ElectraLink

*The ElectraLink guide to*

# Smart Grid and Metering

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*Disclaimer*

This is intended to be a brief, informal and easy to understand guide to some of the issues around smart grid and smart metering. It is not exhaustive as both these areas are developing rapidly. Please contact ElectraLink if there are any areas you would like to discuss further.


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# Energy past, present and future

Climate change. Energy security. Rising energy demand. Renewables. Technology. These are some of the issues shaping our energy future. In the UK we have a heritage of a stable, reliable energy supply, underpinned by excellent engineering and long-term investment in power generation, transmission and distribution. Power flows from centralised generation (predominantly gas, coal and nuclear power stations) through transmission and distribution networks to consumers. When we switch on the lights, we can be confident they will work.

But all this is going to change.

*(Well, hopefully not the bit about the lights working)*

Climate change is forcing us to cut carbon emissions. Oil and gas reserves are finite; geo-politics and economics dictate we don't rely on them too heavily. Energy demand is rising (recession driven downturns notwithstanding). And technology (e.g. electric vehicles, heat pumps) asks more of our resources, but offers answers too.

It seems likely that the future will see a change both in generation mix, and the ways in which power flows. We will see new centralised generation (lots of new nuclear for example), but also lots of new distributed generation. Power will continue to flow out from the centre, but we'll also see more two-way flows: the steady state base power generated by nuclear will be complemented by highly variable and local renewable generation such as wind and photo-voltaic (PV), meaning that at different times different areas will either be exporting or importing energy. And to make this work, there will be a step-change in the information we collect to monitor and run the network.

We're now at the start of a transition – we need to figure out how to move from the centralised grid around which we designed all our energy consumption – electricity flowing from large, predictable generation plant through transmission and distribution networks to consumers, to a grid where there is more, smaller, less predictable and more distributed generation, with power flowing in different directions at different times.

All this while ensuring stability and continuing to keep the lights on.

They are big issues, and the challenges are huge. "Smart" is a word of the moment, and will be for the next few years.

# What is a Smart Grid?

If you search for "Smart Grid" you'll find plenty of helpful definitions.

The term "Smart Grid" seems to mean different things to different people and in reality probably encompasses a broad range of business and engineering developments, frequently serviced by some kind of ICT. In general,"Smart Grid"falls more in the domain of the electricity distribution and transmission organisations, compared to"Smart Metering"where, in the UK at least, the thinking is more around supplier businesses.

In December 2009, the Energy Networks Strategy Group (ENSG) published "A Smart Grid Vision" for the UK[1]. The "vision" includes a definition of smart grid, which is probably as accurate as any :

"A Smart Grid as part of an electricity power system can intelligently integrate the actions of all users connected to it - generators, consumers and those that do both - in order to efficiently deliver sustainable, economic and secure electricity supplies."

The sorts of things that Smart Grid includes are:

- Smart Metering (you need to measure it before you can control it)
- Demand Response (managing consumption in response to supply conditions)
- Energy Storage (storing excess generated power so it can be used at times of higher demand)
- Active Network Management (optimising the network in real time to get more capacity before reinforcement is required)
- Renewables (integrating large scale renewable / micro generation into the distribution grid).
- Micro-grids (networking a collection of small, modular generation sources in a low voltage distribution system)

Smart grid technologies can be de-centralised (e.g. remote micro-grids, localised generation) or centralised (e.g. aggregation of micro-generation to form a virtual power station). We'll talk about all these ideas in the next few pages.

1 Available at http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/network/smart_grid/smart_grid.aspx



### *Smart Metering*

Isn't that covered in the second half of this guide?

Well yes, but smart meters are a key part of any smart grid. A smart meter doesn't just record meter readings. It can also measure voltage and current profiles, phase sequence and angles, active and reactive power, distortion, outages and more. All of which could be very helpful to the network operator in understanding quality of supply issues.

What can we do right now?

We're a way off having a smart meter in every home (see the section later on for timescales), and maybe that would give a network operator more data than they really want anyway. But there are things we could do more quickly. For example, putting a smart meter into secondary substations could reveal a lot of information about where losses are occurring. And we could also use that to more quickly identify outages and other problems.

### *Demand Response*

Demand Response is all about being able to flex your demand in response to supply conditions (prices). This can work on different scales; an electricity trader can manage a portfolio of responding sites whereas a consumer could use price sensitive appliances to do their tumble drying at the optimal time.

What about supply response? Essentially that's what we do now. Generation is flexed to meet demand, with National Grid continually balancing the system. The problem with supply response is that it is inefficient - in order to respond rapidly coal and gas plant need to be kept warm on standby. And of course we're going to see much more nuclear generation in future - and since nuclear is either on or off - it doesn't help at all with balancing.

### *Portfolio Management*

If a trader can manage the demand across their portfolio, they can seek to gain value in a number of areas e.g:

- Get the best market price before gate closure
- Reduce imbalance costs (e.g. by reducing demand if renewable generation is less than expected)
- Frequency control (get paid for providing frequency control services)
- Triad (reduce demand in the three peak half-hour periods in winter).

The EU funded EU-DEEP[2] project tested this approach in the UK and concluded that demand response could be profitable down to a flex level of somewhere between 40KW and 140KW.

(that's something like the equivalent of between 1600 and 5600 domestic freezers being switched on or off)

2 http://www.eu-deep.com/

### *Smart Appliances*

If price signals were published in real time then smart appliances could in principle switch themselves on or off in response. Assuming that this price sensitivity was reflected in tariffs, consumers could perhaps be motivated to reprofile their demand to reduce peak load. This in turn should lead to a more efficient generation portfolio, as there would be a reduced requirement for generation to be on standby to meet peaks in demand.

This is a part of the scope of another EU funded project, known as BEYWATCH[3]. There are plans to do a trial of the concept in Loughborough. And in the US manufacturers such as Whirlpool and GE are motoring ahead with smart appliances such as water heaters[4] and tumble dryers.

3 http://www.beywatch.eu

4 http://www.genewscenter.com/Press-Releases/HD-Supply-Utilities-Offers-New-GE-Hybrid-Water-Heater-with-Energy-Efficiency-and-Demand-Response-Capability-2139.aspx




### *The Smart Home*

Smart appliances could be one element of the "Smart Home" – a home that automatically manages its energy use and digital content (entertainment), security, and perhaps enables eHealth management (e.g. remote access by health professionals to patients at home).

### *Energy Storage*

Compared with other commodities (gas, orange juice, pork bellies etc...) electricity has historically been very difficult to store. As a consequence, our infrastructure is engineered to meet peak demand, which means that much of it is running at less than capacity for significant periods of time. That's why we need to keep those inefficient coal and gas power- stations on standby and we build networks that for much of the time are over-specified. Renewables could make that problem even harder. But renewables coupled with energy storage could be a powerful combo – wind and solar being used to store up energy reserves which can then be discharged at peak times, smoothing out the demand curve.

The pumped storage scheme at Dinorwig in North Wales is agreat example of large scale energy storage – water is pumped uphill at times of low demand. Other types of energy storage include:

- Batteries – particularly interesting when we think about electric vehicles and the huge storage capacity they might have – they could be used for emergency generation or load balancing. Batteries could also be integrated with photo-voltaic cells.[5]
- Compressed Air – air is compressed and stored, and then mixed with fuel to power combustion turbines.
- Hydrogen – electricity is used to produce hydrogen, which can later be combusted.

There are many more, and this is a very exciting field.

5 See for example this scheme in Manchester: http://www.manchester.gov.uk/info/200105/sustainability/4001/electric_car/1



### *Active Network Management*

Active Network Management (ANM) is what is says - monitoring and controlling the distribution network actively, rather than passively. It is particularly pertinent when considering the technical constraints around connecting and operating renewable or distributed generation – which by their nature tend to be intermittent. Passive management of these would be about reinforcing the network, or limiting generation capacity, to cope with the worst-case scenario. Active management is about managing generation and constraints in real time and integrating with other smart grid technologies to make optimal use of the network without requiring reinforcement.

### *Renewables*

Renewables are a driving force for smart grid technologies - the variability of renewable generation means that we need more in the way of automated management. The UK Renewable Energy Strategy 2009 highlights smart grid as an enabler for swifter deployment of renewables.

### *Renewables Obligation*

How do we support investment in renewables? Currently this is done via the Renewables Obligation (RO). Put simply, UK electricity suppliers have been obliged to source an increasing proportion of their energy from renewable sources. Generators of renewable electricity are given a Renewables Obligation Certificate (ROC) for every MWh of renewable electricity generated, and the ROC transfers to the purchasing supplier. Suppliers then meet their obligation by presenting sufficient ROCs – so they need to buy enough ROCs to meet their obligation. Where suppliers can't cover their obligations with ROCs they have to pay an equivalent amount into a fund, the proceeds of which are then shared out between those suppliers who did meet their obligations. So suppliers are incentivised to buy renewable electricity.

### *Feed-In Tariffs*

*Coming soon to a house near you - wind turbines, photo-voltaic cells, biomass...*

Feed-In Tariffs will make installing renewable energy in your home much more rewarding. As well as cutting your electricity bill – by generating some of your own – you'll be paid for every unit of power you create. That's right – read it again. You benefit twice for every unit you produce.

- A fixed payment for very unit generated
- A payment for every unit exported
- Offset of import costs.

The consultation process in ongoing. You can probably guess that the renewable lobby argued for higher tariffs; other parties argued for lower tariffs in order not to distort competition. By way of example, a wind turbine of less than 1.5kW would attract a generation tariff of 30.5p per kWh.

A PV installation could attract up to 36.5p per kWh. Export prices are likely to be in the region of 5p/kWh – so there's money to be made. Government think the tariff levels should provide a rate of return to small investors in the region 5-8%.

## But I still can't afford the up-front investment...

Even though the FITs should help make investment in renewable energy worthwhile, there still are of course many people who won't be able to meet the up-front cost. Consumers may expect to see a range of energy companies taking advantage of the new incentives, offering services to install renewable generation at your property, and handle the finance for you.

### *Green Deal*

## What is the Green Deal?

The Energy Bill introduced to Parliament on 8 December 2010 includes provision for the new 'Green Deal', which is intended to revolutionise the energy efficiency of British properties.

The Government is establishing a framework to enable private firms to offer consumers energy efficiency improvements to their homes, community spaces and businesses at no upfront cost, and to recoup payments through a charge in instalments on the energy bill.

At a local level, the Green Deal will enable many households and businesses to improve the energy efficiency of their properties without consuming so much energy and wasting so much money. A quarter of the UK's carbon emissions come from the energy used in homes and a similar amount comes from our businesses, industry and workplaces. At a national level, the UK needs to become more energy efficient to reduce its greenhouse gas emissions, which risk dangerous climate change. The Climate Change Act 2008 legislated for a reduction in our carbon emissions and set legally binding carbon budgets across all sectors of the UK economy — including our homes, communities and workplaces.

### *Micro Grids*

Micro Grids are low voltage distribution systems of small generators, which can be connected to the main distribution network, or can be operated in "island" mode i.e. disconnected from the rest of the network. They can also encompass techniques such as micro pumped storage, battery storage, micro-CHP and micro-generation.

The concept has again been tested by an EU funded project – there is a presentation at:

http://ec.europa.eu/research/conferences/2009/smart_networks/pdf/microgrids.pdf

Micro grids may be suitable for regions that are geographically distant from main networks. Interest in the UK may be more around networks for communities or green developments.

### *Electric Vehicles*

Step out in the streets of Britain today and the chances are you won't be hit by an electric vehicle. Wait a few years though and the situation could be very different. London[6] and Newcastle[7] are just two cities that have announced electric car ambitions, and the UK government is keen[8].

Electric vehicles pose challenges but also opportunities for electricity networks. Charging your battery as soon as you get home from work would be a big no-no – coinciding with the evening peak demand would cause serious problems. But programming it to charge over- night (maybe from 1am to 6am) might help smooth the demand profile over the 24 hour period. Will network assets be able to meet even this demand? Charged car batteries could possibly be used as a giant energy storage reservoir, sending power back into the network to smooth out the peaks. Are battery technologies up to this? Will consumers want to participate? Will it be economical?

Electric vehicles will require a new infrastructure – a roll-out of physical charging points and supporting network assets, a billing and revenue control framework, as well as everything else needed to enable delivery of electric vehicles to a mass market.

6 http://www.london.gov.uk/view_press_release.jsp?releaseid=22080
7 http://www.onenortheast.co.uk/page/news/article.cfm?mode=search&articleId=3837
8 http://www.dft.gov.uk/pgr/sustainable/olev/

# What about Gas?

Most of the smart grid talk at the moment is about electricity. Gas is different – it can be stored and it takes a long time to get from the beach to the supply point, so there isn't the same need for real-time balancing of the system. However, look out for gas innovation too – active control of thermostats, for example, could help to ease peak load constraints.

Gas storage is beginning to play more and more of a vital role in the wider gas market by increasing the reliability and security of supply and demand in many regions around the globe. Gas storage facilities are becoming increasingly important to secure future supplies of gas for customers, power stations and for the UK as a whole as our dependence on imported gas increases. At present, the UK can only store around 4% of our annual gas consumption, compared to Germany and France who have the capacity to cover over 20% of their needs.



# What is Smart Metering?

Smart metering will radically alter the way we record and manage energy consumption, with the ability for consumers and suppliers to monitor – in close to real time – how much energy is being used and what the cost of that energy is. And smart metering is a necessary part of the smart grid.

A smart meter can record Time of Use (ToU) consumption i.e. it measures when consumption occurred (down to the half hour or smaller interval), as well as how much was consumed. ToU data is useful because that information can be used to encourage consumers to change their behaviour.

Smart meters can send and receive information or instructions – so, as well as reporting ToU data or register readings, they can support credit and pre-payment modes, accommodate different tariffs, send messages to the consumer and allow remote enabling or disabling of supply.

Smart meters can be used in electricity, gas, water and other metering situations - although the costs and benefits in each case will be different.

### *The Benefits of Smart Metering*

Many benefits are articulated, with different emphasis depending on who is talking:

- Accurate billing
- Improved retail competition
- Tariff innovation with ToU tariffs
- Better, lower cost, pre-payment service
- Lower costs for suppliers, due to use of accurate data, and automation of the meter reading process
- Enablement of smart grid technologies
- Energy efficiency and reduced carbon emissions

From an EU legislative point of view, increased retail competition is the key benefit. For suppliers there is the opportunity to both cut costs and innovate. Governments are keen on the envisaged carbon savings.

### *Talking to Meters*

A head-end system is used to manage communications to meters. A variety of technologies are proposed for the head-end to meter link:

- GPRS (always on, can cope with large volume of data, pay by usage)
- Power Line Carrier (slower response times, effectively free from meter to data concentrator but then need GPRS back to the head end)
- Wi-Fi (relatively cheap, high power requirement means limited coverage)
- Radio (long range, requires additional infrastructure)
- Broadband (high bandwidth, could piggy back Digital Britain rollout, but not owned by utility company)

### *Security*

During the next decade UK energy networks will have an increasing dependency on data and system availabilityarising from the deployment of automated generation, demand management and grid control measures. The integrity and availability of data and systems to support these functions will become increasingly critical to the operation of UK energy grids. Furthermore the integrity, authorisation and non-repudiation of data requests and meter control transactions must be ensured to address the risks from erroneous data or unauthorised access.

### *The Data Communications Company*

Communications between smart meters in domestic consumers' homes and authorised smart meter data users will be co-ordinated by a new, countrywide data and communications body. This new central body will have a key role in both data and communications services and is referred to as Data Communications Company (DCC).

DCC will have a pivotal role at the heart of the energy industry. It must deliver a cost efficient and resilient service and be flexible enough to adapt to developments in the industry. DCC will be responsible for the procurement and management of smart metering data and communications services.

The Data and Communications Company Group (DCCG) at DECC is currently engaging with stakeholders on the design and delivery of DCC, the procurement of its data and communications services and other data and communications matters related to the Foundation Programme.

### *How Will Consumers Respond?*

A number of suppliers ran Trials in 2010 to look at how consumers respond to having better information about their energy consumption.

The trials are made up of a combination of interventions: smart meters, real-time display devices, additional billing information, monthly billing, energy efficiency information and community engagement. Due to complete in Autumn 2010, reports on progress are available six monthly. You can read these reports and make your own judgement.[9]

It is planned that the roll-out of smart meters will include issuing a Home Display Unit (HDU) to households. This will be a device that communicates with the meter and presents energy consumption information in a relevant and useful way that enables consumers to better manage their use of energy. This could be an area for innovation and differentiation between suppliers.

Security and privacy are also of course big issues for consumers.

Concerns have been raised about access to data and how this data might be used. For example, perhaps your energy supplier could examine your half-hourly consumption of electricity to determine when you turn on the dishwasher and glean more information than you'd like about how you live your life. There are of course many instances where we make detailed information about ourselves available (think supermarket loyalty cards etc...) but perhaps the difference here is in the perceived lack of ability to opt out.

9 http://www.ofgem.gov.uk/sustainability/edrp/Pages/EDRP.aspx

# What's the Plan?

DECC issued a Smart Metering Implementation -Prospectus on 27th July 2010. It included a statement of design requirements, a commercial and regulatory framework, a timetable for the roll-out and a plan for the rest of the smart metering programme.

August 2011- DECC issued the DCC Services Contract Notice

- Q4 2012 – DECC award the DCC Services Contract
- Q4 2012 – DECC award the DCC License
- Q2 2014 – the DCC Services go Live

The detailed design is underway, preparing functional specifications for smart metering and the detail of the commercial framework. As well as the central systems, energy companies will need to design changes to their systems (such as customer billing etc....).



# ElectraLink's Position

ElectraLink's business is all about supporting the market – from the data and network level right up to the governance of the inter-party agreements that enable smooth market operation. To this end ElectraLink is continuing to work with DECC on a number of Smart Metering Design Groups.

Suppliers are already installing smart meters to some customers. What happens to those meters when the central programme kicks in? Will they be left as stranded assets, and in this interim period what happens when there is a change of supplier?

- Local devices – will a meter work with a home display unit from a competing manufacturer?
- Meter communications – will a meter communicate with a head-end system from a rival company?
- Market – can a new supplier continue to operate a smart meter that was installed by an old supplier?

ElectraLink remains focussed on helping to solve these problems during this period by working with industry to provide innovative ways to ensure smart meters remain 'smart' The interim service allows suppliers to operate a smart meter service for consumers, while delaying large investment in smart metering infrastructure and back- office systems until the DECC Smart Metering Implementation Programme has produced the Prospectus and Detailed Design.A demonstration of ElectraLink's concept has been developed by Siemens, with Software AG and eMeter. This demonstration capability forms part of the proposal currently being made to the Big 6 suppliers.

ElectraLink has extensive experience of developing technical service specifications, open procurement, programme and project management through performing our industry role as the Data Transfer Service Controller. We are now well placed and able to provide a team of experienced high calibre consultants to advise the industry on the crucial stages of specifying, procuring and operating smart metering infrastructure services.

# Who are the Stakeholders?

There are many; these are a few of the“central”bodies.

- Association of Meter Operators – trade association representing meter operators. www.meteroperators.org.uk
- Consumer Focus – statutory organisation campaigning for a fair deal for consumers. www.consumerfocus.org.uk
- Department of Energy and Climate Change (DECC) – they are setting the political and government framework within which smart metering will operate. www.decc.gov.uk
- Energy Networks Association (ENA) - the industry body for UK energy transmission and distribution licence holders and operators. Would want to see a greater role for distributors. www.energynetworks.org
- Energy Retail Association (ERA) – represent the views of the “Big 6” suppliers, which may or may not coincide with those of some of the smaller suppliers. www.energy-retail.org.uk
- Gas Forum – membership organisation for gas shippers and suppliers; consulted by DECC, OFGEM. www.gasforum.co.uk
- MRASCo – administers the MRA and undertakes development activity in relationship to UK electricity processes. Big changes if there are radical changes to the processes. MRASCo is serviced by Gemserv. www.mrasco.co.uk
- National Grid – owns the electricity transmission network in England and Wales; operates the entire system throughout the UK. Owns and operates the gas transmission system throughout Great Britain, and also has a gas distribution business. www.nationalgrid.com
- OFGEM – Office of Gas and Electricity Markets – will regulate changes brought in with smart metering. Currently overseeing the Energy Demand Research Project (EDRP) trials and managing development of the Smart Metering Prospectus. www.ofgem.gov.uk
- SPAA Ltd – administers the Supply Point Administration Agreement in gas. Big changes to process if there is process convergence. Serviced by ElectraLink. www.spaa.co.uk
- Xoserve – operate the gas central IT systems. Running Nexus refresh programme – possible huge impact by smart metering. www.xoserve.com



*Smart Grid. Smart Metering. Everybody's talking about them, but what are they? This short, informal guide will give you a heads-up on some of the issues. It's a fast moving field so stay up-to-date by contacting ElectraLink.*

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