UKERC

UK Energy Research Centre

Future Research Requirements for Smart Metering Workshop

Meeting Report

UKERC/MR/HQ/2011/006

August 2011

UK Energy Research Centre

58 Prince's Gate, Exhibition Road, London, SW7 2PG

The UK Energy Research Centre

The UK Energy Research Centre carries out world-class research into sustainable future energy systems.

It is the hub of UK energy research and the gateway between the UK and the international energy research communities. Our interdisciplinary, whole systems research informs UK policy development and research strategy.

www.ukerc.ac.uk

Contents

Note about the Meeting

There is a considerable body of research being undertaken on smart metering in particular to understand how customers are likely to use smart meters both for Energy Demand Reduction (EDR) and Demand Side Response (DSR). However, the different stakeholders tend to concentrate on particular aspects of smart metering and we lack an overview of the research being undertaken and how this can be used to inform the GB Smart Meters Programme. The objective of this workshop, organised at the request of the Department of Energy and Climate Change (DECC) and held on 22 June 2011 at Imperial College, was to gain a better understanding of the smart meter research being undertaken and what else needs to be done.

Twenty-nine representatives from academic, funding, policymaking and regulatory institutes were present at this workshop. This report is an account of the discussion, comments are non-attributed. After the workshop, participants were invited to leave comments and suggest research topics anonymously on Post-It notes. Selected comments from these notes are presented at the end of each section.

Key Outcomes

1. A whole systems approach is required to understand the interactions with, and value of, smart meters in the context of future energy systems. In particular, the relationship between demand response and demand reduction is imperfectly understood.

2. An interdisciplinary approach is required to transfer knowledge from social scientists, who understand behaviour, to the industry and policy makers responsible for delivering the smart meter programme.

3. Research into possible business models for demand response systems (including storage and distributed generation) and how consumers will be incentivised to use these systems is required.

4. Researchers need to be able to access data from the Energy Demand Reduction Project trials, Low Carbon Network Fund projects and GB smart meter rollout.

5. There is an opportunity to educate users during the smart meter installation process, which may require training the installers or devising other ways of communicating useful and actionable messages to a wide range of users – research is required to inform the best strategy.

6. Research is needed to understand the balance and interaction between direct consumer participation and automated systems.

7. The risks inherent in replacing physical assets by dynamic demand response need to be further researched.

8. Most research is focused on electricity; gas and water metering and the potential for improvements should not be ignored.

Scope of the workshop

Four questions were asked at the start of the workshop:

- What do smart meters need to deliver as an enabling technology for demand-side interactions and future smart grid configurations?
- How does current and proposed research fit into the Smart Meters Programme?
- What gaps are there in current research knowledge, which need to be filled in future projects?
- What does the Smart Meters programme need to do to facilitate future research needs and requirements?

The meeting began with an overview of smart metering research in the UK, and the presentation of a database showing the distribution of smart metering research programmes by discipline.

Energy Demand Discussion

Interventions

The Energy Demand Research Project (EDRP) was introduced. The project investigated consumer behaviour in response to improved information on energy consumption, including both smart meters and non-smart interventions over 60,000 households and four energy suppliers. A review of literature to accompany the EDRP showed that better feedback to the consumer encouraged reductions in energy demand, typically between 5-15% in cases with direct feedback from in-house displays. Furthermore, the EDRP trials have shown that households with smart meters did, on average, reduce their electricity and gas demand (though by smaller amounts – around 3% on average for a combination of smart meter and in-home electricity display, and 3% for gas customers with smart meters alone[1]). The associated in-home display was a significant factor in achieving these savings. Generic advice and historic feedback was also effective in some interventions, with reductions in consumption of up to 5%. It was noted that measures involving financial incentives for demand reduction had no lasting impact.

Combinations of feedback with (written) advice tips were more effective than either in isolation. The ergonomics of the meters and their simplicity of use, as well as high-quality customer support in utilising smart meters and displays, were brought up as important factors in achieving demand reduction. The mechanism of demand reduction from smart meters appeared to differ from electricity to gas – gas reductions seemed to come primarily from the experience of having the meter installed (in conjunction with the arrival of more accurate and trustworthy bills), whereas electricity reductions relied heavily on the in-home display.

The Technology Strategy Board (TSB) is investigating smart metering supply and value chains, and are currently funding 13 projects looking at smart meters in 'smart homes'. They have found some interoperability concerns – the majority of manufacturers find it challenging to develop interoperable systems – which should be addressed through the current work of the Smart Meters Programme.

In Ireland, the Commission for Energy Regulation have carried out three trials of time-of-use tariffs and improved feedback across 5,000 residential and 60 SME customers. There was an overall reduction in electricity consumption of 2.5%, and an average peak usage reduction of 8.8%, for the domestic customers. (Both figures are measured in contrast with a control group with smart meters but no time-of-use tariffs, improved billing or in-home displays). For the SMEs, the results were not nearly as good, with only a subset of SMEs making positive reductions. There appear to be issues with effective engagement of SMEs in this space.

[1] For the full report, see http://www.ofgem.gov.uk/sustainability/edrp/Documents1/Energy%20Demand%20Research%20Project%20Executive%20Summary.pdf

Discussion

The installation process of the smart meters and the possibility that this time could be utilised to inform and educate users further; was brought up. What knowledge would the installers need, not just in operating the meters, but in customer behaviour and communication skills?

The difficulty of connecting social and economic research with technical and business requirements was mentioned by participants. A lot of research on how people use energy has been carried out by social scientists. This is very difficult to utilise by industry/policymakers, partly due to language and definition barriers but mainly because social scientists tend to start from different assumptions about the nature of behaviour and to conclude that systemic changes are needed, rather than specific alterations within existing paradigms. Unsurprisingly, industry and policymakers often tend to find this type of research too challenging to incorporate in the short term, although it may have great value in the longer term.

Social/technical interfaces are an essential subject for research, but it was agreed that ways of carrying this out and communicating it effectively, within and beyond the research community, still need to be developed.

Comments left after the meeting on these issues focused on the necessity of informing and engaging consumers through a variety of measures, as well as focusing on particular consumer groups. One respondent suggested that *'it would be really helpful to have a pilot project on high electricity consumers and practical steps to reduce their demand.'* Another asked if *'consumers also respond to low prices to increase demand.'* A third asked *'What should smart meter installers do while they are in a home, other than install the meter, to encourage energy demand reduction?'*

Ergonomics and the design of the rollout were also popular topics, with one comment saying *'To make sure things don't "flop" on first deployment, shouldn't we engage the user in designing the thing?'* One suggestion was to *'put two social science studies on every implantation/rollout of new technology to (a) understand why people behave as they do, and (b) to quantify these behaviours and motivations.'*

Demand Side Response Discussion

Interventions

The UK has unresponsive demand today – this will change from demand-led supply to more supply-led demand. There is significant value in a system which makes smarter use of existing physical assets – there is a predicted £40-50 billion of new supply industry assets required under a business-as-usual case in which the grid does not make extensive use of ICT technologies. There appears to be no fundamental technological barrier in the deployment of automated demand-side response systems, but any such deployment would be a huge and complex effort. Not all demand-side response has to rely on automation; however, we do not yet know the scope for non-automated response, e.g. through static time-of-use pricing.

There is substantial existing research in the UK in this area. A large quantity is concentrated within two Supergen programmes – Flexnet, which investigates moving from preventative to corrective control and HiDEF, which looks into moving from centralised to distributed generation and control. However, identified gaps in the research map exist, such as research into business models for demand response systems, the magnitude of demand which is price-responsive, and the value of demand response to actors in the system, as well as the impact of 'competitors' to demand-side response such as interconnectors and large-scale storage.

Two Low Carbon Network Fund (LCNF) projects were represented at the meeting, from London and the North-East. In London, smart meters will be installed in homes to understand if it is possible to defer costs of asset reinforcement by encouraging flexible consumption, and if so by how much. Distribution networks need to understand if their consumer profiles have changed rapidly, and also need to look at how they can be changed by various mechanisms. In the North East, the aim is to trial a variety of flexible tariffs across 9,000 customers equipped with smart meters, bringing together a mixture of economic incentives and technology.

The GB Smart Meters Programme also faces some significant challenges emerging from the complexity of the IT and communications systems required, and the risk inherent in such a large, complex and long-lived system with a huge volume of data transactions. Fundamentally, we need to understand the role of smart metering in energy system management and smart grids. Will trialling smart metering systems on a relatively small scale be enough to define specifications for smart metering systems in the future based on the complexity of the full-scale system and the quantity of data to be transferred and processed?

A TSB-funded project, named CLEVER (Closing the Loop for Everybody's Energy Resources) has the aim of developing a large-scale simulator to understand the performance of this large distributed system. This can achieve three things fundamentally – firstly, it can look at how the volume of data transactions change throughout the day. Second, it will take this ideal system, run it over a model of existing networks and technologies for communication, before finally, bringing the results together to find the best communications for smart metering purposes.

Discussion

Low Carbon Network Fund projects in London and the North East will be collecting large quantities of data from their projects – researchers will need to look into this data in detail. From the communications and ICT point of view, we need to understand the potential balance between direct consumer participation and automated systems, what each can offer, and how one might affect the other.

Communication standards for the smart metering system were discussed. Each communication standard has drawbacks. For example, General Packet Radio Service (GPRS) communications are problematic in high-density areas with lots of meters. The balance between consumer behavioural changes and system automation to achieve demand response was discussed. It was widely felt that automation techniques should not be seen as belonging in a different category from behavioural change, but as parts of a system as a whole. It was thought that automation itself changes behavioural conditions.

Demonstration and innovative research are the keys to optimising flexible demand-side behaviour utilising smart meters. However, this will require coordination from the utility operators to be successful. There appears to be a lack of robust business models to encourage take-up of flexible demand response technologies – a view shared by many of the participants. Several participants felt it was important for researchers to integrate modelling with the smart meter deployment programme, including modelling of heat pumps, electric vehicles (EVs) and other electric technologies. This allows the system requirements for these new electric demand sources to be researched and modelled with access to both the data coming from the rollout programme, and the needs that qualitative research into the programme may throw up.

Comments left after the meeting addressed a wide range of issues on demand-side responsiveness, including some on the relationship between demand reduction and demand response. One comment described it as *'poorly understood, though raised as an issue at least a decade ago. Smart grid experiments are springing up in many places, what are the metrics (do they include demand reduction?)'.* There were comments on the business and strategic cases for demand response and Demand Side Management (DSM), with one respondent suggesting *'Business models for demand response'* as a topic, while another asked *'Is domestic DSM essential for a de-carbonised power system?'* It was suggested that demand response research was *'focused on consumer response to price. What about demand response which is either mandated or a contractual obligation?'* This comment gave the examples of Germany and Switzerland, in which the local utility has the right to interrupt heat pump installations.

RCUK – Future Research Needs and Coordination Issues

This session was chaired by a representative from Research Councils UK (RCUK). Recently, the Research Councils Energy Programme (RCEP) conducted an international review of energy research in the UK. One conclusion of this report is that the UK needs to raise its profile in end-use energy demand research. An open discussion was framed around three major questions:

What are the big challenges from a research point-of-view and the priorities for policy evidence?

It was agreed that more work needs to be done to figure out what people might want and expect from smart meters. There also seems to be a big gap in that the research community are not adequately considering a whole systems approach for smart meters. We need to understand where the value is in the energy system from smart meters, and to whom. This is important for policymakers and for the maintenance of a robust business case to support smart meter deployment.

In some respects, the rollout may 'lock-in' GB for at least the next couple of decades. Therefore, researchers and policymakers need to be clear on what this rollout will achieve, and for whom. What are other nations doing in this space, and can GB learn from their successes and failures? It was noted that there are still a lot of unknown factors in the magnitude of any reduction in demand based on the existence and character of the future smart grid, which is still a poorly-defined concept. Interdisciplinary research and analysis of international results are important in order to understand the behaviour of the whole system, as well as the consumers within it.

There are big research 'prizes' in investigating how you can affect user demand – interesting and important because it relates to integrating wind and other low-carbon generation. The value to the network industry here is working out how much the need to invest in further physical infrastructure could be displaced.

Researchers need to test whether integrating demand with supply will decrease security. Little work so far has been done on working out the risk profiles of demand (although the SuperGen projects are addressing this to some extent). Without these profiles, industry will be extremely wary of incorporating the demand-side actively into the system, as it will be unknown how much this will decrease security. Can responsive demand really be trusted to displace transformers and generation plants?

The Smart Metering Research landscape in the UK, in particular how the various research communities relate to each other and the role of industry players.

How can the research community use the resources the UK has generated in this area, in particular the huge data sets collected as part of various research initiatives? Data from the EDRP project is likely to be available (although not at the time of the workshop). The various LCNF programmes are large-scale implementations which could yield substantial data results. LCNF programmes are also subject to a knowledge sharing requirement – the results and datasets will be made available to the public. However, even though several thousand homes are involved, the demographics of these homes break down into fairly small blocks, which may not give adequate data sets at the scale required to model a nationwide rollout.

Many UK research projects, in order to provide high-quality conclusions and recommendations, would require access to real-world smart meter data at high spatial and temporal resolutions. Specifications need to ensure that actual smart meter data can be accessed by researchers, and this is already beginning to happen. It was the view of several participants that this data could turn out to be the most important early outcome of the Smart Meters Programme.

How UK Smart Metering Research can inform and make an impact on the Smart Metering Implementation Programme.

There is a complex range of potential research areas – people would like to do research with the installed smart metering architecture, but also want to do interesting things regarding smart meters with assisted living and other new communications opportunities, not even necessarily in relation to energy. Where do research programmes like this sit in the landscape? There are also opportunities for business modelling – how do these new services work and who do they benefit?

There is an issue of 'closing doors' – is GB missing opportunities right now? The UK research community should put some capability into assessing this possibility. One of the prime benefits may be saving on assets – the UK needs to have confidence that these smart metering and DSM efforts will work, and can result in savings being made on assets.

Participants also raised the issue of consumer pushback. Internationally, we have seen several examples of major consumer pushback against smart meters and time-of-use tariffs, for example in Victoria, California and Ontario. In a liberalised energy market, it is important to be careful in introducing these tariffs to avoid exacerbating customer distrust against their suppliers. Energy companies may wish to be selective on which customers get smart meters first, giving them to more engaged and interested customers in the beginning to build awareness and solve some teething problems. Once large-scale rollouts begin, major problems are often noticed. The British Gas rollout of smart meters, already under way, will give some indications of what to expect, both from consumer attitudes and technical problems.

Attendee List

First Name	Last Name	Organisation
Colin	Axon	Brunel University
Matthew	Barton	ETI
Sarah	Bell	UK Power Networks
Adrian	Butt	DECC
Modassar	Chaudry	Cardiff University
Sarah	Darby	ECI
Brian	Drysdale	Cardiff University
Penny	Dunbabin	DECC
Gareth	Evans	OFGEM
Hannah	Foreman	EPSRC
Michael	Harrison	DECC
Nick	Jenkins	Cardiff University
Dritan	Kaleshi	Bristol University
Filomena	La Porta	EDF
Russell	Layberry	ECI
Matthew	Lipson	DECC
Andrew	Melchior	TSB
Nic	Newey	DECC
Paul	O'Neill	CER
Laura	Platchkov	DECC
Gary	Raw	Consultant
Alex	Rogers	TEDDI Project
Robert	Sansom	Imperial College
David	Shipworth	UCL Energy Institute
Goran	Strbac	Imperial College
Lee James	Thomas	Cardiff University
Joshua	Thumim	Centre for Sustainable Energy
Jacopo	Torriti	Centre for Sustainable Energy, Surrey
Judith	Ward	Sustainability First
Kamalanath	Samarokoon	Cardiff University