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Smart grids, smart users? The role of the user in demand side management

Murray Goulden*, Ben Bedwell, Stefan Rennick-Egglestone, Tom Rodden, Alexa Spence

University of Nottingham, Nottingham NG7 2RD, UK

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ABSTRACT

Smart grids are a key feature of future energy scenarios, with the overarching goal of better aligning energy generation and demand. The work presented here considers the role of the user in such systems, and the contexts in which such roles might emerge. The data used is drawn from focus groups with 72 participants, using novel scenario techniques to contextualise smart grid technologies in domestic settings. Two contrasting visions of the smart grid are presented, a centralised system based on current institutional arrangements, and an alternative system in which decentralisation of generation and control is pursued. Using the concepts of 'energy consumer' and 'energy citizen', the paper considers what forms of engagement are likely to be generated by the two visions. We propose that smart grid designs must look beyond simply the technology and recognise that a smart user who is actively engaged with energy is critical to much of what is proposed by demand side management. We conclude that the energy citizen holds out most promise in this regard. The implications of this for policy makers are discussed.

1. Introduction

Energy systems are undergoing enormous transformations around the world. Though loosely defined, the concept of the 'smart grid' entails power networks transmitting digital information as well as energy. The primary purpose is to allow (near) real time consumption and generation data to be transmitted between different nodes, but it also allows for possibilities such as remote activation of appliances. In combination with facilitating increased amounts of distributed generation, often from renewable sources with variable output, the goal is to optimise the balance of generation and consumption in order to achieve efficiencies [1].

More than just a grand technological project however, a smart grid has the potential to fundamentally change the social dynamics of the energy system. Two opposing visions of how the smart grid's potential might be realised are established [2], though they should be considered two poles of a continuum rather than a binary choice. The first, in keeping with the centralised, hierarchical paradigm which has defined the energy systems of the last century [3], entails centralised generators increasing monitoring and control of end-user consumption [4], as detailed in UKERC's '*Smart Power Sector*' scenario of smart grid futures [5]. Henceforth, we refer to this vision as 'centralised demand side management' (CDSM), as a specific form of the generic term 'demand side management' (DSM). The alternative involves blurring the distinction between generators and end-users, with the latter—whether as individuals or communities—increasingly independent through microgeneration and self-management, a model Wolsink calls 'DisGenMiGrids' (distributed generation micro grids) [2], and similar to UKERC's '*Groundswell*' scenario [5]. These contrasting visions share the same technologies, but differ radically in the social structures underpinning them.

In extending generator control of consumption, centralised demand side management targets the provision of accurate usage information to consumers, including dynamic pricing tariffs, and the remote control of electricity load and devices. Within these approaches there is considerable latitude in regard to the role envisaged for the user; however all require integration into daily routines and so some degree of user interaction. A 'weak' version of CDSM might simply entail a 'smart' implementation of dynamic pricing tariffs, in which certain white goods are remotely triggered to run during low demand periods. A 'strong' implementation could include using real-time pricing signals and new technologies

* Corresponding author at: Horizon, NGB Building, University of Nottingham Innovation Park, Triumph Road, Nottingham NG7 2TU, UK.
E-mail addresses: Murray.goulden@nottingham.ac.uk (M. Goulden), Ben.bedwell@nottingham.ac.uk (B. Bedwell), Stefan.Rennick_Egglestone@nottingham.ac.uk (S. Rennick-Egglestone), Tom.rodden@nottingham.ac.uk (T. Rodden), Alexa.spence@nottingham.ac.uk (A. Spence).

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to encourage and enable users to 'time shift'[1] energy-intensive behaviours away from periods of peak demand, or towards periods when fluctuating renewable energy generation is high. Such an approach would require energy to take a prominent role in the ordering of household activities (see [6] for a more detailed appraisal of what this range of options might look like).

To date, a considerable body of work has been generated from practice theory-based studies of energy use in domestic contexts, (e.g. [7,8]). Some of this work has called for a disassembling of the producer–consumer divide which has defined the energy systems of the last century, to be replaced instead by the kind of 'co-management' of resources [9] seen in DisGenMiGrids. Strengers extends this further, calling for 'co-management of practices' [10], a more ambitious vision which recognises the co-production of *demand*—that is the relationships in which wants and needs are formed—as well as supply. By contrast, much of the work to date on DSM specifically has been narrow in focus and concerned with individual users, disregarding the dynamics of the shared household as a deployment site [11,12]. Research that has explored this area is often limited to certain aspects of DSM, for example on smart metres (e.g. [13]), in home displays (IHDs) [14,15]; dynamic pricing [16]; or peer comparison feedback effects [17].

Researching the societal implications of smart grids faces similar problems to that of other new technologies (e.g. biotechnologies, nanotechnologies) in gaining insight into socio-technical systems that do not yet exist. The uncertainty of future technologies necessitates defining them for research participants. In doing so the context and framing used can have a large influence on responses. Despite this, the necessity of such research stems from the considerable benefit in upstream engagement with new technologies where lay perspectives help to direct research and development efforts [18], and smart grids are no exception in this regard [6].

The current research makes use of contravision scenario films [19] within a series of focus groups in order to engage members of the public with the range of potential smart grid technologies available within future energy systems. These enable us to probe people's understandings of, and engagement with, their own energy consumption, and explore interactions with current and future smart grid technologies. Recent work draws attention to the prominent role that the user is expected to play within smart grid systems [20]. Our core interest is what that role might look like, and the consequences of it. Two forms of public are identified—*energy consumers* and *energy citizens*—which in crude terms are distinguished by their orientation: as energy end-users and energy system participants respectively. It is argued that the energy consumer frame is a consequence of the same paradigm that drives CDSM, and yet it undermines the very thing CDSM hopes to achieve—namely a grid in which consumption adjusts to meet generation. We propose that energy citizens, aligning with DisGenMiGrids, hold out much greater potential in this regard. The implications of this for policy makers are discussed.

2. Methods

2.1. Theoretical framing

Exploring the role of end-users within smart grids requires an understanding of the context in which energy and associated devices are used within the home. In this section we will outline our implementation of practice theory, and explain the energy citizen and energy consumer concepts which structure our analysis.

Practice Theory is employed here as a means of unpacking the mundane, embedded use of energy in day-to-day life. Practice theory has a number of overlapping formulations [21,22], but as applied here it breaks down practices into four components: materials and infrastructures; rules and knowledge; embodied skills; and engagements and meanings [8].

Time-shifting showering for example, entails material technological changes to feed signals (e.g. electricity unit costs) to the user through the smart grid and associated display device, and incorporating new knowledge of how the system works. It also potentially entails changes in skills—for example the user altering their showering routine to complete it in five minutes instead of eight—and also possibly in meanings—as in the shower's symbolic purpose switching from a refreshing wake-up before work, to a relaxing destress after work. Changing the practice of showering is comprised then of multiple elements unique to it. Additionally, and importantly, showering practices as with most domestic practices, are often developed in a dynamic way through interactions both with other members of a household and wider society, through interaction and negotiation. These include powerful norms conferring proper behaviour, for example signifying not only suitable hygiene, but also achieving this with a rapidity appropriate for the contemporary time-poor adult (showers being faster than the baths they supplanted) [7, Ch. 5].

We use this perspective on energy use—embedded in the social and physical infrastructure of daily domestic life—to structure our analysis. The manner in which it is deployed might be characterised as 'weak' practice theory [23, p. 1279] as we do not adopt practices as our unit of enquiry. Instead, our overarching frame is that of energy consumer and energy citizen. This preference for maintaining the human actor as our focus stems from a desire to avoid reducing the individual to a mule-like 'carrier' of practices. Our hybrid approach is an attempt to recognise that energy use emerges from complex socio-technical landscapes, whilst still maintaining the agency of the human actor.

2.1.1. Energy consumer and energy citizen personas

The specifics of these twinned concepts will be given in Section 3, here though we wish to provide a background to their formation. The concepts emerged during data analysis, out of the necessity to reconcile the tensions inherent within individuals' accounts. One such tension was between a wish for energy to remain invisible and a demand for more knowledge about energy consumption and efficient usage.

These concepts exist as both personas and frames, which is to say they are both enacted from within and imposed from without, in a manner that is co-constructive. We deploy these personas as characters—roles that are performed, or in the case of frames *expected* to be performed, with a particular set of assumptions about their orientation to overarching social structures (in this case, the 'energy system' in its broadest sense). In this they differ somewhat from the typology of energy system users deployed by van Vliet [24], which is "defined by the kind of relationship between providers and consumers" [p. 3]. Van Vliet identifies three types: (i) customer; (ii) citizen–consumer; and (iii) co-provider. The latter two overlap with energy citizen as used here, however our formulation is less concerned with formal relations between actors, favouring instead the actor's *orientation* to the energy system—that is to say their knowledge, and meanings of the system and their role within it—reflecting this paper's interest in how to enrol smart grid participants most effectively.

Energy consumer and energy citizen personas should not be read as mutually exclusive. Many participants adopted one persona

[1] Time shifting involves the moving of energy-consuming practices away from times of peak electricity demand, in order to ease the demands placed on electricity generation.