Smart Grid – enabling energy efficiency and low-carbon transition

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OVERVIEW

Climate change and energy security have emerged as key issues in many countries. Achieving a low carbon economic transition and energy-security in the UK will involve big changes to the way it supplies and uses energy.

Smart grid is a key to deliver low carbon electricity more efficiently and reliably. It allows integration of new forms of renewable sources, enables consumers to manage and reduce energy use and minimises costs to the benefit of all. The UK is at the forefront of smart grid development, through investing and taking action on policy and commercial requirements, innovation and research.

I. What is a 'SMART' GRID?

A smart grid is all about information and control. **A smart grid is fitted with information and communications technologies (ICTs) to the electricity network to enable a real-time, two-way communication between suppliers and consumers, creating more dynamic interaction on energy flow, which will help deliver electricity more efficiently and sustainably.**

Key ICTs elements will include sensing and monitoring technologies for power flows; digital communications infrastructure to transmit data across the grid; smart meters with in-home display to inform energy usage; coordination, control and automation systems to aggregate and process various data, and to create a highly interactive, responsive electricity grid that can maintain a demand-supply balance on a second-by-second basis.

II. Why will we need a 'SMART' GRID?

Today's grid is very reliable and can deal with normal fluctuations in electricity use. The size of electricity grid and power stations are generally built at capacities that can comfortably meet peak demand, and it involves flexible but high-carbon electricity generation technologies that adjust supply quickly in response to day-to-day fluctuation in demand.

However, the path to decarbonisation will present new challenges in electricity control.

1. A change in electricity demand at the distribution level is expected as consumption patterns shift, such as higher electricity load with the use of electric vehicles.
2. Electricity generated from renewable sources such as wind and solar is variable, and nuclear energy has inflexible output.
3. Localized renewable generation like roof-top solar panels installed at household and community level provides a useful energy source to meet local demand, changing the size of electricity drawn from the distribution network and requiring connection that can supply onto the electricity network when in excess.
4. Connection with offshore wind generation as well as greater interconnection with other countries to allow imports and exports of renewable energy.

The deployment of these low-carbon technologies will mean less predictable electricity production as well as changing load patterns and a need to enable electricity flow in both directions, thereby requiring new, flexible ways of balancing supply and consumption.

Smart gird will take us a step further towards an affordable, low carbon energy system, allowing integration of renewable energy and green technologies while benefiting customers in cost savings through efficient energy use at home and in the electricity system.

III. Benefits of Smart Grid

1. **Deliver more precise demand side management**

   With the application of ICTs in a smart grid, suppliers can read the real-time information on electricity consumption and make use of demand side management strategies like dynamic tariff and compensation schemes to engage consumers to reduce usage or shift demand to off-peak periods to optimise the demand-supply balance.

Demand side management
Demand-side response (DSR) is changes in energy use by end-users in response to an incentive. This change in customer behaviour could be used to provide flexibility in our energy system to, amongst other things, counteract intermittency in renewable generation. The roll-out of smart meters provides an opportunity for all customers to engage with demand response.

2. **Greater information, improved energy efficiency and reduced bills**

   Smart metering gives consumers a clearer picture of energy consumption. The visibility helps them control electricity use more efficiently, save money and reduce carbon emissions. The dynamic tariff provided by suppliers will further reward consumers for energy use at off-peak and lower prices times.

3. **Minimise costs and allow maximum use of capacity**

   Improved demand management can reduce peak demand and permit overall increase of electricity use in off-peak periods without building costly new power plants. Not only will this save the costs passed onto customer bills, it will also reduce the reliance for peaking generation from high-carbon stations.

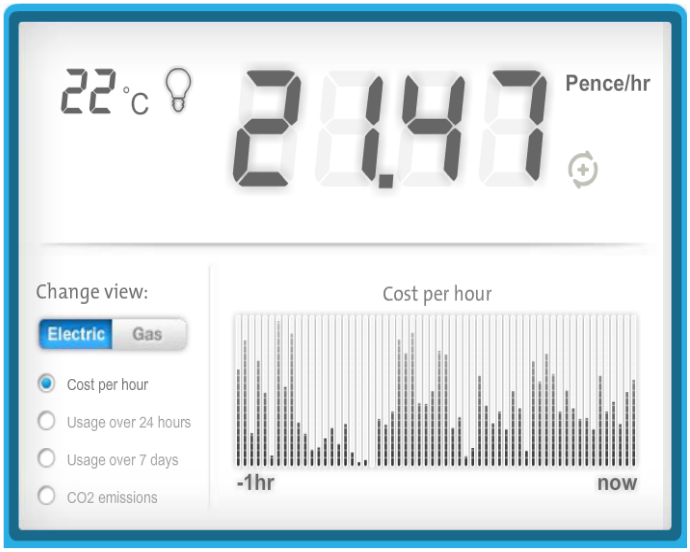
4. **Increase network control and support integration of renewable generations and low-carbon technologies**

   A highly automated and responsive smart grid that continuously provides and processes information on system conditions will enhance the ability to monitor and manage fluctuations, including from distributed and renewable energy generation. It also means greater visibility of the network, which helps identify problems more quickly and improve the overall stability and reliability.

IV. SMART METER – a key component

Smart metering is a key enabler of a smart grid. The rollout of smart meter is a major national programme in the UK and one of the largest and most complex investment programmes undertaken by the energy industry. With the foundation stage started in 2011, 53 million smart meter for electricity and gas meters will be installed across all households and small non-domestics premises between 2015 - 2020.

What is a Smart Meter?
Unlike traditional meters which have to be read physically to give a customer or supplier information about how much energy has been used, they automatically pass accurate meter readings to energy suppliers and support smart appliances. Domestic customers will be offered an In-Home Display (IHD) linked to their smart meter, enabling them to see what energy they are using and how much it is costing.



The **benefits of smart meters** include:
Consumers benefits:

- **Reduction on energy consumption and save money** as a result of better information on costs and usage which drives behavioural change
- **Accurate meter data and bills** for customers
- Provide accurate measurement of electricity export to grid from localised micro-generation, **enable opportunity for localised generation**

Businesses benefits:

- **Reduced operation costs** for suppliers in reading meters, handling disagreement on readings and regular inspection visits
- Ability to monitor consumption patterns and provide **better information to suppliers to manage electricity network**
- **Support the development of new services** such as time-of-use tariff
- **Benefit from electricity loading shift** brought by customers shifting demand from peak to off-time hours in response to different cost signals.

Clear value in smart meter adoption
UK's latest Impact Assessment in 2013 estimates a positive net present benefit of £6.7 billion over the period to 2030, by delivering total benefits of around £18.8 billion and costs of around £12.1 billion. At consumers' level, an annual bill saving of around £24 a year by 2020 is expected, rising to £39 a year by 2030.

More than 50 countries are installing or planning to install smart metering equipment, with individual states in the US, Canada and Australia having their own roll-out programmes. Some common drivers include:

- increase competition in the electricity market which is a major motive for the Danish roll-out.
- improve the efficiency of the electricity distribution network and engage customers to reduce consumption during peak times after significant power outages in Australia.
- positive results of comprehensive metering trials and associated cost/benefit analysis in Ireland.

V. REALISING SMART GRID – the UK development

The UK has introduced a range of supportive policies and programmes to build a smarter network and drive innovation of smart technologies. These include:

- A legally-binding commitment in carbon emission reduction by 30% by 2020 and 80% by 2050.
- Setting out a clear Vision of a UK Smart Grid and a route map of the ways in which smart grid could be delivered.
- A national rollout of 53 million smart meters which are a key enabler of smart gird, and will pave the way for a transformation of how energy is supplied and used.
- Setting up a government-led cross-industry advisory group called 'Smart Grid Forum' to help inform Smart Grid policy development, tackling and advising on issues ranging from regulations, market structure, commercial barriers to technology requirements.
- Developing regulatory and commercial arrangements by independent energy regulator, Ofgem.
- Building industry capability and testing new technologies. Incentive mechanisms, such as a Low Carbon Network fund, to support innovation and trials of smart grid technologies. This is further supported in the UK by a leading ICT sector and a world-class technology innovation hub hosting numerous R&D centres in energy and smart technologies.
- End-users engagement through activities such as large-scale trial and demonstration projects.

Research and trial:

The Energy Demand Research Project is a large-scale trial conducted in over 60,000 households to investigate how consumers reacted to improved information about their energy consumption over the long term. The combination of smart meters and real-time displays consistently resulted in energy savings up to 11%, with an average of 3%.

Low Carbon London is a trial being carried out until end-2014 to look at the impact of a wide range of low carbon technologies, including intermittent local generation, electric vehicles, etc. on London's electricity network, and test how 'smart grid' technologies can be used to manage these changes in a low-carbon economy. For example, the programme has installed 6000 smart meters throughout London to monitor changing consumer demand patterns in response to dynamic tariffs according to supply level, and the subsequent effect on London's electricity network.