem to be addressed but more as a consumer opportunity.

The purpose of the steering group is to promote Demand Side Response activity and flexibility in GB electricity markets; ensuring coordinated delivery of objectives to achieving increased scale by 2020. The group will respond to the challenge: “What will it take to achieve demand-side participation at scale in the GB electricity markets by 2020?” It will focus on:

• **A Coordinated Approach:** Working in a coordinated way to consider the scale of DSR activity potentially deliverable by 2020 UK markets and where feasible, identifying some deliverable goals;

• **Customer Outreach:** Raising awareness and understanding of the opportunities for DSR with market actors and customers (particularly I&C, but at a later stage possibly SME and domestic);

• **Customer-Led Products:** Making it easier to participate in DSR in GB markets; how to ensure the demand-side can compete on equal terms with the supply-side – covering schemes and market arrangements today as well as future requirements and long-term investability. Being open to making changes to schemes and products;

• **Certainty and Stability for the Demand-side:** Ensuring the environment and markets offer the right level of certainty for DSR to be a long-term viable proposition for customers. The group will have a primary focus on awareness raising and problem solving for existing and future balancing schemes, but will also cover awareness and coordinate input where appropriate to other schemes outside of balancing.

The campaign is described in more detail in Appendix I.
Reducing Delivery and Contract Charges

Transmission Charges
Distribution Charges
Getting Better Contract Prices
Reducing Delivery and Contract Charges

Maintaining sufficient capacity to meet peak demand is the guiding principle behind the charges levied by the national and regional network operators. Investment programmes are geared to replacing ageing assets and increasing capacity in areas where demand is rising.

National Grid and the distribution companies construct their charging frameworks to discourage larger customers from using power at peak times and in the case of the distribution companies encourage consumption at off-peak times.

There are clear gains for the network operators and suppliers alike if the peak on the system can be restrained and increased use made at off-peak times.

Transmission Charges

Transmission Network Use of System charges (TNUoS) to give them their full name cover the cost of maintaining the high voltage power lines and systems which transport electricity from power stations to the local distribution networks. They total about £2 billion per year and make up about six per cent of a typical electricity bill for a larger industrial or commercial customer.

The charges are recovered for half-hourly metered consumers using the "triad system". This takes the average of their recorded consumption during the three peak half-hours on the system with the proviso that there must be at least ten days between each peak. These peaks occur between November and February and typically between 4:00pm and 7:00pm.

This consumption figure is applied to zonal charges depending on location. Zonal charges vary with the highest in the south and south west and the cheapest in Scotland and the north reflecting the distribution of generating capacity and the distance the power must travel down the national high voltage network. Non half-hourly metered customers are charged on the same principle using estimated consumption data. Charges are calculated on the basis of £ per kW demand or pence per unit (kWh).

Half hourly metered customers can therefore reduce their annual transmission charges by reducing their consumption when a peak demand half-hour or triad is expected. Suppliers assist in this process by contacting their customers when they think one is coming.

Reducing Delivery and Contract Charges

Figure 2.1: National Grid’s Transmission Charging Zones and Rates
Demand Use of System Tariff Zones
## Reducing Delivery and Contract Charges

### Transmission zone charges 2015/16 actual

<table>
<thead>
<tr>
<th>Demand Zone</th>
<th>Zone Area</th>
<th>Demand Tariff (£/kW)</th>
<th>Energy Consumption Tariff (p/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Northern Scotland</td>
<td>23.469195</td>
<td>3.388532</td>
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<tr>
<td>2</td>
<td>Southern Scotland</td>
<td>26.789320</td>
<td>3.559740</td>
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<tr>
<td>3</td>
<td>Northern</td>
<td>32.617844</td>
<td>4.283661</td>
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<tr>
<td>4</td>
<td>North West</td>
<td>35.683316</td>
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<td>5</td>
<td>Yorkshire</td>
<td>36.287690</td>
<td>5.185476</td>
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<tr>
<td>6</td>
<td>N Wales &amp; Mersey</td>
<td>35.620770</td>
<td>5.679363</td>
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<td>7</td>
<td>East Midlands</td>
<td>39.066214</td>
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<td>8</td>
<td>Midlands</td>
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<td>South Wales</td>
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<td>South East</td>
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<td>14</td>
<td>South Western</td>
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### Transmission zone charges 2016/17 (January 2016)

<table>
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<tr>
<th>Zone</th>
<th>Zone Name</th>
<th>HH Demand Tariff (£/kW)</th>
<th>NHH Demand Tariff (p/kWh)</th>
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<tr>
<td>1</td>
<td>Northern Scotland</td>
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<td>2</td>
<td>Southern Scotland</td>
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<td>Northern</td>
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<td>North West</td>
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<td>Yorkshire</td>
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<td>N Wales &amp; Mersey</td>
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<td>East Midlands</td>
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<td>London</td>
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<td>Southern</td>
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<td>14</td>
<td>South Western</td>
<td>48.580421</td>
<td>6.877890</td>
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</tbody>
</table>
Reducing Delivery and Contract Charges

**Distribution Charges**

Distribution Use of System Charges (DUoS) cover the costs to run and maintain a safe and reliable system from the exit points of the transmission network to businesses, homes and other end customers. Distribution charges account for about £5.5 billion per year and typically make up about 16 per cent of a business electricity bill. They are therefore more significant in cost terms to the transmission charge.

The electricity infrastructure includes overhead lines, underground cables, as well as substations and transformers. These networks are owned and operated by the Distribution Network Operators (DNOs).

There are 14 distribution zones which mirror the Area Boards previously administered when a nationalised industry. Today they are owned by six privately owned businesses as shown in Figure 2.3.

DNO’s tend to have a monopoly over electricity distribution in their area, so they are subject to strict price control regulations. These price controls are administered and reviewed by the energy industry regulator, Ofgem. Price controls are reviewed and set for eight year periods. These reviews determine how much distribution network operators can invest in their networks, and how much income they can collect from distribution charges over the period.

Unlike transmission charges, DUoS charges are based on published tariffs with prices graduated across three time bands from red peak through amber standard to green off-peak. The time periods and published rates for one of the DNO’s show that units of electricity delivered between 16:00 and 19:00 hours Monday to Friday costs five times as much to deliver through the distribution system as the wholesale price of the electricity.

With the ratio of red to amber at 57/1 and the ratio of red to green at 159/1 for this DNO it is abundantly obvious that significant savings can be achieved by reducing consumption during the red periods transferring it to the amber or preferably the green zones where possible.

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**Figure 2.2: The Distribution Network from Transmission to Customers**

Source: Northern Powergrid
Reducing Delivery and Contract Charges

Figure 2.3: The Distribution Network Operators

The DNO groups and individual DNOs are:

- Electricity North West Limited
- Northern Powergrid
  - Northern Powergrid (Northeast) Limited
  - Northern Powergrid (Yorkshire) plc
- Scottish and Southern Energy
  - Scottish Hydro Electric Power Distribution plc
  - Scottish Electric Power Distribution plc
- Scottish Power Energy Networks
  - SP Distribution Ltd
  - SP Manweb plc
- UK Power Networks
  - London Power Networks plc
  - South Eastern Power Networks plc
  - Eastern Power Networks plc
- Western Power Distribution
  - Western Power Distribution (East Midlands) plc
  - Western Power Distribution (West Midlands) plc
  - Western Power Distribution (South West) plc
  - Western Power Distribution (South Wales) plc
Reducing Delivery and Contract Charges

Table 2.4: Example of Distribution Charges for Half-Hourly Metered Customers

Western Power Distribution (South West)

Rates for all distribution regions appear in Appendix III

<table>
<thead>
<tr>
<th>Time periods</th>
<th>Red Time Band</th>
<th>Amber Time Band</th>
<th>Green Time Band</th>
</tr>
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<tbody>
<tr>
<td>Monday to Friday</td>
<td>17:00 to 19:00</td>
<td>07:30 to 17:00</td>
<td>00:00 to 17:00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19:00 to 21:30</td>
<td>19:00 to 21:30</td>
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<tr>
<td></td>
<td></td>
<td>00:00 to 07:30</td>
<td>00:00 to 07:30</td>
</tr>
<tr>
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Table of red, amber, green charges and times

Graph of weekday LV HH metered charges p/kWh

Getting Better Contract Prices

With wholesale power prices and delivery charges varying so widely by time periods within the day and over the week, the first port of call for a power supplier asked to provide a quote is to obtain the customer’s half-hourly consumption profile.

If the supplier is successful with his offer then he will pay both the wholesale and the delivery charges together with the balancing charge which is the mechanism for reconciling the precise half-hourly consumption recorded by each customer as against the blocks or clips of consumption provided for within the contract.

Not a problem if the contract provides for complete pass through of these charges to the customer but if prices between the supplier and the customer are fixed for the contract length a mismatch could well arise between the charges the supplier will have to pay out on behalf of the customer and the money received by the supplier from that customer through the supply contract.
Reducing Delivery and Contract Charges

Not surprisingly suppliers will be keen to minimise this risk. They will look closely at the profile to determine how predictable the load shape has proved over the day, week and season in the past. They are also likely to ask you whether you anticipate any changes in the consumption profile over the contract period ahead. The supplier will not want to find he has purchased too much or too little to cover the contract nor to find that the demand profile has changed with greater consumption at peak times and consequently higher delivery charges than budgeted for.

Knowing your profile is therefore the essential first step to securing a competitively priced contract. If the supplier suspects you are not in control of when you use the power or the previous bills show erratic swings in consumption without explanation then he will build in a significant risk premium into the quote or even decline to quote at all. The old adage "pile it high and sell it cheap" simply does not apply to the power market as many larger users have found out to their surprise. Rather the larger you are the more risk the supplier can foresee.

The ability to practice Demand Side Response will benefit not only the customer but also the supplier. High price periods can be avoided and consumption boosted to take advantage of off peak charges. If the contract involves the forward purchasing of supply clips you will also have the option of selling back volumes purchased if higher prices prevail nearer the time of offtake.

Customers with their own generation plant or with access to private generation can also benefit by working these supplies in tandem, with taking from the national grid. If open market prices are low then maximum use can be made of the public supply. But when they are high, supplies can be switched to own generation or even diverted from own generation into the national grid. We will see in the following chapters the array of services now on offer from National Grid to encourage turn down and reward additional capacity when required.
Helping to Balance the System

**Frequency Response**
What Are Frequency Response Services?
Firm Frequency Response (FFR)
FFR Bridging
Frequency Control by Demand Management (FCDM)
Enhanced Frequency Response

**Reserve Services**
What Are Reserve Services?
Short Term Operating Reserve (STOR)
STOR Runway
Fast Reserve
Demand Turn Up
Demand Side Balancing Reserve (DSBR)

**Capacity Market**
What Is the Capacity Market?
Capacity Mechanism
Transitional Arrangements
Trials
Helping to Balance the System

System Operator National Grid provides a number of opportunities for major energy users to get involved in Demand Side Response and earn revenue for their business. 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 what’s on offer. It explores the range of demand side services that National Grid currently buys, weighs 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.

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 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 needs energy users to provide frequency response services, where they’re expected to act fast – in some cases within one second – and increase, decrease or shift demand, or turn on back-up generation 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.

Major energy users can participate in the following frequency response services.

Firm Frequency Response (FFR)

FFR is one of the most valuable balancing services to National Grid on a £/MW hour basis. Those who wish to participate must be able to provide a minimum of 10MW to the grid within 30 seconds of a frequency event, such as a power station tripping out. Historically, this 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.
Helping to Balance the System

It’s a growing market for demand side users and more major energy users are engaging with the market as National Grid seeks to remove barriers to entry. Like other balancing services, providers are paid an availability price for the times they make their energy available, along with a utilisation fee whenever they’re called on to provide the service.

National Grid buys FFR through a monthly electronic tender process. Once service providers pass a pre-qualification assessment and sign onto a framework agreement, they can then tender in for a single month or multiple months.

Frequency data from National Grid suggests static FFR providers can be expected to be called upon roughly 10 times a year at the pre-set frequency trigger point of 49.7Hz. In other words, they’ll provide the service when the system frequency drops below 49.7Hz.

Dynamic FFR involves continually varying either generation or demand and doesn’t, therefore, have a pre-set trigger level. 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.

Figure 3.1: Dynamic and Static Frequency Response

The requirements for businesses providing FFR include:

- Having suitable operational metering and frequency relay equipment to automatically interrupt demand.
- Delivering a minimum 10MW within 30 seconds.
- Operating at their tendered level of demand/generation when instructed.
Helping to Balance the System

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

FFR Bridging

For businesses that are unable to meet the 10MW threshold for FFR, an FFR Bridging service exists that allows them to build up their DSR volume over a set term of one or two years.

Providers are paid an agreed fee per MW, which is dependent on the speed of response they can provide. This revenue increases as more MWs are added.

In Summary – FFR Bridging

What type of business is FFR Bridging best suited to?
Those that have the potential to build 10MW of volume, but who need the time and support to achieve it.

Why would a business choose FFR Bridging over other services?
They’re keen to enter the valuable FFR market, but don’t have the current capacity to provide 10MW of volume.

Frequency Control by Demand Management (FCDM)

FCDM is a service that helps prevent dramatic falls in frequency by automatically interrupting the demand of customers that use large amounts of electricity (more than 3MW) when frequency falls below a trigger point of 49.7Hz. This helps the system because as demand falls, frequency should increase. Once it has stabilised, the provider manually restores its demand connection, as shown in Figure 3.2.

Providers of FCDM must be able to interrupt their electricity supply with two seconds notice for a period of 30 minutes.

To achieve this automatic interruption, a provider needs to install equipment which can detect a fall in frequency below the pre-set level of 49.7Hz. To deliver a secure supply of electricity, National Grid needs to know how much daily load providers are able to shed on a week-ahead basis.
Therefore, the service is best suited to businesses that have predictable daily usage and are minimally affected by a 30-minute interruption. This sort of forecasting may be difficult for a single site to manage, so energy users may benefit from working with a third-party provider that can aggregate a large number of demand customers together.

**Figure 3.2: Frequency Control by Demand Management**

One of the benefits of FCDM over FFR is that performance (actual MW availability/nominated MW availability) is measured on a monthly basis rather than every half hour. This helps reduce potential penalties for inaccurate forecasting of load. FCDM also has an enduring term and fixed price, so there’s no need to continually tender into a market.

Frequency data from National Grid suggests providers can be expected to be called upon roughly 10 times a year at the pre-set frequency deviation of 49.7Hz. In other words, they’ll provide the service when the system frequency drops below 49.7Hz. The service is seen as a relatively uncomplicated route to market for demand side providers.

Providers of FCDM must meet the following minimum requirements:

- Demand must be a minimum of 3MW, which may be achieved by aggregating a number of small loads at the same site (as covered in Chapter 4).

- Demand reduction must take place within two seconds and be sustained for a minimum of 30 minutes. They must have suitable operational metering and frequency relay equipment to automatically interrupt demand.
Helping to Balance the System

In Summary – Frequency Control by Demand Management

What type of business is FCDM best suited to?
Those that have a predictable daily usage profile and are minimally affected by a 30-minute interruption.

Why would a business choose FCDM over other services?
FCDM has an enduring term and fixed price, so there’s no need to continually tender into a market. Performance is measured on a monthly basis rather than every half hour, which reduces the penalties businesses potentially face for inaccurate load forecasting.

Enhanced Frequency Response

Enhanced Frequency Response is a new, faster frequency response product, which requires businesses to provide full frequency response in less than a second. This is a dynamic service, meaning the provider continually varies generation or demand in response to frequency changes, rather than responding to a pre-set frequency trigger.

The product is a pre-fault rather than a post-fault service, which means it’s designed to manage frequency prior to faults occurring on a daily basis.

National Grid expects the service to be of particular interest to battery storage developers, but they are keen to hear from any type of businesses that can meet the service’s requirements.

The requirements for Enhanced Frequency Response include full power output provided in under a second, with delivery sustained for at least nine seconds. But as a product still in development, National Grid expects to adapt its requirements as it gains experience in operating the service.

In Summary – Enhanced Frequency Response

What type of business is Enhanced Frequency Response best suited to?
Those that have the flexibility to alter their demand or generation within a second in response to the system frequency movements.

Why would a business choose Enhanced Frequency Response over other services?
It offers potentially good financial returns. As a general rule, the faster a business can provide frequency response, the more they get paid.
Reserve Services

What Are Reserve Services?

In order to deal with unforeseen increases in demand or a lack of generation, National Grid requires access to sources of additional power in the form of generation or demand reduction.

These additional sources of power are referred to as ‘reserve’ and there are a number of reserve services that National Grid procures to help balance supply and demand within various timescales.

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 extended response time of 20 minutes.

STOR represents about 2GW of reserve energy that National Grid can call upon if there’s a sudden loss of power anywhere on the system. The STOR year is split into six seasons in line with the varying requirements across the year. An example of this can be seen in Table 3.3.

Businesses can tender for a committed or flexible contract. The committed route holds the most value, where a business makes itself available for all availability windows. This provides National Grid with more assurance that reserve will be there when it’s needed.

Flexible service providers have greater freedom to decide closer to real time which windows they make themselves available for. The start and end times for each window – for weekdays (WD) and non-weekdays (NWD) – for each STOR season (1-6) are shown in Table 3.3.

The last full tendering round for STOR (Tender Round 27) saw a rise in availability pricing. For transparency, National Grid publishes the prices that were accepted and rejected for STOR.

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 typically contracts for 20 minutes or less.
- Delivering the contracted MW for a continuous period of not less than two hours.
- Being able to deliver at least three times per week.
Helping to Balance the System

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 two-year period is attractive for many parties as energy prices continue to rise and alternative revenue streams become increasingly sought after. Over the last few tender rounds, the STOR prices have increased significantly for providing a committed service. It also offers flexibility for businesses as they can tender for the flexible service and declare their availability a week ahead of delivery.

Why would a business choose STOR over other services?
It’s easy to manage and helps a business enter into the demand side world. Businesses can expect a better financial return by providing a committed service over a flexible service. However, providing a flexible service may give an energy user more freedom.

Table 3.3: The Six Seasons of STOR

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</table>
Helping to Balance the System

**STOR Runway**

If a business doesn’t have the ability to provide 3MW through STOR, National Grid offers a growth contract called STOR Runway. As the name suggests, it’s designed to help businesses get off the ground in demand-side services.

Providers secure a contract to deliver a set amount of volume, which is grown to 3MW over the course of an agreed timeframe. By the end of the process, the business will have grown its volume sufficiently to participate in STOR. Under this service the provider is paid availability at 1MW declaration in order to assist with the growth of their portfolio.

**In Summary – STOR Runway**

- **What type of business is STOR Runway best suited to?**
  Businesses that have the ability to grow to 3MW.

- **Why would a business choose STOR Runway over other services?**
  STOR Runway offers businesses a supportive service to grow their portfolio during a set period up to the required 3MW.

---

**Figure 3.4: STOR Availability and Utilisation Payments**

[Diagram of STOR Availability and Utilisation Payments]

- **Optional Window**
- **Contracted MW**
- **Availability Window 1**
- **Availability Window 2**
- **Utilisation ‘Call Off’**

Legend:

- **E** = Availability Payments
- **Yellow Triangle** = Utilisation Payments
Fast Reserve

Fast Reserve is used by National Grid 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 flick 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 50MW within four minutes of instruction. This rapid and intensive requirement has resulted in a Fast Reserve market that’s dominated by pump storage businesses, which can simply open a valve and generate MW extremely quickly.

Combined cycle gas turbines have also successfully provided the service in the past, while trials have been conducted to aggregate 20MW distributed generators up to a total of 60MW. So opportunities do exist in the market.

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

The requirements for participating in Fast Reserve are:

- Active power delivery must start within two minutes of the dispatch instruction at a delivery rate in excess of 25MW/minute, and the reserve energy should be sustainable for a minimum of 15 minutes.
- Delivering a minimum of 50MW.

In Summary – Fast Reserve

What type of business is Fast Reserve best suited to?
Those who can make a large volume – a minimum of 50MW – available to the grid extremely quickly. Pump storage units currently dominate this small market.

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.
Helping to Balance the System

Demand Turn Up

Demand Turn Up is a service that will pay businesses to increase their demand when there’s too much energy in the system – typically overnight and during quieter times during the day. The majority of providers will be expected to respond within ten minutes of a signal, but the service will also be requested day-ahead at times.

While most other balancing services are used to soften peaks in demand, Demand Turn Up works in the opposite direction by encouraging providers to use more energy when there’s insufficient demand on the grid.

The service could be an attractive option for major energy users who have a flexible load and don’t have a set requirement for when they use their energy. One business that showed an early interest in the service has to run a number of motors for six hours a day, but has no time constraint on when to run them. With Demand Turn Up, this customer would receive an availability fee, and then, when they’re asked to run, they’d be paid in the region of £60-£75 per MW hour, which means they’ll essentially run that particular business process at no cost.

The required times of use for the service should allow businesses to participate in Demand Turn Up alongside other balancing services, such as STOR.

National Grid expects the service to grow as more renewables come into the system. For now, bi-lateral agreements will be signed on an individual basis with providers.

In Summary – Demand Turn Up

What type of business is Demand Turn Up best suited to?
Those with the flexibility to consume more energy, and carry out practical business processes, when there’s too much renewable energy in the system. Typical businesses might include water pumping stations, some manufacturing loads, cold storage and space cooling.

Why would a business choose Demand Turn Up over other services?
They don’t have to. Demand Turn Up is designed to encourage businesses to use more energy when demand is low. Therefore, timescales shouldn’t clash with other balancing products, which makes it compatible with other demand side revenue sources.
Helping to Balance the System

Demand Side Balancing Reserve (DSBR)

A time-limited product, DSBR is aimed at major energy users who are willing to reduce their electricity use between 4pm and 8pm on winter weekdays in return for payment. Demand reduction can be delivered by reducing or shifting load, or running on-site back-up generation. The product is solely for the winter period.

One of the main objectives of DSBR is to identify volume which hasn’t participated in demand side services before. So it’s an ideal option for businesses who want to explore their options and see if it’s for them.

It is designed to balance the system in the unlikely event that there’s insufficient capacity to meet demand. While National Grid did not call on DSBR providers over the winter of 2014/15, the product has been called upon for 2015/16. The product was originally only available for 2014/15 and 2015/16, but National Grid expects it to be extended for a further two years.

A couple of aspects of DSBR will appeal particularly to businesses that haven’t engaged with demand side services before. Firstly, it doesn’t require any form of additional technology to be fitted to their site. So anyone who’s subject to half-hourly metering is ready to go.

Secondly, DSBR’s response time is targeted to be at least two hours, which gives new providers a certain level of comfort should they need to respond to a signal from National Grid. Good revenues can be earned too, with payments of up to £16,000 per MW of demand reduction from 2016/17.

DSBR provides a good opportunity for businesses that aren’t sure about other services to explore their options in the demand side market. National Grid can also provide a team to walk new providers through the DSBR process.

In Summary – Demand Side Balancing Reserve

What type of business is DSBR best suited to?
Anyone who’s subject to half-hourly metering with high – but fairly stable – demand. Businesses that have been involved in DSBR so far include utility companies, water companies and other major energy users who have the ability to reduce demand or offset it for a period of time, with two hours’ notice.

Why would a business choose DSBR over other services?
It’s an effective taster of operating within the demand side world, requires no additional technology to be installed on-site and gives businesses a longer response time.
Capacity Market

What Is the Capacity Market?

The Capacity Market is one of the main building blocks in the UK 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 a series of auctions – also known as the capacity mechanism.

Capacity Mechanism

The capacity mechanism is a catch-all term for the auctions National Grid runs to guarantee capacity for any given year.

The main T-4 auction runs annually and buys capacity from providers that they’re then contracted to deliver in four years’ time. For many demand side providers, the idea of being held to a contractual position four years ahead could present a challenge.

With that in mind, two further auctions have been developed to encourage demand side participation and ensure its potential is fully exploited. These are called the transitional arrangement auctions, which are specifically designed to give demand side providers a leg up into the market, and the T-1 auction, a top-up auction for the T-4, which runs one year ahead of delivery.

Transitional Arrangements

Transitional arrangement auctions have been put in place to help demand side providers enter the Capacity Market. They’ll be used to provide a small amount of capacity, while giving demand side providers an opportunity to test the market before they lock into any long-term obligations.

They will work in exactly the same way as the main Capacity Market auction, but for a much shorter term. The first transitional arrangement auction ran in January 2016, for delivery in winter 2016/2017, with a second to be held in January 2017 for delivery in winter 2017.

The auction will provide payment for capacity, similar to availability payments in other services. They’ll be paid this money upfront to give them the financial certainty to provide the capacity they’ve tendered when it’s needed on the system.
After the two transitional arrangement auctions are complete, demand side providers will then be able to take part in the T-1 auction. This is a top-up auction for the 2018 delivery year, which will pick up any gaps left over from the T-4.

The idea is that the T-1 auction will be filled by demand side participants and then, from 2018, providers will be able to decide whether they’re ready to commit four years ahead in the next T-4 auction or stick with the T-1.

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 that can be really beneficial.

Trials

Energy companies run regular trials to find new and innovative solutions to the big questions facing today’s changing energy market. These pilot schemes often help shape the new services of tomorrow. Energy users can find out how to participate in these exciting opportunities by monitoring the websites of network companies, energy suppliers and the regulator Ofgem.
4

Accessing the Schemes

Going Direct or Using an Aggregator or Third Party?

What Are the Main Benefits of Going Direct to National Grid?

What Are the Main Benefits of Going to an Aggregator or Third Party?

Bidding into the Capacity Market

Working with National Grid

Choosing an Aggregator or Third Party

Getting Started
Businesses considering entering the demand side arena may not be sure what steps to take. This chapter explores the main access routes to this profitable market.

**Going Direct or Using an Aggregator or Third Party?**

The main routes to enter the demand side market are either by providing services directly to National Grid or by working with one of a growing number of Demand Aggregators or other Third Parties.

Which road a business takes is largely dependent on whether they meet the energy (MW) requirements for the services that National Grid buys and whether a business has capacity to manage the relationship.

If providers have the commercial knowledge within their business to meet the individual product requirements, they can go directly to National Grid. Equally, providers can go to an Aggregator or Third Party, who play the role of simplifying the participation in demand services for businesses.

There are a number of companies that operate in the Aggregator and Third Party space; these tend to be Demand Aggregators, Suppliers and other Third Parties.

Aggregators and Third Parties 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 them. 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, both routes of entry are beneficial to operating the electricity system as either avenue will drive growth in demand side markets. National Grid fully supports and encourages the services provided by Aggregators and Third Parties.

Both options have their own merits, so it’s up to individual providers to decide which one suits them best.

**What Are the Main Benefits of Going Direct to National Grid?**

- Businesses get experience of direct contract management with National Grid and have access to specific contact leads for each product
- 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.
Accessing the Schemes

What Are the Main Benefits of Going to an Aggregator or Third Party?

• 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
• Businesses receive revenue without having to worry about the day-to-day management of the service
• They can simplify the offering to businesses so that Demand Side Response becomes a clear and interesting value proposition

Size is just one factor when a business makes its decision. National Grid, Aggregators and Third Parties can provide levels of information and support, and it’s down to individual providers to decide which route works best for them.

Bidding into the Capacity Market

Large energy users have three ways to bid into the Capacity Market.

• T-4 – the main T-4 auction runs each year and allows energy users to sell capacity that they are then committed to deliver in four years’ time
• T-1 – the top-up auction for each delivery year allows providers to sell smaller amounts of capacity one year ahead of delivery
• Transitional Arrangements – this auction, which will run in 2017, gives demand side providers an opportunity to test the market before they lock into any long-term obligations. Providers bid one year ahead of delivering capacity.

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/registration.aspx

From there, they’ll be walked through a pre-qualification process and introduced to the specific details of how to participate.

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 bid.
Accessing the Schemes

Working with National Grid

As outlined in Chapter 3, National Grid 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 they may be able to sign a direct contract with National Grid.

National Grid provides a specific point of contact for each of the demand side services it buys, and these are the perfect starting point for anyone interested in participating. Up to date details can be found on National Grid’s website at http://www2.nationalgrid.com/uk/services/balancing-services.

Below are a few other ways to get in touch.
For Balancing Services Contracts:
commercial.operation@nationalgrid.com
+44 (0)1926 654611

For DSBR:
DSBR.SBR@nationalgrid.com
+44 (0)1926 655258
For Capacity Market team:
emr@nationalgrid.com
+44 (0)1926 655300

Choosing an Aggregator or Third Party

Businesses can choose to offer demand side services through an Aggregator or Third Party.

Appendix II provides a list of Aggregators and Third Parties. However, National Grid does not provide advice on which to choose. It’s down to potential providers themselves to spend time researching and talking to the various players in the market to establish which one best suits their requirements.

The list of Aggregators and Third Parties in Appendix II should not be treated as exhaustive. And National Grid cannot make any specific recommendation about the performance of any of the companies listed.
Accessing the Schemes

Getting Started

A report by Energyst Media in 2015 showed that 67 per cent of businesses weren’t participating in Demand Side Response, because they didn’t understand the patchwork of products available or because they felt they were too small to make a difference. But, as this booklet has shown, it’s a market that’s open to everyone and it’s simpler than businesses might think to get involved.

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 or by talking to an Aggregator or Third Party. The first step for connecting with National Grid is via the email address commercial.operation@nationalgrid.com. Submit a question or comment and a relevant contact at National Grid 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 Third Parties are available to answer questions, provide tailored information and advise on the financial benefits of participating in this demand side revolution.
5

Case Studies of Profitable Demand Side Response

1 – Ministry of Defence
2 – United Utilities Water Company
3 – London Underground
4 – Sainsbury’s
5 – Aggregate Industries
6 – Northern Powergrid
7 – DONG Energy
1 – Ministry of Defence

Demand Side Response has affected the Ministry of Defence, both as an immediate issue and affecting future development of the estate.

The District Network Operators (DNOs) are now approaching the MoD requiring us to prove that we use at least 75 per cent of the capacity that we have contracted from them, and in one case, we have had the site capacity lowered under statutory powers as the case could not be supported for the high capacity reserved; historically, the MoD, like a number of organisations, have reserved capacity to safeguard future potential expansion of sites, as military requirements alter over the years.

However, this is no longer an acceptable practice in light of the Government’s policy to reduce demand side usage, and to mitigate infrastructure investment capital costs. We have increasingly found the DNOs unwilling to reserve or even provide capacity, without us providing evidence that we will use it.

Accordingly, the MoD has taken a robust approach to Demand Side Response, and especially reduction, both to reduce costs of infrastructure investment and overall usage costs. From the technical side and the manual side we are making full use of private sector knowledge and experience in achieving this.

The MoD via its estates branch, Defence Infrastructure Organisation (DIO), has carried out its annual TRIAD stand-down campaign to reduce transmission charges, along with an innovative ‘Red Tuesday’ DUoS competition, to encourage personnel to hold meetings or alter their working hours to avoid using IT and other equipment during the ‘red’ peak phase of DUoS pricing.

The early findings are that this has had an impact on usage levels and reduced demand, albeit to a limited extent, as the scheme is in its early days, but the indications are that it works.

In the case of generation, the MoD has started to look at self-generation, partly by renewables, to meet its needs and to reduce reliance on the grid; and via STOR, to generate income from our assets, as the MoD possesses very large standby generation systems. (Combined they can generate 2.7 Terawatts).

The importance of MoD sites to national security and to assist the civil authorities means that the estate has to have a very resilient energy profile, to enable operations to continue under ‘Business Continuity’. This has meant that the DNO demand reduction programme has had an impact on our assets, and forced the MoD to take a more lateral approach to energy usage, and this is a good thing, as it has encouraged more efficient use of the assets, reduced usage and maintenance costs of the estate.

As the Demand Side Response process continues to develop, we will have to further pursue both energy and asset efficiency, to allow the release of reserved capacity, or demonstrate that there is a development project that will
require it. We believe that similar issues affect the other Government bodies, especially fixed asset rich ones such as the NHS and Education.

As an organisation, we are developing an estate wide demand management structure, and procedures, to ensure efficient usage of our procured capacity, and to minimise the costs. At this stage, we are limited to STOR, load shedding and demand reduction in itself, but we will be looking at supplying energy either as a demand standby form or even as basic full generation to use any excess from our future renewable facilities.

2 – United Utilities Water Company

United Utilities Water Company is well on the way to building a “virtual power station.” Energy manager Andy Pennick describes how getting smarter with energy use can pay dividends and boost green credentials.

“We know that energy is one of our biggest costs so our mantra is to use less, generate more and use our assets smarter. We’ve done a lot of work already on installing more energy-efficient equipment and we’re generating some 18 per cent of our own electricity through biogas and other renewable sources. But it was the ‘getting smarter’ that led us to trialling Dynamic Demand, a dynamic frequency response solution offered by Open Energi.”

Water companies are ideally placed to make use of frequency response. Certainly we use a lot of power, but often we can be flexible about when we need to use it thanks to the storage available in our assets.

Take clean water pumps for example. Some service reservoirs have many hours of storage and the pumps don’t necessarily have to operate immediately when water levels start to fall. Another good example for wastewater is the air blowers on activated sludge plants. When managed, there’s headroom available in the process that allows for flexibility in precisely when the air blowers need to cut in, especially suitable for those with variable speed drives.

In 2014 we decided to trial Dynamic Demand at three sites, Hoghton water pumping station, Bolton Wastewater Treatment Works and Birkenhead Wastewater Treatment Works.

What Are the Challenges?

It was easy enough to identify the types of site and process that would lend themselves to Dynamic Demand, but one of the biggest challenges we faced was persuading our operational teams that it was a good idea!

The top priority for our employees is maintaining compliance. We had to create a cultural shift so they were prepared to accept handing over some control of our processes. We did that by sitting down with the operators involved and working through the numbers in extreme detail.
HazOp is a risk-based analysis tool we use to brainstorm all the things that could possibly go wrong on each site where we planned to trial the technology.

This allowed us to set safety margins within which the equipment could respond to changes in frequency. Once outside those margins, the process takes priority again. It does require a certain trust in the solution and that was the most difficult obstacle for us to overcome.

We know that energy is one of our biggest costs so our mantra is to use less, generate more and use our assets smarter.

**What’s Next?**

To date we have installed the technology at ten of our larger activated sludge plants, (biological wastewater treatment) including Davyhulme in Manchester, St Helens, Preston, Runcorn, Warrington and Widnes. We have also successfully integrated Dynamic Demand onto other sites, for example a water pumping station. Over the coming months we are targeting a further ten activated sludge plants and have started to evaluate new waste and fresh water processes that we feel would work with the technology.

We are also embarking on a programme with Kiwi Power to automate our back up diesel generators for deployment in the STOR market alongside working on DSR trials with our local DNO, Electricity North West.

Our aim, by 2020, is to provide access to 50MW of Demand Side Response for National Grid – enough to displace a peaking power station. I think that’s a very tangible ambition, and it shows there’s real potential for industry to help build a sustainable future UK energy market.

**3 – London Underground**

Some of the UK’s biggest energy consumers are supporting plans to boost the use of demand side measures. Russell Fleetwood, Generation Manager at London Underground, explains how and why his organisation is getting on board.

The Tube is the biggest power consumer in London, and has the largest private power network in the country. So we’re well-placed to reduce our demand, which is why we signed up for one of the new innovative demand response services: Demand Side Balancing Reserve (DSBR) run by National Grid.

Through DSBR London Underground is able to offer 55MW of demand reduction.

DSBR makes use of our own stand-alone emergency back-up supply at the Greenwich Power Station. The power station, which dates back to 1902 and was originally built to provide power for London’s Tram network,
is currently used exclusively as a back-up for the Tube network. Should normal supplies be interrupted, it would be called upon to help with the safe evacuation of passengers and staff, so it needs to be 100 per cent available at all times.

Similarly, we can use Greenwich to reduce our reliance on National Grid’s power. Through DSBR we are able to offer a significant demand reduction of 55MW, and can quickly respond by switching to Greenwich’s five gas turbines for the length of time required.

**Being More Efficient**

Being on call means we are able to utilise one of our older assets – though we have to also be aware that we have to look after it, and not run it into the ground! Currently, the Greenwich power station is used between 200 and 300 hours a year, but that’s about to change as it undergoes a major revamp which will see new more efficient and cleaner gas engines installed.

**The Benefits**

Reducing carbon emissions is part of TfL’s overall strategy and the new engines will provide a steady source of cheap, low-carbon power for London’s Tube network. Work is also being done to explore how the scheme could generate cheaper energy for people in London too. The waste heat produced could be used for heating water, and this would be pumped to homes connected up to the system.

Taking advantage of Demand Side Response has been a positive experience for London Underground. It’s enabled us to make use of an existing asset, as well as creating additional revenue – and that can only be good for stakeholders and Tube users alike. It’s a very, very, positive project for London.

I’m sure Demand Side Response is something that we will have to grow in the future to help smooth out customer demand and to help reduce carbon emissions. We’re fully supportive of that at London Underground.

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**4 – Sainsbury’s**

Supermarket giant Sainsbury’s is aiming to unlock the demand side potential in a network of 400 stand-by generators located around the UK.

Keeping the energy bill for Sainsbury’s in check is a major undertaking. It’s a challenge that we’re taking seriously and in recent years we’ve invested in more than 100 biomass boilers, 40MW of solar PV, introduced LED lighting, 27 Ground Source Heat Pumps and Green Gas CHP. As a result our absolute energy consumption today is lower than it was in 2005-06, despite opening 52 per cent more space in that period.
So, we’ve made a good start, but we have only really scratched the surface in terms of what we could do through Demand Side Response. The opportunity is huge because our business accounts for something like 0.6 per cent of all electricity consumption in the UK.

**Investigating the Role of On-site Generation**

In the event of a power cut each of our sites has a back-up generator set in place, which starts up if the site comes off the grid for any reason. These generators produce enough power to enable each facility to function for a period of time and to get people out of the building safely. What we do know is that we have approximately 130MW of generation capability that could be put to use providing demand response. However, the hurdle we need to overcome is the complexity of getting those generators connected to the grid.

**Negotiating Connection**

The process of connecting new on-site generation is complex and time-consuming. It’s also not set up to deal effectively with a situation like ours with 400 individual sites, each needing to be assessed as a separate entity.

At present we need to apply for each potential connection to one of the 14 Distribution Network Operators (DNOs) and the time between submitting an application and receiving a ‘yes or no’ decision is between 45 and 90 days.

In addition, because our generator sets are used as back-up currently, they are not connected directly to the grid. This necessitates a significant amount of investigative work to provide the necessary technical specifications and data to the DNO. We estimate that the cost of completing the application process for 350 sites would run to millions of pounds.

There is no easy answer because the DNO needs to be sure that any connection does not cause a problem on the local grid. It would certainly encourage businesses like ours if there was a process to validate potential connections en masse. We would also welcome a centralised fee with each DNO to provide clarity on costs.

It’s unlikely that all 400 of our sites will be suitable for connection, but certainly we think 250-300 is a realistic figure.

We have only really scratched the surface in terms of what we could do through Demand Side Response.

**Going Live**

We’ve reached an exciting point in the development of our demand response capability with the first 150kW generator set to go live in
Dewsbury, West Yorkshire. This will be followed by a 1.2MW generator at our Tamworth depot in Staffordshire, so we will be able to assess the success of both small and large scale options.

At the same time we’re looking at other technologies. For example, later this year we will launch a trial of battery storage at our Melton Mowbray store, which aims to store up off peak electricity to be released on demand. We want to prove the principle before assessing a wider roll-out.

In addition, we’re working with Open Energi, using their expertise in frequency response to examine what else we can do across Sainsbury’s to reduce our energy consumption.

I think the message is that, as part of Sainsbury’s 20x20 Sustainability Plan, demand response technology has a part to play. We have 130MW of generation just waiting to be used. It’s now about working with the energy industry to make it happen!

5 – Aggregate Industries

In 2013 Aggregate Industries equipped bitumen tanks at over 40 asphalt plants across the UK with Open Energi’s Dynamic Frequency Response technology, known as “Dynamic Demand”. Collectively these tanks are providing 4MW of flexible capacity to National Grid and earning significant revenues for the company in return.

Aggregate Industries and Open Energi worked together to develop and install the technology to turn the bitumen tanks into “smart devices” that can automatically adjust their electricity consumption in real-time to help balance electricity supply and demand.

The technology provides a front line service to National Grid which responds in seconds to changes in grid frequency and is called upon 24/7, 365 days a year. The bitumen tanks may respond several times a day but typically only for a few minutes at a time. Aggregate Industries earns revenue for the tanks’ availability, regardless of whether or not they are utilised.

Bitumen tanks are ideal for Dynamic Demand because their consumption of electricity is not time critical. Although they need energy, as long as they operate between temperature limits it does not matter precisely when that energy is used. The technology is able to optimise the operational performance of the tanks whilst maximising their availability for Dynamic Demand.

The project is expected to reduce UK CO₂ emissions by almost 50,000 tonnes over the next five years, equivalent to 390,000 individual journeys from London to Paris by plane. Embracing this innovative technology has also helped Aggregate Industries to identify significant energy savings in the region of 350,000kWh per year.
Aggregate Industries is now exploring the potential for other assets to work with Dynamic Demand, and has begun equipping pumps at quarry sites with the Dynamic Frequency Response technology.

Aggregate Industries’ Director of Asphalt, Chris Hudson, says: “We are committed to sustainability and strive to exhibit leadership in our sector. Our collaboration with Open Energi, and the roll-out of this cutting edge technology across our sites, demonstrates our pioneering approach to tackling energy management and carbon reduction.

6 – Northern Powergrid

As the Distribution Network Operator serving customers in the North East of England, Yorkshire and parts of Lincolnshire, Northern Powergrid is at the sharp end of the debate on Demand Side Response (DSR). Head of Regulation and Strategy Jim Cardwell explains the challenges and opportunities ahead.

In many areas of life we are already accustomed to differential pricing or congestion charging. We pay different prices for train tickets whether or not we travel at peak times. Also, in energy, the Economy 7 tariff has historically offered consumers the chance to benefit from lower prices for electricity used in the night.

In other words, society should be no stranger to the concept of Demand Side Response (DSR). Of course, familiarity is one thing, achieving widespread DSR participation is quite another. We learned a great deal about the way domestic and commercial customers could engage with DSR by taking part in the Customer-Led Network Revolution project. This was a four-year trial with 13,000 customers to assess the potential of novel smart grid schemes and network technologies.

DSR in Context

DSR is significant to a business like Northern Powergrid. We have about 3.9 million customers, of which 3.6 million are domestic households. As more renewable sources of generation and low-carbon demand such as electric vehicles and heat pumps are connected to the grid, we estimate that local grids like our own could need to carry twice as much load as they do today by 2050.

The UK could save over £5 billion in energy costs and 11 million tonnes in carbon emissions if techniques trialled in the Customer-Led Network Revolution are deployed.

We are considering how to accommodate these new low-carbon technologies at the least cost to our customers. If we can pay customers to provide us with flexible generation or to reduce their consumption at peak periods, it can defer the need for us to carry out reinforcement work.
Case Studies of Profitable Demand Side Response

How the Trial Worked

In the trial we set out to test the appetite of consumers and to understand the technical challenges of creating a smart grid for the future.

On the industrial and commercial (I&C) side we partnered with 16 customers, providing about 17 megawatts of DSR. These customers used a mix of on-site generation and ‘turn down’ to generate the load and we found no major technical hurdles – customers who declared themselves available provided around 80 per cent reliability.

Certainly, the I&C market provides us with the quickest opportunity to widen the use of DSR and, over the next eight-year period, we have committed that before we do any reinforcement work in our major substations we will first speak to customers to see how they can help us.

Working with Domestic Customers

About 11,000 residential customers participated in the trial, 650 of whom tested time of use tariffs to see if they could alter their energy consumption habits and save money at the same time.

The results were interesting – we saw an average 10 per cent lower peak consumption and about 60 per cent of customers saved money on their bill. However, certain demographic groups, specifically families with young children and older customers, told us that they found it difficult to adjust their patterns of electricity use.

As more renewable generation and loads are connected to the grid, we estimate that local grids like our own could need to carry twice as much load as they do today by 2050.

We are supporting the widespread introduction of domestic smart meters to ensure we can respond appropriately to fix any defects on our network as the roll-out increases pace. Looking ahead, we need to ensure that we make effective use of this new source of data to develop a more efficient network.

The response from SMEs

During the trial we found that engaging the SME community was the biggest challenge. This is a very diverse group of businesses, whose focus is understandably on managing their day-to-day operations. DSR was not high on their list of priorities and I think this underlines another truth: the demand side is part of the solution, but not the only one.

We will need to continue to reinforce the network, identify and develop new smarter network technologies and integrate these approaches to maintain a reliable network service at least cost. The approaches will differ according to the situation and our work has helped to identify what solution is appropriate for different circumstances.
Case Studies of Profitable Demand Side Response

DONG Energy, the UK and world leader in offshore wind, have developed a new solution to help balance their portfolio and fulfil contracts in the most cost-effective way. By simply reducing consumption or ramping up on-site generation, customers can help balance the grid and make new revenue, by taking a share of their reduced system-balancing costs.

Because of the intermittency of wind generation DONG from time to time have to buy from the market energy produced from other sources in order to balance their portfolio. This product will allow them to do so at the least cost.

Who Can Participate?

DONG Energy customers with flexibility in supply and consumption can participate in RBR. DONG’s wind portfolio operates 24/7/365 so the Renewable Balancing Reserve (RBR) is available during any half-hourly period throughout the year, unlike many schemes that only require participation during periods of peak demand.

What makes Renewable Balancing Reserve different?

- It is available 24/7/365 – customers just choose a convenient half hour period
- No obligation or commitment – no restrictions at all on the level of participation, and no fixed volume requests needed.
- Peace of mind – there are no penalties for non-participation.
- Quick and simple to set up – no hardware installation is needed, saving time.
- Renewables focused – shows support for renewable energy.

How it Works

Renewable Balancing Reserve operates via an online portal, which is very simple to set-up and use.

1. Set the times in which you can participate, and the minimum price you are willing to accept via the online portal.
2. Based on your settings, we alert you of times to reduce your consumption, and the revenue available to you.
3. You confirm whether you are able to participate.
4. You receive payment according to the actual consumption, shown in your next invoice.

More information is available at: energyservices@dongenergy.co.uk
Appendix I: Power Responsive Campaign from National Grid

What Is the Campaign All About?
Power Responsive is a collaborative programme of work that aims to grow participation in Demand Side Response in the GB by 2020.

It strives to bring businesses, suppliers, policy makers and other stakeholders together in order to maximise opportunities and shape the growth of the market in a collaborative way. It’s essentially a framework for turning debate into action.

Why Is it Necessary?
The goal of Power Responsive is for businesses and consumers to be intelligent energy users, save on total energy costs and secure the GB’s energy now and in the future.

The move to a low-carbon economy coupled with rapid advances in technology and innovation are transforming electricity supply. National Grid believes the challenge is on to exploit new opportunities by changing the way Great Britain uses electricity.

The company wants to encourage more businesses and consumers to participate in Demand Side Response. By increasing, decreasing or shifting electricity consumption, they’ll earn revenue and reduce their carbon footprints.

Demand Side Response may be in its infancy, but it’s already reality. National Grid 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.

The more businesses that get involved in Power Responsive, the bigger the impact, and the greater the chain reaction in growing Demand Side Response. National Grid believes everybody can play a role and benefit from this developing market.

Campaign Journey
After its launch in summer 2015, four work streams were established for Power Responsive.

1. **Co-ordinated approach** – this is about demand users and the energy industry co-ordinating to address barriers to the demand side market

2. **Customer outreach** – building more awareness of schemes and a clear value proposition

3. **Customer-led products** – creating a package of products that works for demand users

4. **Certainty and stability** – ensuring Demand Side Response is a long-term investment proposition
Appendix I: Power Responsive Campaign from National Grid

Autumn/winter 2015 saw a number of early breakthroughs, including the creation of a steering group and campaign roadmap, the publishing of a demand side Product Map, as well as progress being made on the development of the new Demand Turn Up service.

**How to Get Involved**

Businesses that are interested in shaping the future of Demand Side Response should visit National Grid’s Power Responsive website – www.powerresponsive.com. From there, they can get involved in the conversation, register for updates and share their experiences of DSR.
Appendix II: Aggregators and Third Parties

As described in Chapter 4, energy users can choose to enter the demand side market by working with Demand Aggregators, Energy 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.

Ameresco Limited – http://uk.ameresco.com/
British Gas – https://www.britishgas.co.uk/
Cynergis Projects Ltd – http://www.cynergis.com/
EDF Energy – http://www.edfenergy.com/
Endeco Technologies – http://endeco-technologies.com/
EnerNOC UK Ltd – http://www.ernnoc.com/
E.ON – https://www.eonenergy.com/
Flexitricity – https://www.flexitricity.com/
GDF SUEZ Energy UK – http://www.gdfsuez-energy.co.uk/
KiWi Power Ltd – http://www.kiwipowered.com/
Limejump Ltd – http://www.limejump.com/
Matrix – Sustainable Energy Efficiency – http://www.matrixsee.co.uk/
Npower Ltd – http://www.npower.com/
Open Energi – http://www.openenergi.com/
Restore – http://www.restore.eu/
Reactive Technologies – https://www.reactive-technologies.com/
Stor Generation Ltd – http://www.vps.energy/
Tempus Energy – https://tempusenergy.com/
Tezla Energy Ltd – http://www.tazlaenergy.co.uk/
UK Power Reserve Ltd – http://www.ukpowerreserve.com/
Utilitywise – https://www.utilitywise.com
Appendix II: Aggregators and Third Parties

Legal Notice

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

National Grid 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.operation@nationalgrid.com
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 2016/17 charges. A map of the DNO areas is shown in Figure 2.3.

### Electricity North West

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<th>Red Time Band</th>
<th>Amber Time Band</th>
<th>Green Time Band</th>
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<tr>
<td>Monday to Friday (Including Bank Holidays)</td>
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### SP Energy Networks (Scottish Power Distribution plc & MANWEB plc)

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### Northern Powergrid (North East)

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<td>Saturday and Sunday</td>
<td>00:00 to 24:00</td>
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<tr>
<td>All Year</td>
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<tr>
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<td>10.772</td>
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<tr>
<td>HV HH Metered</td>
<td>7.839</td>
<td>0.374</td>
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### Northern Powergrid (Yorkshire)

<table>
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<th>Time Bands for Half Hourly Metered Properties</th>
<th>Red Time Band</th>
<th>Amber Time Band</th>
<th>Green Time Band</th>
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<td>Saturday and Sunday</td>
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<td>All Year</td>
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<tr>
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<td>0.035</td>
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Appendix III: Distribution
Network Charges

Scottish and Southern Energy (Scottish Hydro Power Distribution)

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<th>Amber Time Band</th>
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Scottish and Southern Energy (Southern Electric Power Distribution)

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UKPN (London Power Networks)

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<td>Saturday and Sunday All Year</td>
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<tr>
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<td>0.017</td>
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### Appendix III: Distribution Network Charges

#### UKPN (Eastern Power Networks)

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<td>19:00 to 23:00</td>
<td>20:00 to 23:00</td>
<td>00:00 to 07:00</td>
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<td>Saturday and Sunday All Year</td>
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#### UKPN (South Eastern Power Network)

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<td>Saturday and Sunday All Year</td>
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#### Western Power Distribution (East Midlands)

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<th>Amber Time Band</th>
<th>Green Time Band</th>
</tr>
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<td>00:00 to 07:30</td>
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<tr>
<td>Weekends</td>
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#### Western Power Distribution (West Midlands)

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<th>Green Time Band</th>
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<td>Monday to Friday (Including Bank Holidays) All Year</td>
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Appendix III: Distribution Network Charges

### Time Bands for Half Hourly Metered Properties

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<th>Time periods</th>
<th>Red Time Band</th>
<th>Amber Time Band</th>
<th>Green Time Band</th>
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<tbody>
<tr>
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<td>07:30 to 17:00</td>
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<table>
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<th>Amber Time Band</th>
<th>Green Time Band</th>
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</thead>
<tbody>
<tr>
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<td>19:30 to 24:00</td>
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<tr>
<td>LV HH Metered</td>
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More detail of Distribution charges are available at:

Electricity North West – [http://www.enwl.co.uk/our-services/use-of-system-charges](http://www.enwl.co.uk/our-services/use-of-system-charges)


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


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 a NHS Trust, where as Chair of the Audit committee he had first-hand knowledge of the impact of energy costs on the public sector.

Profting from Demand Side Response

Making Money and Avoiding Penalty Charges
Reducing Delivery and Contract Charges
Helping to Balance the System
  Frequency Response
  Reserve Services
  Capacity Market
Accessing the Schemes
Case Studies of Profitable Demand Side Response
Appendix I: Power Responsive Campaign from National Grid
Appendix II: Aggregators and Third Parties
Appendix III: Distribution Network Charges 2016-17