Smart energy, and society?

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Introduction

High energy consuming nations are caught up in the political ideology of smart energy technologies as a panacea for the combined crises of energy security, cost and greenhouse gas emissions. The idea of the smart grid is presented to us as a key component in the transition to a low carbon energy system, linking increasing intermittent supplies of electricity (from renewable sources) with flexible demand (consumers). A key element of the 'smart grid' concept is the smart meter, which is attributed with having the properties needed to educate households and businesses about their energy use, and to train them in self management of demand. Hence the smart meter is expected to work not just at household or building scale to give a global picture of energy use, but also ideally at the scale of each electrical appliance that is permanently plugged into any socket. Smart meters are a key technology to enable consumers (using computers, smart phones or tablets) to track their energy use in real time, to compare their consumption with that of others, or to benchmark against their own past consumption. They also a key technology to enable producers to change their prices over the course of a day ('time of use tariffs') or disconnect appliances remotely.

Smart meters are being installed in businesses and households in over 50 countries. EU policy specifies that subject to positive findings from a cost-benefit analysis at the national level, 80% of European households should be smart metered by 2020. This target has already achieved and surpassed by early adopters like Italy, Finland and Sweden, but a recent European Commission (2014) report suggests that the estimated costs and benefits of smart meter introduction varies greatly between countries, with a positive business case reported for only 16 of the 27 EU members. The UK is amongst the countries anticipating a positive business case and the UK government is aiming to install some 53 million smart electricity and gas meters into homes and small businesses in the period 2015-2020, at a total cost of £11 billion pound. This cost will be charged to the consumers, initially raising household bills, although the government anticipates that in the longer run, the average consumer will be saving some £25-40/ year if they use the smart meter information to reduce their energy use (DECC, 2013). Not only is there a strong interest amongst policy makers in assessing the outcomes of this huge programme, but there is also interest from the utilities and industry, in potential new markets for the latest smart metering technologies, and for capturing the efficiencies they may generate. Those representing energy users - householders and businesses - wish to ensure that consumers do in practice benefit from the predicted savings. Anti-smart metering campaigns have sprung up in several countries (Australia, Netherlands, California, UK), questioning if consumers will see reduced bills and raising concerns about health and safety, privacy, data protection, control over appliances or protection against tariff changes. Media coverage of smart meters has included a few spectacular stories about technical failure ('spamming fridges') and reported hacking of personal data or the remote control of domestic white goods. This has done little to increase public enthusiasm for the technology. The explicit focus on the 'consumer benefits' in smart meter roll out in EU member states, challenges governments to overcome implementation problems, bad publicity and perceived risks, as well as identify and secure specific benefits to

different groups of energy users, including those who are already vulnerable to energy poverty and/or are less able to reduce or shift their energy consumption pattern.

Developing technology is one thing, but understanding the social and political beliefs informing its development, and how it is taken up in use when people interact with it is another and the need to understand the social practices and processes driving these interactions is gaining increasing recognition. 'Smart Grid GB', the body set up as 'national champions' for smart grid development in the UK, finds that whilst 84% of people have heard of smart meters only 44% want one in their homes[1]. Some in the sector suggest this is due to complex tariff structures, high energy costs and perceptions that the energy companies responsible for installing the meters are only out for themselves. Smart Grid GB are charged with rallying support for smart meters, and have introduced the cartoon characters 'Gaz' and 'Leccy' as part of a national advertising campaign. This suggests to householders that smart meters can transform relationships between consumers and energy companies, as well as deliver savings from reductions in energy use. Wishing to widen awareness and appreciation of smart meter technologies amongst the general public, British Gas' 'Smart Meter Challenge' involves participating families blogging about their experiences of living with smart meter technologies. The trial aimed to test attitudes towards energy use and how people think about energy consumption in the context of other activities and spending, as well as the extent to which smart meters help them have more control over their energy use[2].

The research agenda

This ongoing 'smart energy revolution' raises important societal issues about and beyond the label of 'consumer benefit'. Smart energy metering represents a particular example of the pervasiveness of digital monitoring technologies in everyday life. Where the meters are located on the outside of the property, many people may not even realise they have been installed with a smart meter. And with the purchase of new electronic goods, the internet of things is arriving by stealth into our kitchens and bathrooms, capable of two-way real-time communication with a third party. The data they collect is valuable not only to the company providing us with energy but potentially to any company looking to identify new customers and target them more effectively. Beyond the practical issues of how to get people to embrace smart meters and how to ensure consumer benefits, we need to address a range of more critical but equally important research questions, including:

- How will this technology be configured in terms of control, ownership and management? (how) will remote control become the norm? What are the consequences for our practices and lived experience when smart appliances and the internet of things are turning the house into a closely monitored surveillance zone? Who will own the data and how will privacy, consent, consumer access to data, liability and benefit-sharing be negotiated and governed? Who is responsible and capable to intervene when smart appliances malfunction, are hacked or are mismanaged?
- How will the technology be socialised? To what extent will (some) people adopt and engage with energy feedback that can be supplied through smart meters or self metering? If smart meters are accepted or tolerated, (how) will people engage with the information provided? And if knowledge of their own energy use increases, how may that change people's perceptions – of themselves, of others, of 'the problem'. And how (if at all) do these views translate into (short/long lasting) behaviour? Who will gain or lose?
- How may the market evolve to make use of the opportunities offered by micro-metering and real time data exchange? Will time-of-use billing create a class of privileged 'any time'

[1] http://www.smartenergygb.org/
[2] http://www.theguardian.com/british-gas-smart-meter-challenge

consumers, similar to those who are able and willing to pay road congestion charges? To what extent will smart meters provide a platform for encouraging energy efficient investments in the home, and will they open the door to new business models – e.g. for companies that sell thermal comfort, certified reductions of energy consumption or lease technologies for decentralised energy storage. Will smart meters encourage virtual consumer coops that bulk-buy electricity, or open the door to locally targeted investments or energy consumption reductions which reflect the localised costs of grid maintenance?

The above questions illustrate the socio-technical nature of the transition towards smart energy. These questions cannot be addressed through numerical analysis of smart meter data without paying attention to the experiences of people in their own homes. Nor can they be answered through social science research methods without engaging with the technical context. Indeed, one of the key reasons why technologies-in-use rarely perform as expected, lies in the fact that the person who is uttering the expectation, has insufficient knowledge of both the technology and the users. These questions call for a bundling of relevant expertise across the disciplinary boundaries of engineering, informatics and social science. In many countries it was (and sometimes still is) especially the latter that was missing from the mix of expertise. Social science, if called upon at all, was typically brought in at a later stage, to 'educate the public' and 'create acceptance'. But of course technical design without up-front engagement with end-users is far less likely to yield products that may be 'acceptable' to members of the public, and the marketing or branding of a problematic product is a professional activity that cannot be mistaken for academic social science research.

In order to ensure that smart energy metering will indeed yield more benefits than costs to society, we need research which can integrate the development of new digital technologies and the assessment of the technical feasibility of energy savings, with a sophisticated understanding of what does (or does not) motivate and drive behavioural change in relation to domestic energy consumption, the directions and conditionality of behavioural change at the individual and household (or office) level and the role(s) of technology therein. In recent years, the UK Research Councils have funded a wide range of interdisciplinary energy projects. In doing so, they have created a vibrant energy social science research community.

This Special Issue

This special issue was organised by the Transforming Energy Demand through Digital Innovation Network (TEDDINET[3]). Funded by the UK Engineering and Physical Sciences Research Council (EPSRC), the purpose of this interdisciplinary network (combining social science, engineering and informatics) is to encourage collaboration and exchange between the many interdisciplinary demand-side energy projects in the UK, to collate research findings and increase the impacts of the research by working with government, industry and the third sector.

When we floated the idea of a first special issue on smart energy and society, we were impressed by the level of interest; despite the very short lead time, we were offered 14 papers, double of what the journal could hold. It shows that this Special Issue is well timed and well placed to bring together the mounting insights that current academic research offers to our understanding of smart metering technology from a social science perspective. These insights are important not only for other

[3] See www.teddinet.org

academics in the field – of which there are a growing number – but also for those practitioners involved in smart meter policies and the development and delivery of smart meter technologies, and for those who are expected to adopt the systems and respond by changing their patterns of energy use. Given this journal's aims of 'linking the analysis of science and technology with the strategic needs of policy makers and management', it provides a great forum in which to show-case the latest research and promote its capacity to inform debate among those involved in the policy and management of smart meter technologies. The seven papers and two book reviews that make up this Special Issue reflect in their coverage and extent the multifaceted nature of interactions between smart meter technologies and society; thus they will be of interest to a wide audience.

In terms of smart meter technologies and mechanisms for delivering energy efficiencies, the papers consider debates about demand side response (Murtagh et al; Fell et al; Abi Ghanem & Mander), the UK Smart Metering Equipment Technical Specifications and Smart Meter Implementation Programme (Pullinger et al), the apportioning of energy consumption through smart meter technologies in the workplace (Bedwell et al), the potential for serious games to address energy literacy by improving the feedback of smart meter data and helping people to identify energy savings option (Wood et al) and the differing public perspectives on 'smart homes' – exploring much broader types of electronically enhanced (and therefore energy-consuming) services, such as assisted living, health and security (Balta-Ozkan et al). Some papers report on empirical research with householders to understand their perspectives on measures to promote energy efficiency (Murtagh et al; Fell et al; Balta-Ozkan et al); others report empirical research with the designers and engineers of the technologies to understand their conceptualisations of consumer engagement (Abi Ghanem & Mander). Some papers provide reviews of our current understanding of people's engagement with energy issues in social settings where they are not the bill payer, like employees in the workplace (Bedwell et al) or children in a household (Wood et al), whilst others analyse policies, standards and strategies (Pullinger et al). Between them, the papers focus on individuals (as consumers and creators of technology), in both domestic and non-domestic settings, as well as on society as a whole and on governance structures (through national policy implementation). Geographically the papers are focused on European contexts, considering cases in the UK, Germany, Italy, Spain and France. Theoretically the papers draw on environmental and cognitive psychology, science and technology studies, social practice theory, sociology of expectations. The papers clearly represent a wealth of empirical and conceptual understanding and below we consider some of the key messages to emerge from them.

Key messages

A number of papers speak to the need to interrogate more fully the assumptions about the consumer and consumer behaviour amongst those developing and delivering smart meter technologies. By speaking directly with designers and engineers involved in the development of smart grid technologies, Abi Ghanem & Mander consider their expectations of those who will be engaging with the technology. The authors adopt a 'sociology of expectations' lens to explore how designers and engineers situate the technology in 'an ideal' form of consumer behaviour i.e. one that is based on economic rationality. The study reveals that whilst designers and engineers consider current consumers to be 'irrational', they hope that their technology is a device to generate a 'future rationality' amongst consumers.

Through their analysis of the UK Smart Metering Equipment Technical Specifications, Pullinger et al also find the normative assumptions about the consumer and consumer behaviour to be limited, particularly in relation to the form of feedback that smart maters must provide, as set down in the formal Specifications. They suggest that the current technical formulation will limit the potential of the Smart Meter Implementation Programme to fulfil its energy demand reduction objectives. They propose instead that attention could be directed to 'reflection practices', or the process of mindfully thinking about how one's routines fit with personal motivations, values and life goals. Provision of feedback could then be designed to target and promote particular practices oriented to reducing energy use, rather than to energy *per se*. Wood et al suggest in their review of the utility of 'serious games' in enhancing energy literacy and encouraging energy saving behaviours, that games which most closely simulate lived experiences – with all their 'messiness' as it is often referred to – will also be most effective in achieving their objectives.

The paper by Murtagh et al echoes these findings, reporting that demand response mechanisms also involve simplistic assumptions about consumer behaviour, being as they are, based on ideas of 'rational utility'. This supports a vision, they argue, of demand response as purely an engineering and technological entity which enables possibilities of economising on energy use. Whilst the authors found that economic considerations did drive some householder perspectives, for example around whether they would opt in or out of peak pricing, householder reasoning was based on a mix of factors and was not necessarily in line with freely chosen economic utility – more often it was because they felt they had no choice given a lack of financial resources. Peak pricing is therefore seen as coercion, whilst incentives for active demand management are seen as having potential to shift societal patterns, for example around the timing of the main family meal (to coincide with cheaper energy supply rates), raising concerns over social justice in relation to energy saving technologies. Murtagh et al therefore argue that transforming demand should be considered not just in terms of economics or energy from the perspective of the utilities and their stakeholders, but also in terms of the impacts it has on individuals, families and society – particularly the fuel poor, those in poor health and those who are disadvantaged. They argue for the deployment of technologies which can protect the vulnerable and allow energy behaviours with potentially the greatest adverse social impact to be ring-fenced.

A second key message to emerge from across the papers is that around issues of control, trust and relationships with energy providers. Fell et al's paper specifically addresses issues of perceived control, in their case in relation to pricing mechanisms for demand side response (DSR) (as enabled through smart meter technologies), finding a substantial degree of variability in how control is perceived. Fixed Time Of Use (TOU) tariffs were perceived positively as they were thought to increase personal control over costs, dynamic TOU tariffs divided opinion, and direct load control was perceived as reducing control, including over appliances and overall autonomy. The principal antecedents of perceived control (or lack of it) were found to be trust, information, predictability and choice. When similarly provided with scenarios of energy provision mechanisms, as mediated through smart energy technologies, householders in the trials of Murtagh et al felt that remote demand control during critical peaks of demand contravened their rights of control over their own homes. Again, trust in their energy providers was found to be an important issue in generating particular perceptions. In their cross-European analysis, Balta-Ozkan et al also found evidence of mistrust of both utilities and the government amongst householders in all three case-study countries; the UK, Germany and Italy. Whilst there were differences between urban and non-urban

settings, this was considered a major barrier to the future of smart home technologies despite, as the paper outlines, what they have to offer in terms of security and assisted living.

In the workplace in stead of the domestic sphere, Bedwell et al also touch on issues of trust and relationships, but in their case to suggest that small to medium sized groups of employees who already strongly identify with – and therefore trust? – each other, are best placed as the 'units' to target in public competitions to reduce energy use in the workplace. Smart meter technologies which enable the apportioning of energy use to these groups may thus offer a way forward in these environments; however thinking through how this may relate to domestic settings is challenging.

There are just some of the messages and insights to emerge from the papers. Between them the papers clearly set an agenda however for increased attention to be given to the social aspects of smart meter technologies, both by academic researchers and by those who design, develop and deliver these technologies. It is an agenda that is echoed in a timely and insightful account from Australia, by Yolande Strengers.

Smart Utopia?

Strenger's (2013) book *Smart energy technologies in everyday life: Smart Utopia?* has been well received by those studying social aspects of smart meter technologies, providing as it does, an in-depth empirically-based but theoretically rich account of the subject. Drawing on theories of social practice and science and technology studies, Strengers provides a strident critique of what she refers to as 'Resource Man' – the embodiment of assumptions around technology users as rational, utility-maximising and technologically-literate consumers (a critique that is clearly supported by many of the papers in this Special Issue). She argues the 'smart utopia' which is envisioned through smart energy projects is fundamentally flawed, given its focus on technology and information provision, and suggests that by increasing demand for technologies it may ultimately promote energy intensive lifestyles. Instead, she argues, we should focus on the 'ontology of everyday practice', giving recognition to the materiality and different forms of knowledge which are involved in 'practices-that-use-energy', such as cooking or cleaning. Shifting our focus to these things Strengers argues will enable a 'reimagining' of the future of smart energy technologies that is more in line with the reality of everyday lives.

Strengers states that she is keen for her book to speak not only to other researchers, but also to those involved in developing and delivering smart energy technologies. This Special Issue therefore contains two reviews of the book, the first by a social researcher, currently working for the Association for the Conservation of Energy, and the second by a technologist from the construction and energy sector, currently Lead Technologist at Innovate UK. Between them, the reviews provide a view of the depth and utility of the book from their differing perspectives.

The first review (Royston) provides an excellent, informed account of the book, drawing out its fundamental arguments and offerings, but going much further by placing these in the context of current literature and debates in the field. Royston's discussions are based around three themes; forms of feedback and knowledge, dealing with change and innovation, and the (im)materiality of energy, each of which adds significant intellectual depth to arguments made in Strenger's book. Drawing on the book, Royston ultimately suggests that we need to think more deeply about what

'the problem' is that smart energy technologies are attempting to 'fix' in order to identify a more appropriate approach, one which is more in line with the realities of everyday lives.

The second review (Holland) provides a very different interpretation of the book, written, as it is, from the perspective of someone from the energy technology sector. Holland sees the greatest contributions of the book as being to draw attention to the reality of people's homes and lifestyles, and how smart energy technologies must be designed to fit in with these, rather than the other way around. He recognises his position as a reader who can comment on the ability of Strengers to communicate with those in the energy technology sector, and whilst persuaded by her overall argument on the dominance of Resource Man and simplistic assumptions of energy user behaviour by the sector, he questions what she offers in return. Holland would like to see a more straight forward 'answer' as to how to move forwards and is frustrated by the limited proposition that what is needed is the identification of a new approach – rather than an actual proposal of some new approach itself. This is understandable and is no doubt a sentiment shared by others in the sector who look to academic work to provide actionable insights. This speaks to wider debates around the utility of academic research, which despite the 'impact agenda', is often not direct, clear or straight forward. It also suggests the need for better communication between academics and practitioners so that both have realistic expectations of what the other is able to offer.

Conclusions

The smart energy debate and its array of contemporary technological artefacts is coming and will by various, as yet indeterminate, means have material impacts on the provision of energy, its patterns of use and the distribution of its costs and benefits; the forms that a smart(er) energy system may take however are still up for grabs. Academics interested in the social & political interaction with, and the social shaping of smart energy technologies are keen to push that in a way which accounts more fully for the everyday practices that drive energy use both in the home and workplace, and to draw attention to the importance of trust, perceived control and relations between those providing and those consuming energy. This may be the first time that this topic area is explored in a Special Issue, but given the importance of the topic and the growing research community attending to it, we are sure it will not be the last.

References

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