Demand Side Flexibility – innovation at the edge of the network

Energy consumers will be expected to play a much more active role in the management of future electricity networks. But while the opportunities are significant, so are the challenges.

The power landscape is undergoing the most fundamental shift in its history. Driving that change is the development of a model in which the large, centralised generators of the past are supplemented – and increasingly replaced – by networks of distributed power sources. Many of these new sources use renewable energy technologies with intermittent and unpredictable output.

For society at large, the emerging energy generation model offers important potential benefits, including lower CO^2 emissions and less reliance on energy imports.

For network operators, however, it makes balancing supply with demand even more challenging, and potentially places transmission and distribution infrastructure under greater strain.

The industry is striving on multiple fronts to address these challenges. Part of the answer will come from investment in an appropriate mix of generating assets, for example through the use of gas, biomass or oil-fired generation capacity to meet demand peaks or troughs in renewable energy production. Energy storage, both at grid scale and at point-of-demand is also an area of intensive research.

Inevitably, however, tomorrow's electricity networks will also require changes in the behaviour of energy users. Demand Side Flexibility is the industry's catch-all term for an array of user-level actions that can be applied to balance loads on the electricity network with the available supply. Those actions include load shifting, such as shutting down heating or cooling systems during periods of peak energy demand, as well as on-site generation or energy storage.

In the UK, Demand Side Flexibility is still in its infancy, but ambitions for the approach are considerable. National Grid has an aspiration to procure 30 to 50 percent of the UK's power balancing capability from demand side sources by 2020[1]. The Association for Decentralised Energy estimates that, by 2020, the UK will have 9.8GW of demand side energy capacity, including both demand reduction potential and the use of on-site combined and heat and power (CHP) and back-up generation capacity[2]. That's equivalent to between a fifth and a third of the UK's total energy demand, depending on the time of year[3].

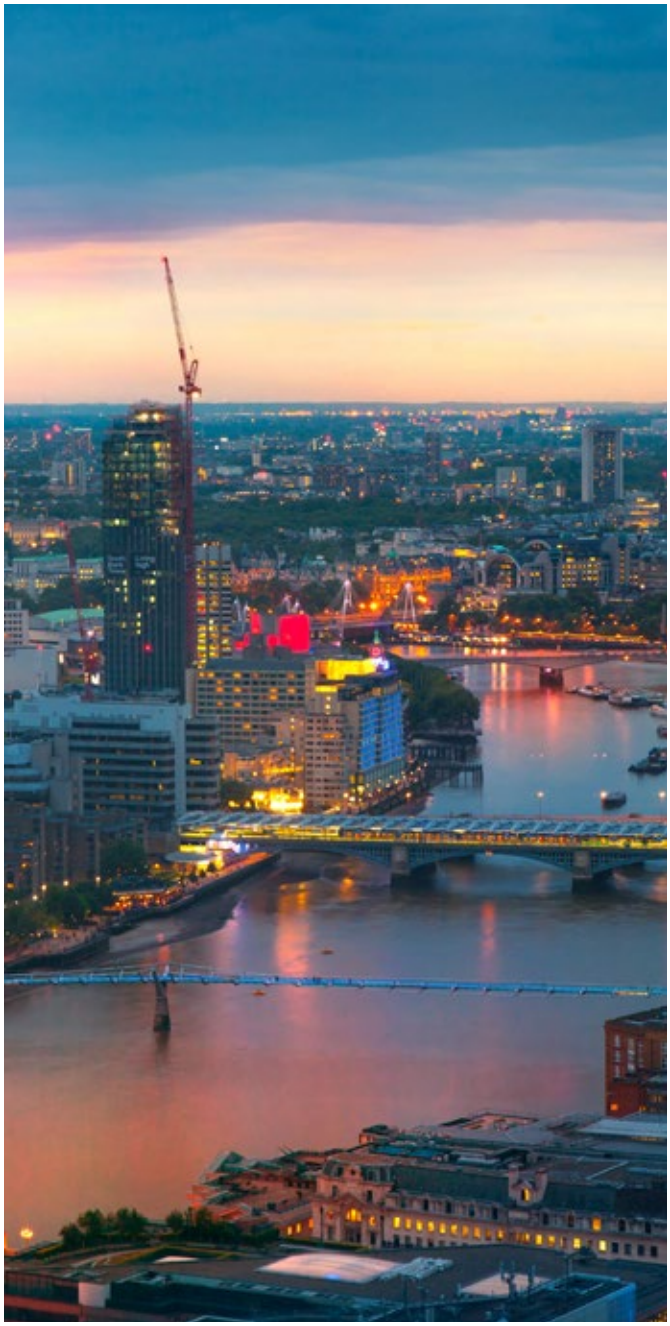
Demand side options

Demand Side Flexibility plays several different roles in the electricity network, depending on the nature of the equipment in use at the consumer's site, and the ability of their processes to accommodate requests to adjust the level of power consumed or generated by that equipment.

- Balancing services help the grid to keep its voltage and frequency in the target range, as generators are ramped up or down in response to demand changes or generation outages elsewhere. These services require assets that can respond quickly, within seconds or minutes, but the duration of that response is also likely to be short.
- Capacity adjustment services help the grid to cope when demand exceeds the available grid capacity. These services might require a reduction in demand of minutes or hours. Energy users can often do this with minimal impact on productivity, for example by temporarily shutting down pumps. Or they can switch over to local energy storage or back-up generation capacity.
- Peak avoidance. This entails shifts in energy consumption away from times of peak demand. This approach is probably the most familiar demand side measure, for example through dual-rate domestic electricity pricing. Large industrial energy users may pay electricity transmission costs determined by their consumption in the "Triads" – the three half hour periods of the year when total electricity demand is highest[4]. As the precise date and time of the Triads can't be known in advance, the system encourages users to reduce consumption whenever a demand peak is probable – usually early evenings on cold winter days.
- Demand turn up. In regions with high renewable generating capacity and limited network capacity, energy users may be paid to temporarily increase their consumption during periods of low demand[5].
- Distributed energy generation and storage. Large consumers often invest in back-up technologies, such as battery storage or on-site diesel generators. These assets can be configured to make spare capacity available to the network, generating extra revenue for their owners.

Building flexibility

For Demand Side Flexibility to achieve its full potential, a number of commercial, technical and cultural barriers must be overcome. Before industrial or commercial users adopt measures to increase the flexibility of their electricity consumption, or to make excess capacity available to the



network, they need to understand the technical opportunities available to them. They also need appropriate incentives to install new equipment or make adjustments to operating practices. While most companies currently involved in demand side flexibility schemes today say they are satisfied with their participation, many others have little awareness of the available schemes, or of their potential benefits.

Some organisations are already adopting these approaches. One major high street retailer has participated in a number of DSR (demand side response) schemes. While its primary aim has been a reduction in carbon footprint, as part of wider efforts to improve sustainability, the group expects the effort to deliver future economic benefits too. Another UK supermarket chain has also integrated DSR technology into its building control systems and store refrigeration equipment.

Implications for operators

It will not just be energy users that need to modify their equipment and processes, however. As both generating capacity and control mechanisms move to the periphery of the electricity grid, the distribution network will evolve from a passive transporter of energy to an active participant in supply quality and stability. Today's Distribution Network Operators (DNOs) will become Distribution System Operators (DSOs).

The data-rich, active networks needed to meet the flexibility demands of the future will require significant investments in ICT infrastructure. Operators will need to expedite the roll-out of smart metering. To facilitate rapid response, they will need to establish decentralised control systems covering groups of substations, or install automation at the substation level. Utilities will require new automation/sensor technology in the MV and LV networks, to enable the processing of the data collected to forecast the demand, control and optimise the distributed energy resources (DERs) such as: photovoltaic, wind, combined head and power (CHP) plants, battery storage, micro-grids and demand side response (DR). The flexibility offered with these DERs will be used to balance and stabilise the grid.

That transformation will require new approaches to technology and management, with equipment and approaches that are sophisticated enough to deliver advanced capabilities while being sufficiently robust and cost effective to allow operators to manage hundreds or even thousands of installations across their networks.

How Capula can help

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[5] http://powerresponsive.com/wp-content/uploads/2017/01/Power-Responsive-Annual-Report-2016-FINAL.pdf

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