Exploring the role of intermediaries in smart grid developments

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Introduction

Smart grid pilot projects have been initiated in a number of locations across the UK, e.g. London, Manchester, and Milton Keynes. Funded from the UK energy regulator's (Ofgem) Low Carbon Network Fund (LCNF), these projects focus on the development and application of various innovations to augment distribution network management (Ofgem, 2015). Innovations considered in these projects include various technologies such as smart meters and electrical energy storage devices, as well as novel institutional arrangements which form the basis of commercial Demand Side Response (DSR) initiatives.

DSR initiatives aim to reduce electricity demand at peak times or alleviate fault recovery. Major energy users (e.g. industrial and commercial) that are able to generate their own electricity and/ or switch off or turn down non-essential equipment at peak times are recruited to DSR initiatives. Contractual arrangements are established to formalise arrangements between these energy users and the system operator (e.g. the National Grid) or Distribution Network Operator (DNO). However, while these institutional innovations are an important component of smart grids, little is known about the processes through which they are developed and the role of intermediaries such as aggregators in these. In this contribution, we draw on a range of sources including the UK Government funded projects to begin to address this gap in knowledge.

Smart grids and by extension DSR initiatives are developed in response to local contingencies such as the need to integrate renewables. Thus to ensure validity, the case study method was followed since context should not be ignored and cannot be separated from the DSR initiatives investigated. Consistent with the case study research method (Robson, 2011), data were collected from multiple sources using multiple methods such as reviewing reports developed in smart grid projects available in the public domain. The results of the case study research are presented in the following section.

Key Findings

Established by the UK Government, to date the LCNF has funded a number of smart grid innovation projects, which have been led by DNOs. In the UK, DNOs own and operate regional electricity network infrastructure that transfer electricity from National Grid's transmission network to the majority of consumers. The innovation projects have considered alternative ways to manage distribution networks given changing demand patterns and the growth of distributed generation. These demand patterns include 1) increased demand from existing and new customer loads, e.g. electric vehicles, heat pumps, and 2) reversed power flows from distributed and renewable electricity generation, e.g. solar photovoltaic and wind turbines. Tackling increasing demand has traditionally required costly and disruptive conventional network reinforcement, such as building new substations and/ or strengthening network cables. A notable advantage of DSR is that it can be used by DNOs to alleviate short term or seasonal network constraints without having to reinforce the network infrastructure (UK Power Networks, 2014; WPD, 2015; Northern Powergrid, 2015). Thus, rather than engineered solutions to upgrade the network, DSR initiatives seek to tackle demand and involve commercial relationships between the DNO and its industrial and commercial customers.

DSR was tested in several LCNF funded smart grid innovation projects to reduce customer load during times of peak electricity demand and/ or alleviate fault recovery. There are principally two ways for customers to provide DSR capacity; these are

- Load reduction
- Generation

Multiple relationships between DNOs and their customers are needed to achieve appropriate capacity from DSR. However since DSR is a relatively new initiative, engaging with customers to procure DSR is something that DNOs are less familiar with. In general, DNOs do not build commercial relationships with their customers other than through network connection agreements and resolving faults. Therefore, to enable DSR arrangements on distribution networks, aggregators played a role in several smart grid innovation projects to provide DSR capacity through their existing relationships.

Aggregators are firms operating within the demand side energy services market. They specialise in aggregating DSR capacity and providing this capacity to various users. In this paper, a DSR user refers to utility firms who procure DSR to augment network management. For example, the UK National Grid has a well-established DSR initiative known as the Short Term Operating Reserve (STOR), which it uses to support balancing and maintaining supplies. Working as intermediaries, aggregators construct and put in place the requisite commercial arrangements with major electricity customers (e.g. industrial and commercial) who are able to provide DSR. Aggregators also collaborate with various actors in the energy sector to identify and develop user cases for DSR, e.g., to balance intermittent and distributed electricity generation.

Many smart grid innovation projects have invited aggregators to help develop DSR on distribution networks, see for example, UK Power Networks, Northern Power Grid and Western Power Distribution. In these projects, commercial arrangements were established between the DNO and the aggregator. More specifically, the work of these intermediaries in DSR initiatives led by DNOs involved:

- Identifying and recruiting major electricity customers (which in some instances aggregators may already have a relationship with) to DSR initiatives led by DNOs
- Executing dispatch arrangements between DNOs and their customers providing DSR
- Developing and implementing monitoring and control equipment to manage DSR

In meeting the need for DSR, aggregators identify organisations with DSR capacity, build relationships with and recruit them as energy partners to DSR initiatives. In many instances, organisations with DSR capacity are non-domestic organisations, such as industrial and commercial entities with significant electricity demand. Crucially, aggregators promote the business case for such organisations to participate in DSR and provide a point of entry for many that cannot qualify to contract directly. Here aggregators argue that DSR can provide the following benefits to participants:

- **An additional revenue stream**: owning and maintaining stand-by electricity generation can be costly for organisations. DSR can offer such organisations an opportunity to gain a revenue or reduced costs associated with these. Similarly, organisations whose electricity consumption can be turned off or down for a short period can benefit from DSR. However, generation and/ or load reduction may only be possible as long as it does not compromise the organisations core activities or user comfort levels.

- **Corporate Social Responsibility (CSR):** DSR can also contribute to an organisation’s energy and carbon management as well as CSR credentials. Aggregators often undertake a survey on organisations’ sites to review energy consuming activities and identify DSR capacity.

Working as intermediaries, aggregators also negotiate with their energy partners to establish contractual and commercial arrangements that enables DSR which complies with the user requirements. Aggregators therefore need requisite capabilities to understand both the operations of organisations providing DSR capacity via for example, load reduction or generation, and the user case for DSR.

In addition to their commercial understanding of DSR, such arrangements also require technical capabilities to operate and maintain DSR. Aggregators therefore develop and implement control and monitoring equipment necessary to aggregate DSR capacity and to comply with user requirements. In many instances, aggregators have remote access and controls enabling them to manage DSR activities on their energy partners’ sites, which they use to respond to requests for DSR.

Discussion and Conclusions

In summary, DSR initiatives are important components of smart grids that can help decarbonise the energy sector as well as offer financial and operational benefits to participants involved:

1) DSR potentially offers network operators an option to manage electricity demand and supply rather than reinforce networks;

2) DSR provides additional value to organisations that can provide DSR capacity;

Acting as intermediaries, aggregators play an important role in the development of DSR and smart grids. Indeed, for such actors, the potential of DSR on the distribution network may grow the DSR market and lead to additional commercial opportunities. Clearly more work is needed to unpack and further develop these intermediary practices. Several approaches to conceptualising intermediaries and their practices are available. For example the Accessibility Mobility Receptivity (AMR) conceptual framework (Trott, 2005) has been used in a normative way to promote efficacious intermediary practices as part of technology transfer (*cf.* Cook et al., 2006), as well as in analytical mode to explore intermediary practices associated with service and institutional innovations (Cook et al., 2012). This framework suggests that intermediary practices promote:

1) accessibility – the availability of innovations and information about them;

2) mobility – the establishment of intermediary channels through which innovation can move between sources of innovation and contexts of application;

3) receptivity - the ability and willingness of the receiving organisation to accept, absorb and utilize an innovation *ibid*.

Drawing on the AMR framework, the findings of this paper suggest that aggregators form a mobility channel for DSR innovations, e.g. between a DNOs and major electricity customers. However, far from a linear unidirectional process, this seems to be a two-way interactive process through which receptivity to DSR innovations is constructed. On one hand, aggregators' help major electricity customers to explore their internal environments and articulate ways to reduce electricity demand. On the other, aggregators help utility firms such as DNOs to redevelop DSR innovations in response to such articulations.

Thus in conclusion, far from lying out there waiting to be discovered, receptivity to DSR innovations is constructed through aggregator practices, which are fundamentally interactive. This suggests that user centered models of innovation, which render successful innovation the outcome of a tight fit between innovations and user needs identified *a priori*, may be of limited value in the development of DSR initiatives. Rather, work to develop DSR initiatives should focus on creating contexts in which intermediary interactions, through which receptivity to associated institutional innovations is constructed, can flourish.

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