Open Energi has partnered with Tarmac to provide Demand Response.
Demand Response is paving the way for a completely different electricity market. A market that doesn’t require fossil fuelled peaking power, a market that can integrate renewable energy efficiently and a market that gives consumers control over how, when and from where they consume their energy.

In recognition of this, National Grid has established Power Responsive, a framework for turning debate into action with a practical platform to galvanise businesses, suppliers, policy makers and others to seize the opportunity to shape the growth of Demand Response collaboratively, and deliver it at scale by 2020.
Balancing electricity supply and demand

Electricity cannot be stored economically, so at any moment in time, electricity supply and demand 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.

When electricity supply and demand are equal, the grid frequency measures 50 Hertz (Hz). If supply exceeds demand, the frequency will rise above 50 Hz. If demand outstrips supply, it will fall below 50 Hz. National Grid has a statutory mandate to keep power balanced between 49.50 - 50.50 Hz. It has a range of tools at its disposal to help it manage this, from fast acting frequency response to pricing strategies designed to discourage consumption at certain times of day.
Dynamic Frequency Response

What is it?

Dynamic Frequency Response is a service required to maintain the second-by-second balance of supply and demand on the grid and is vital to maintaining the stability of the electricity system.

The grid frequency (measurable from anywhere on the network) must be kept at 50 Hz and any deviation from this value indicates there is too much or too little supply to meet the demand. Hence frequency response has traditionally been bought from generators who are able ‘to track’ the grid frequency by altering their output up or down to bring the system supply and demand back into balance.

Open Energi is the first company to provide this service from the demand side, providing a fully dynamic frequency response service by adjusting the consumption of energy users in line with grid frequency to mimic the output of a large power plant.

When is it used?

National Grid requires around 1.5GW of dynamic frequency response to be online at any one time. Around 1GW is low response for when demand is greater than supply and around 0.5GW is high response for when supply is greater than demand. However as this happens rarely the full volume of service is only called upon very occasionally. Typically loads are only switched for one to two minutes at a time, and 80% of switches are for less than four minutes.

Dynamic frequency response service requirements:

- Deliver a response (up or down) within 2 seconds for up to 30 minutes
- Delivers a minimum of 10MW of service (can be several aggregated loads)

Suitable assets:

- Traditionally provided from large coal gas and hydro plants
- Open Energi’s Dynamic Demand platform aggregates together a wide range of energy assets
Static Frequency Response

What is it?

Enough frequency response must be available at any one time to provide adequate power to cover the loss of a large power station. National Grid meets the large majority of this requirement from dynamic providers but static providers can also be of use in this case.

These providers do not ‘track’ the frequency constantly but instead will provide all their response if the frequency ever deviates below a certain value (indicating there has been a large loss of generation). The service is provided by fitting a frequency relay switch which will either cut off demand or start up fast acting generators.

When is it used?

Whenever the frequency deviates below 49.7 Hz the service is triggered; this happens around 10 times per year.

Static frequency response service requirements:

- Deliver a response (Low response only) within seconds (10s for primary and 30 seconds for secondary) for up to 30 minutes
- Delivers a minimum of 10MW of service (can be several aggregated loads)

Suitable assets:

- Interruptible processes such as cement manufacturing
- Diesel generators on hot standby

Pumps at Welsh Water are helping to balance the grid in real-time
Frequency Control by Demand Management (FCDM)

What is it?

Frequency Control by Demand Management (FCDM) provides a very similar service to static frequency response; however it is contracted slightly differently. It provides an immediate response to a sudden lack of supply which needs to be managed very quickly.

Owners of large electricity consuming sites – such as cement kilns or smelting plants – will fit a relay to their loads which is triggered the moment the grid frequency drops below a certain value.

When is it used?

The ‘trigger frequency’ for FCDM is typically 49.7Hz like static frequency response, but that may vary across different contracts. Providers of FCDM will have their electricity supply automatically interrupted when the system frequency crosses the low frequency relay setting on site. FCDM contracted loads are typically called upon 10-30 times per year.

FCDM service requirements:

- Provides the service within 2 seconds of an instruction
- Delivers for a minimum of 30 minutes with suitable operational monitoring
- Delivers a minimum of at least 3MW of service (can be several aggregated loads)

Suitable assets:

- FCDM is one of the older demand response services traditionally provided from aluminium smelters and cement plants
Demand Turn-Up

What is it?

Demand Turn Up is a service to help National Grid manage periods of low demand on the system. This is a problem for National Grid as there needs to be a certain amount of large thermal generation online at any one time to ensure system stability (inertia, voltage control, frequency regulation etc).

Energy consumers can provide a valuable service by increasing their demand (or equally turning down on site generation) upon request. This presents an economic solution to alternative measures such as instructing wind farms to power down.

When is it used?

Demand Turn Up is required over the summer months and specifically during the middle of the day (to manage solar PV generation spikes) and overnight (when demand is naturally at a minimum). National Grid will issue a ‘call’ with the start time and duration specified well in advance (~6 hours), providers must be able to sustain response for up to two hours if required.

Demand Turn Up service requirements:

- 1 MW minimum tendered volume (can be aggregated together)
- Response time is not of great importance for this service
- Must be able to sustain response for at least 2 hours

Suitable assets:

- On-site generation which runs regularly, for example CHPs are suitable but not back-up generators
- Equipment capable of a long sustained response, thermal loads like data centre cooling can be suitable

United Utilities provides over 1MW of flexible demand from their Davyhulme Waste Water Treatment Works in Manchester
Short Term Operating Reserve

What is it?

Short Term Operating Reserve (STOR) helps National Grid to manage a shortfall in supply by either providing additional electricity generation from spare plant capacity and back-up diesel generators or by reducing electricity demand. At least 90% of STOR provision comes from increasing generation whilst the remaining 10% comes from demand-side reductions.

When is it used?

STOR services are used by National Grid when there is a shortfall in electricity supply resulting in what is known as a grid ‘event’. National Grid will issue a STOR call to specific providers who must then each provide power within their tendered response times. Whilst frequency response services provide an immediate response (0-30 minutes), STOR services can help National Grid to meet demand in the mid-term (20 minutes - 2 hours+) as larger, more efficient generation can be brought back online.

STOR service requirements:

- 3MW minimum contract size (this can be aggregated from smaller loads)
- Responds to a call from National Grid in no more than 4 hours
- Must be able to deliver power to the grid (generating power or curtailing load) for a minimum of 2 hours
- Must be able to deliver at least 3 times per week
- Must be able to recover and deliver service again within 20 hours of a unit’s last STOR call

Suitable assets:

- Diesel generators, gas turbines, gas engines, pumped storage and hydro plants
Demand Side Balancing Reserve

What is it?

Demand Side Balancing Reserve is a service introduced in Winter 2014/15 to help National Grid manage with tight generation margins until the Capacity Market starts in 2018/19. It was designed to access a large volume of demand response very quickly and hence has low entry requirements, for example no additional metering or communication hardware is needed. Essentially National Grid will ask large energy consumers to not consume power over the evening peak.

When is it used?

Demand Side Balancing Reserve can only be used after National Grid has issued a formal warning to the market that it is forecasting there will be little spare capacity to meet the evening peak. Then National Grid can issue instructions to individual providers well in advance to provide response in time for the evening demand peak.

Service requirements:

- Be able to respond within 4 hours of receiving a call
- Must be able to hold response for at least one hour

Suitable assets:

- Production facilities capable of deferring energy consuming activities
- Back-up generators
The Capacity Market

What is it?

The Capacity Market is intended to ensure the UK has sufficient capacity available to meet the winter peak demand and is open to both generators and demand response providers. Successful bidders into a capacity auction will receive an availability payment throughout the year, as long as they provide their tendered capacity during a system “stress event”.

It is important to note that the Capacity Market is not a balancing service and hence Capacity Market payments can be earned alongside revenues from balancing services such as STOR and FFR.

When is it used?

If National Grid decides the system is approaching a tight margin of spare capacity they can issue a “stress event”. This gives capacity market participants a 4 hour warning, at the end of this the full amount of MWs bid into the auction must be provided. As the service will first arrive in 2018/19 it is not yet clear how many stress events are likely to arise in a single year.

Capacity Market service requirements:

- Minimum size 2MW (can be aggregated)
- Capacity must be provided until National Grid end the “stress event”, which could mean indefinitely

Suitable assets:

- Large power stations like coal and gas plants
- Small scale power stations like gas turbines and gas engines
- On-site generators such as CHPs and back-up diesel gensets
Price incentivised demand response

In addition to participation in specific Demand Response programmes electricity consumers are also incentivised to alter their energy usage by responding to price signals. For example price spikes occur during times of peak demand when electricity consumption on the system is greatest. Shifting consumption away from these times reduces the size of the peak system demand. This brings significant benefits as it defers the need to increase the capacity of generation and transmission infrastructure.

There are a number of variable pricing components on an electricity bill which might deliver a price signal to alter behaviour. The two main ones are:

- Transmission Network Use of System (TNUoS) charges recover the cost of building and maintaining the transmission infrastructure for National Grid. For industrial and large commercial consumers these are referred to as ‘Triad’ charges.

- Distribution Use of System (DUoS) charges recover the cost to the distribution network operator of building and maintaining the system.

Other variable pricing components include:

- The Balancing Services Use of System (BSUoS) charge recovers the cost of the various actions National Grid takes to keep the system in balance at all times (such as demand response services). It is a flat fee which varies daily.

- Suppliers often offer a two-tier pricing model where electricity is cheaper at night. This reflects the lower wholesale electricity prices at this time.
Triad (TNUoS) charges

What are they?

National Grid charges levies against large consumers to help recover the cost of building and maintaining the transmission infrastructure. These are known as ‘Triad charges’ and are only taken from those who consume energy during the winter peaks.

There is a strong incentive for consumers to shift demand away from these periods of high system demand as the Triad charges can be highly punitive and are rising year on year.

When do they occur?

The Triads refer to the three half-hour settlement periods with highest system demand between November and February, separated by at least ten clear days.

They traditionally occur on a weekday between 16:30 and 18:00 but can only be determined after the winter has finished. Hence consumers must predict when the Triads will occur and decrease demand during these periods to avoid this cost.

Distribution Use of System (DUoS) charges

What are they?

Distribution Network Operators use DUoS charges to cover the cost of converting and transporting power from the high voltage transmission lines through local distribution grids to domestic, commercial and industrial consumers.

These local grids are expensive to operate and maintain. Around three times as much power is lost to heat and wastage through the low voltage distribution grids as in the high voltage transmission grid. DUoS charges are about £5.5 billion per year and typically make up about 16% of a typical electricity bill.

When do they occur?

DUoS charges apply at all times but are far greater in magnitude during times of peak demand on the local network (Red Band).

The Red Band window is defined but differs for each of the 14 distribution networks. Usually they occur around 4-7pm and only ever on weekdays.

The Capacity Market Levy

What is it?

The Capacity Market Levy recovers the cost of the contracts awarded in the Capacity Market. The charge does not vary by region and will be introduced in Winter 2016/17.

When do they occur?

The Capacity Market Levy is applied from November through to February on weekdays at 4-7pm.
Terminology

Grid Frequency. Grid frequency is a continuously changing variable that is determined and controlled by the second-by-second (real time) balance between system demand and generation (supply). If demand is greater than supply, the frequency falls. If supply is greater than demand the frequency rises. National Grid has a statutory mandate to maintain frequency at 50 Hertz (±1%).

Grid balancing. Grid balancing refers to the process of balancing electricity demand and supply to maintain grid frequency at 50 Hertz (±1%) and ensure the security and quality of electricity supply across the transmission system. National Grid procures a range of balancing services in order to manage this process.

Low response. In the context of a Frequency Response service, Low Response refers to an asset temporarily decreasing its electricity consumption. Low Response can be divided into two categories:

- Primary response. Asset responds within 2 seconds, reaches maximum capacity within 10 seconds and sustains this for 30 seconds.
- Secondary response: Assets responds within 30 seconds and sustains this for up to 30 minutes.

High Response. In the context of a Frequency Response service, High Response refers to an asset temporarily increasing its electricity consumption, delivering full service within 10 seconds and sustaining this for up to 30 minutes.