Hub Guide 8 – Overcoming Grid Constraint

Introduction

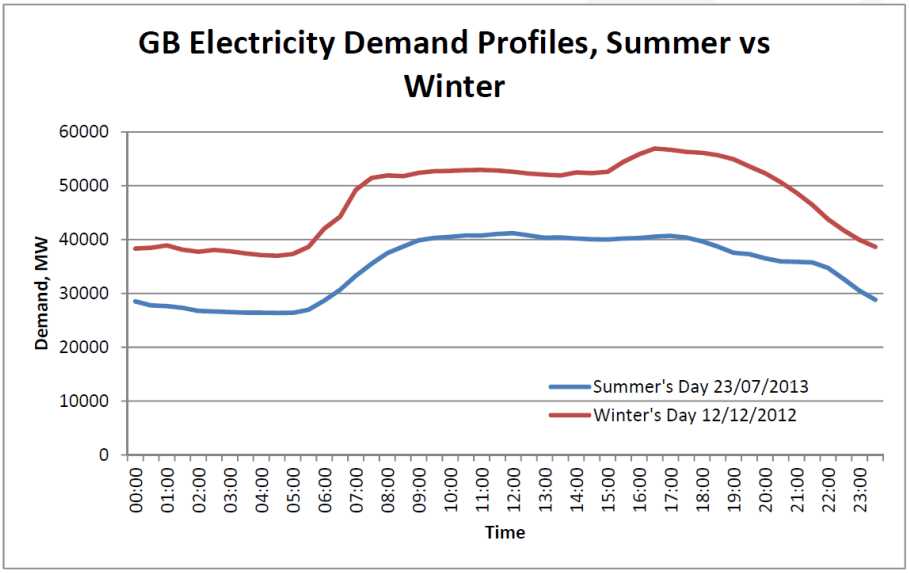
This Hub Guide is an introduction to assist anyone dealing with a grid constrained site. The Guide covers some background to how the network operates, why grid constraint occurs, some potential solutions and what steps you can take.

The Energy Hub has developed a series of Hub guides which are available on our website www.energyhub.org.uk. This includes Guides 5 - 7 about the power network. If you have any further enquiries after reading the guides, please contact info@energyhub.org.uk.

Background

The UK electricity system comprises generators and consumers. These are linked together by the national transmission network managed by National Grid, and regional distribution networks managed by Distribution Network Operators (DNOs). The power network operates to strict performance standards, both for frequency and voltage, from generation to the point of consumption.

The local network experiences specific load imbalances that affect the operating conditions at certain times of the day and seasonally, for example on cold winter evenings.



Graph 1: Seasonal and daily variations in GB electricity demand (DECC)

This creates fluctuation and imbalance in the network. These imbalances cause heat problems in the cables and transformers, which create both inefficiencies and network supply disruption. This may result in the consumer experiencing power supply loss (blackouts), equipment malfunction or a drop in performance due to reduced system voltage (brownouts).

The variability of these conditions is dealt with through several national and local mechanisms:

- The Capacity Market ensures that there is enough electricity to satisfy national demand
- The Flexibility Services Market deals with frequency response and imbalances between supply and demand
- Local network management curtails the export of power from generation plant onto the network.

How are network improvements achieved?

Planned improvement of the network is managed under the RIIO[1] price control agreement mechanism, which operates between each network operator and the energy regulator, Ofgem. These improvement costs are built into consumer electricity tariffs and are broken down according to which part of the network is incurring the cost.

Unplanned upgrades are either funded by the network operator or by those applying for a supply or export connection or wishing to change their current load requirements. The Electricity (Connections Charges) Regulations 2002 set out the rules where a request is made for a new or altered electrical connection. If the request requires reinforcement of the network (e.g. the installation on the network of upgraded cabling, transformers or other works) the cost is assessed by the network operator and allocated between itself and the applicant. Charges that are fully funded by the applicant include new cables and substations installed for the customer. Charges that are part funded are normally the cost of reinforcing the network to allow for the customer's connection.

Some of the outlay can be recouped when new customers connect to the upgraded part of the network, using a mechanism termed the *second-comer principle*, based on the new customer's connection application fee. These second-comer application fees may be passed on to the first customer or retained by the DNO, based on what was funded by who during the original upgrade, and how much new load is being requested. This arrangement is time-limited, as is the charge for any new connections, with specific timescales agreed with the network operator. Changes to the regulations in 2017 take account of the situation where an Independent Connection Provider (ICP) has undertaken the work.

1 RIIO (Revenue=Incentives+Innovation+Outputs)

Network improvement costs can in certain cases cost several million pounds, should the new connection application result in the need to upgrade the distribution network or the distribution network-transmission grid interface. In addition, since the DNO is not allowed under Ofgem RIIO rules to upgrade ahead of need, there could be a delay of months or years, should the applicant decide to wait for the upgrade to be completed as part of the DNO's planned improvement programme.

The DNO operates a waiting list for connections, termed *committed reserve*. This arises where offers for a new connection have been made by the DNO, which is then obliged to allow the applicant time to agree for the work to proceed. Specific applications are commercially confidential; as a result, new applicants may be aware that they are in a queue without knowing who is ahead of them, or for how long that committed reserve will be held pending action.

Possible Solutions

There are solutions which can be applied now or will become commercially viable and acceptable as alternatives to traditional reinforcement of the network.

Demand-side management

Reducing electrical demand should always be a key consideration for those designing or refurbishing sites (i.e. buildings and associated site infrastructure, plant and equipment) so that the connection cost can be kept to a minimum. This can be achieved through a range of site design, building-fabric efficiency and control measures for all areas of electrical consumption. A simple example is better building-insulation measures, or design orientation to capture or dissipate electrically-generated heat passively to avoid mechanical cooling.

The electrical function of the building can be managed using a Building (Energy) Management System (BEMS or BMS) which can integrate monitoring and performance data with active, automated demand management. These systems can be managed by an on-site server, or (increasingly) be cloud-based and managed remotely to meet set performance criteria. Building and property managers can realise operational, financial and carbon-saving benefits, by making sure that their building management system keeps the building working efficiently and to agreed conditions that are appropriate to its use.

Many domestic and small business consumers can already manage their building's performance themselves, with the introduction of monitoring and control using a smart meter. This can be achieved in a variety of ways, to deliver energy, carbon and cost savings. The simplest technique for consumers is to use time switches to change the profile of demand, to help move consumption from peak tariff period, to a period of the day when tariffs are lower.

Demand diversity

This approach can be applied during the design of new developments, or where developments are seeking more power from the grid beyond their current connection capacity. The idea is to manage potential imbalance, by creating mixed-use developments with different consumption profiles, which are complementary and when brought together, create a smooth load profile at the nearest sub-station.

Connecting to local generation

Building operators can use locally-generated power, for example solar or wind, rather than import power from the local network. This could take the form of power generation located on-site and connected into the building's electrical system on the customer side of the consumption meter (termed *behind the meter*). Alternatively, a private wire connection could be employed, which involves installing a cable from a source of generation directly to the point of power consumption. The demand could be an individual building, a single consumer with several buildings, or a range of users located close to each other.

Depending on the demand, the generation offsets some or all the grid power that would usually be used by the consumer. This approach can work out cheaper than securing additional connection capacity, but there are legal, commercial and technical disadvantages.

Grid sharing

It may be possible to share a connection with one or more parties. This could be an appropriate solution, for example where there is an existing nearby connection which has spare capacity, or where there are multiple developments, each seeking a connection. This approach could also allow the opportunity to connect to local energy generation through an additional private wire arrangement.

It is already commonplace, particularly for new housing and commercial developments, to develop a private distribution network. This then connects to the DNO network, with the responsibility of meeting the regulatory and technical standards up to the connection point, falling to an Ofgem-licensed Independent Distribution Network Operator[2], which undertakes the local role of the regional DNO.

Moving towards an actively managed network

Third party companies offer services which aggregate demand management across individual consumers, selling this *aggregation* into the Flexibility Services Market[3]. The aggregator installs active control and monitoring to be able adjust the performance of electrical equipment located on the local network, typically in response to network demand. This approach can deliver benefit for the network, as well as generating consumer cost savings and revenues.

2 https://www.ofgem.gov.uk/electricity/distribution-networks/connections-and-competition/independent-distribution-network-operators
3 https://www.nationalgrideso.com/balancing-services/frequency-response-services

Some energy suppliers offer variable tariffs to incentivise consumers to change their pattern of energy use (termed their *power profile*) to times when their tariff is lower. An example of variable time of use tariffs is offered by *Agile Octopus*, who go further by trying to match local demand and generation.

Where new generation could cause major network imbalance, DNOs may address this by offering *flexible connections*. The DNO's connection offer is conditional on the generator either turning down or stopping export of power when there is a network imbalance. In return, the generator can secure a connection where traditionally the DNO would have refused to grant one. This approach can be applied in reverse for certain consumers, who may be prepared to accept a disrupted supply in return for access to the network.

Some DNOs are also offering to pay local generators and consumers for additional local flexibility, to help balance the network in areas of significant constraint. The benefit to the local generator or consumer is additional revenue or income, while the DNO can reduce stress on the system and delay the cost of investing in the network. The current Piclo Flex service is an example of DNOs offering contracts for flexibility in areas of significant constraint that occurs during winter evenings.

Developing a smart grid

A smart grid is an electricity network that can intelligently integrate the actions of all users connected to it – generators, consumers and those that do both (called *prosumers*) – to efficiently deliver sustainable, economic and secure electricity supplies. The key elements of a smart grid are:

- Smart meters – recording and disseminating consumption and generation data, usually at half-hourly intervals
- Energy assets – consuming storing or generating power
- Internet-based connectivity for monitoring and controlling site equipment – smart grids are created by adding information and communication technology (ICT) to existing power networks
- New tariff models to allow consumers to realise the benefit of shifting their demand away from peak periods of the day.

This can be applied to a small part of the network called a microgrid. This is a local energy grid with control capability, which means it can disconnect from the traditional grid and operate autonomously for periods of time, although a grid connection will continue to be required in most cases unless the scheme is fully independent (termed *islanded*).

The key benefits of this approach are:

- Increased ability to deploy local renewable generation
- Reduced network imbalance reflected in reduced operating costs of the network
- Reduced energy losses across the network
- Avoids or defers investment in expensive network upgrades.

These benefits should result in:

- Decarbonisation of the electricity system
- Reduced investment and operating costs, which could be passed on to the consumer through their tariff
- Opportunities for new stakeholders to engage in the market through new business models as prosumers
- Potentially reduced consumer costs who may also be able to take a further step towards local trading of power, termed *peer-to-peer energy trading*.

The role of your DNO

Some of the approaches set out above are already available to you, even if your site does not face a grid constraint. However, where there are connection challenges, whether to add new load or generation to the network, the DNO will need to know your requirement in kVA or MVA[4]. Therefore, it is worthwhile having an early discussion with the DNO, along with obtaining any specialist advice from a qualified electrical engineer, to anticipate any network issues that could affect your development.

All DNOs provide various forms of heat maps, which provide customers with an indication of how easily they would be able to make a connection in any DNO area. This is done by indicating the capacity that is available and any constraints that apply. Information on available capacity is set out in each DNO Long-Term Development Statement (LTDS). This provides useful information on substation loadings and fault level in a standard tabular form, primarily for 33kV and 132kV voltages. Both are freely available through the respective DNO website and are a useful indication of whether you are likely to encounter a connection constraint.

DNOs generally provide surgeries, where customers can meet with DNO design staff to look at specific areas and gain an insight into the likely costs to connect, before making a formal application. Some may cater for ad-hoc requests for advice. This may be a charged-for service.

Some DNOs may also encourage an optioneering approach. This allows customers to submit several different capacities for the same site and receive budget costs, allowing a preferred option to be progressed to a formal offer.

4 kVA – kilovolt amperes, MVA – Megavolt amperes

DNOs themselves are undergoing transformation to become active network managers, called Distribution System Operators[5]. Currently the DNOs control and maintain the distribution networks. Under the DSO model, the operator will take a more active role in managing local electricity generation and use. Under this new model, the DSO securely operates and develops an active distribution system, which comprises networks, demand, generation and other flexible, distributed energy resources.

What steps can I take?

NOTE: Early dialogue with your DNO is vital to be able to assess whether you can use these techniques in your circumstances. Specialist advice should always be sought from a suitably competent professional.

The following steps may help you develop a strategy to alleviate unnecessary grid upgrade costs:

- For existing sites, there are some initial things to locate; these include your metering arrangements - how many connection points there are, the Meter Point Administration Numbers (MPAN) and the rated voltage and load rating at the point of connecting to the network. This information may be displayed or published on your original connection agreement(s) or associated DNO-approval documentation.
- Establish the site load and energy consumption profile, using best available actual data (e.g. half-hourly metered data through your energy supplier) or where this is not available, using benchmarks, for example published by the Chartered Institution of Building Services Engineers (CIBSE)[6], the Building Services Research and Information Association (BISRIA)[7] or using BEES Sector tables[8].
- For new sites, or where you plan to grow an existing site, estimate the anticipated load and consumption profile, based on current regulatory standards (i.e. Building Regulations and local planning conditions) to give you a Business as Usual (BAU) scenario. This will need to be broken down, where relevant, into residential and specific commercial uses (e.g. office, industrial, warehouse unit); also include any specific equipment loads like ventilation, refrigeration or motors.
- Using the techniques set out above, design your alternative site scenario, incorporating generation, storage and demand management capabilities, to reduce both the demand load and variability in load profile.
- The DNO will be able to estimate the cost for a grid upgrade and the financial contribution they would require and, where offered, set out connection cost options based on the BAU and alternative.

5 http://www.energynetworks.org/electricity/futures/open-networks-project/open-networks-project-overview/
6 https://www.cibse.org/Knowledge/knowledge-items/detail?id=a0q20000008I7evAAC
7 https://www.bsria.co.uk/about/
8 https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees

Where to go for help

Weblinks for Distribution Network Operators:

- Electricity North West
- Northern Powergrid
- Scottish Power Energy Networks
- Scottish & Southern Electricity Networks
- UK Power Networks
- Western Power Distribution
- Electricity Distribution Map – regional grids and operators
- Energy Networks Association
- Independent Distribution Network Operators

What the Energy Hub can offer you

The Energy Hub can help you in the following ways:

- Online and telephone advice
- Access to case studies, briefings and guidance from authoritative sources
- Signposting to other supporting organisation
- Brokerage and stakeholder engagement
- Project structuring and critical review.

Legal Disclaimer

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