Some Smart Meter Technology and User Issues

Marcus Wigan
Principal: Oxford Systematics
Adjunct Professor, Faculty of Communications and Information Technology, Swinburne University
Melbourne Australia
mwigan@swin.edu.au; www.mwigan.com

Abstract—**Smart meters have become a matter of concern for many populations, although the technology is as always politically neutral. The focus on electricity rather than *all* metered services, water, gas and electricity is one aspect of this public concern.**

The heavy emphasis on Smart Grids, overall energy supply stability [1] and the extension of control into the home by power generators, allied to poor communications by governments and power generators in a range of countries have led to an increasingly well founded series of problems:

1. **Symmetries in power between consumer and supplier**
2. **Privacy issues [2, 3]**
3. **Data ownership issues**

The paper examines some of the user-side issues in context, and the imbalances between industry and consumer, how these have been addressed to date, and ways forward.

Keywords-component; Smart Meter; Smart Grid; SCADA; Privacy; demand response

I. INTRODUCTION

Issues of government intervention, integration of the various and varied initial energy and metering polices, and privacy and data ownership issues differ substantially in the handling of these social impacts of electricity smart meters [4]. It remains to be seen which politico-technical models will prove to be the more successful in this important emergent area of the Internet of Things[1], and what success is regarded as comprising. Possibly this will only become clear once water, gas and electricity are all integrated with home automation and the information and regulatory systems that tie all these together. The last element may well prove to be the most critical social impact.

The current perception that the end user is the last and least significant step in the chain of important decisions and regulatory consideration will be severely undermined once it is realised more widely how the unit device addressability of power using units within homes interact with the overall operation of smart grids as a whole. Acute system security vulnerabilities are opened up by these bidirectional information and control flows. A specialist SCADA company in Israel reports as a result of security audits of water and power systems with smart meters:

> "*The command and control nature of the Smart Grid data network poses a difficult challenge from a security perspective. No longer are the nodes of the control network located in secured server rooms or located inside a fenced cabinet with an alarm and/or video surveillance system. The nodes, or meters in this case, are located in the homes and businesses away from the public eye and with almost no possibility for the utility to restrict access and detect tampering events. In other words – the end points of this micro-level command and control network are a sitting duck. The utility must assume that these devices will be investigated, audited and tampered with. Imagine what an interesting case study such a meter poses to any engineering student or aspiring computer hacker who wants to pave his way to fame at the expense of the utility. The ease and discreteness of access to the Smart Grid nodes, along with the traditional lack of security state of affairs common in control/SCADA[2] systems field protocols is a dangerous mix" [5]*

As they become an integral part of emergent smart grid systems, end user consumers need to play a far great role in the development deployment and utilisation of smart meters in their homes and small businesses. The command and control philosophy so far apparent in government and power generator approaches is inadequate to address these emergent issues. When it is noted that this is simply the first of many 'Internet of Things' deployments, but with heightened sensitivities even beyond the time/space focus of Location Based Services [6], it will be difficult to manage politically if a greater level of participation and information and regulatory power is to be accorded to civil society and to the end users themselves.

---

[1] The IoT European Research Cluster provides a useful focal point for this, with their annually-updated document at http://www.internet-of-things-research.eu/pdf/IoT_Cluster_Strategic_Research_Agenda_2011.pdf

[2] SCADA – Supervisory Control and Data Acquisition

II. CONTEXT

The civil society aspects of smart electricity (and indeed water and gas) meters have been inadequately handled by many governments around the world, as they have been seen largely as a tool to save on energy generation and smart grid investment and have largely neglected the education and engagement of civil society. The price for this neglect is now being paid in terms of various levels of social resistance. Industries have succeeded in many countries, including Victoria Australia, in subscribing government to mandating smart electricity meters, at end user cost, but still owned by the power distributors or generators. Victoria was a global early first mover in the privatisation of public energy generation and distribution assets. Such cases are a *tour de force* of political acumen on the part of the industry, but certainly myopic on the part of governments and under-serving of their end-user electorates.

This top down socio-technical climate is apparent in many western societies. For example, the US National Action Plan [7] considers 'demand response' to be the imposition of variable power rates and disconnections from the power generator standpoint, with no coverage of end user empowerment or participation.

Differences in treatment by governments are underlined by comparisons between Asia, UK, EU and Victoria Australia. All these regions have major similarities and major differences, which highlight many of the international commonalities and differences that have emerged. The APEC policy [8] is indicative of the broader Asia inclusive polices. The huge scale of Chinese smart meter deployments and other Asian take-up and developments will have wider implications, whether successful or not, and should form part of the ongoing watching brief of regulators and smart meter implementation strategies in other countries.

The countries favoring directive political structures will see more rapid deployments, but given some of the early findings in US, UK et. al., the savings in power usage might not be fully realised due to the emergent need to engage end users and consumers more effectively [9,10]. These developments will be of mutual interest to countries embracing both types of political systems. The APEC framework is addressing the issues in the first instance from the perspective of Smart Grids.

The industry/government axis has dominated in the discussions on smart meters in most domains, and the end user concerns have been subordinated to general grid operations and investment issues and the cost benefit analyses on the savings to energy supplies by engaging time of use tariffs and minimizing energy supplier and installation costs [11].

Significantly absolutely no attention at all has spent on the key area of most rapid growth in business: namely microdata of user behavior – a functional role for which bidirectional communication smart meters are perfectly suited.

We wish to highlight the importance of this aspect of the socio-technical system mediated by fresh information-monitoring capacities that has been largely treated solely as a technical issue.

It is not.

It is past time that the end user orientation was given adequate attention, as its neglect has caused extensive – and not entirely unjustified - negative user responses.

It is interesting to note that the demand management (industry side oriented) reports certainly acknowledge the potential for social injustice, due in part to inability to respond to price signals, but to a lesser degree due to the ability to understand the implications of having a smart meter.

From a paternalistic (social justice) standpoint the possible abuses of power due to unmoderated shifts to time of day metering, the ability to understand and respond to targeted terminations of supply to specific in-home devices, all too possible under smart meter management programs, have been assessed or addressed at even a broad level [12].

Little has yet emerged on such issues as internal behaviours and responses within households relating to tariffs, device control, information integration, HAN utilisation, alternative expenditure and device purchase and competition analysis: nor has any attention yet been paid to any consequential negotiations for energy supplies within the household in any coherent manner. The supply side and household responses to time of day tariffs and energy usage information feedback have been done at a broad level, but not the consumer behavior aspects below the household unit level. This is about to occur, with little or no preparation of the public on the implications of the looming capabilities and capacities as the Internet of Things connects their own devices.

Agent based models of smart meter diffusion at the industry level have been built [13], but, as previously proposed [4], agent based models of household activities, linked to choice models of prospective and actual outcome behaviors are well matched to the need to balance the current supply side domination of the debate and address this missing aspect of energy sustainability impacts and opportunities.

Such proposals have still not realised to be necessary, largely due to the partitioning of the perceptions of sustainability research groups, industry, government and end user interests and the obscuranticism of governance caused by the intermediation of retail and distributor competition and their commercial goals.

Studies of the effects of enhancing the contestability of the often-troubled relationships between energy suppliers and end user considers offer further benefits, and the regulatory capacity constraints that might currently make this appear to be infeasible. There is also a very real risk of abuses of the increased information power and control possible via smart meter data that will reside with energy suppliers in a smart meter smart grid context [12]: further and more broadly based work is clearly needed.

Most studies to date have treated demand side issues essentially as a load balancing issue for the smart grid, with the ability to shed load at the individual device level included without any consideration of the consumer perspectives. This is an issue that is rising in importance for many reasons. Even the large-scale studies done for the UK Ofgem recently concluded:

"*It is becoming clear that electricity and gas consumption are not affected in the same way but the details are only now starting to emerge. The way in which different segments of the population can be engaged, and how they will respond to interventions, also merits further investigation. The key questions concern getting consumers' attention, motivating them to take action and providing them with the necessary knowledge and resources."[14]*.

It should be noted that the Ofgem concluded that gas and electricity smart meter user responses to information are genuinely different. Australia and the UK (in particular) 'consulted widely with stakeholders' but almost entirely (and explicitly) excluded end user consumers[3]. Yet significant comments are made about demand response assumptions made in cost benefit analyses are repeatedly made in both countries' official analyses. In the US National Action Plan not a single end user consumer submission was received [7].

The broad intent of smart metering is to enable greater information to be available to all parties and particularly to enable the smart grids to function. The extent to which the capacity to manage demand through variable pricing by time and by load based pricing and - at second order - to enable the real time response of consumers is still not well understood. Improved information provision to households, even restricted to aggregate levels, can allow consumers to reduce their power usage.

This is a very different stance to the specific shutdown of individual devices (enabled by full smart meter implementations), that is part of the privacy and control problem that is engaged by the provision of Home Access Networks (HAN) and the bidirectional communications capacities of smart meters capable of managing identified domestic devices.

Until home automation and individual device addressability is fully implemented, and the necessary deployment of home readouts (allowing real time monitoring of utilisation and home based generation) has been evaluated, the full implications of the cross connections between privatised power generators, home storage, and home living and transparency will not emerge into the public eye.

III NON-PRICE ISSUES

Early analyses of energy utilisation highlighted the socially regressive nature of most domestic energy pricing mechanisms [10.]

These are not the sole impacts, and some of the others may be categorised as follows:

1. Loss of control over home devices
2. Privacy
3. Security vulnerability
4. Uncertainty over the prices to be levied at any given time

Recent tentative Australian official recognition of consumers concerns over the data were partial [15] but at least a start. Privacy and data linkage and exploition are sleeping giants in this domain. The microdata available from smart metering is potentially the most valuable single commodity created as a consequence of smart meter installation.

Several sources have reported that the of bi-directional meters to deliver a rapid stream of real time data can be used to fingerprint the signature of specific television programs[4]. Such microdata level will be an even more intrusive (and valuable) asset – as the energy industry will see it – which is being handed to them as a bonus without the concomitant contribution to the consumers who will involuntarily (if systems are not redesigned to protect them from this) provide it - and who, once they understand its power, their full and renewed specific consent. The ownership of this data will quickly become controversial in itself.

Ownership has a a material economic value and this should at the very least be shared between consumer and energy supplier.

[3] The closest that the UK gets, even for non-domestic consumers is *' examining whether specific provisions are required for non-domestic consumers or third parties providing services to them, to access their data'[13]*

[4] University of Munster tests http://www.metering.com/node/20028

Price uncertainty at a given time, like unanticipated termination of power to a specific device or premises, affects both attitudes and behaviours at the consumer end of the chain. Here the issues can clearly be addressed by a combination of consultation, contract, regulatory clarity and process structures with mass customisation of tariffs [16], times of use and terms. Power abuses (eg for debt recovery) will also need regulation [12].

The treatment of Smart Meters has to date been dominated by industry and top-down government investment perspectives. Solely supply side perspectives are now clearly inadequate, and consumer engagement and perspectives are now critical to overall success. As the UKERC cited: '*put social science studies on every implantation/rollout of new technology to (a) understand why people behave as they do, and (b) to quantify these behaviors and motivations*' [17].

A key neglected policy area is the use of the information and communication capabilities to engender mass customisation – and enabling dynamic scanning of offers and supplier switching by the customer.

III. IV Conclusions

Smart Grid systems are being developed to serve customers. These will become increasingly sensitive and 'smart'. IBM has recently pinpointed the emergent 'smart energy consumer' [18] as a result of utility survey research emphasizing the importance of information to and about these people [19].

It would be prudent for both governments and smart grid planners and engineers to make an early start on catching up with fuller engagement with, and better understanding of, their energy customers.

References

[1] M. Roozbehani, M. A. Dahleh, and S. K. Mitter, "Volatility of power grids under real-time pricing," *IEEE Transcations on Power Systems,* 2011 (in press).

[2] C. Cuijpers, "No to mandatory smart metering does not equal privacy," Tilburg University: TILT Weblog Law and Technology http://vortex.uvt.nl/TILTblog/?p=54, 2009.

[3] C. Cuijpers and B.-J. Koops, "Het wetsvoorstel 'slimme meters': een privactoets op basis van art. 8 EVRM," Centre for Law and Technology University of Tilburg for Onderzoek in opdracht van de Consumentenbond, Tilburg NL2008.

[4] Wigan, M.R. "Smart Meter Tradeoffs" *IEEE International Symposium on Technology and Society in Asia (ISTAS) 27-29 October 2012*,

[5] C4, "The dark side of the smart grid: smart meters and (in)security," 2009.

[6] R. A. Clarke and M. R. Wigan, "You are where you have been: The privacy implications of location and tracking technologies," *The Journal of Location Based Services,* vol. 5, p. 138, 2011.

[7] Federal Energy Regulatory Commission Staff Team, "National action plan on demand response," 2010.

[8] Anon, "Progress report on the APEC smart grid initiative (ASGI): Multilateral Framework for the APEC Smart Grid Initiative," 2011.

[9] S. Darby, "The effectiveness of feedback on energy consumption: A review for DEFRA of the literature on metering, billing and direct displays," Environmental Change Unit: University of Oxford April 2006.

[10] G. Raw and D. Ross, "Energy demand research project: Final analysis," AECOM, St Albans June 2011.

[11] A. Kemp, A. Whitfield, B. Quach, Y. Hedynach, and T. D'Souza, "Report for the Ministerial Council on Energy Smart meter Working Grouop. Cost benefit analysis of smart metering and direct load control: Overview report for consultation," NERA Economic Consulting, 29 February 2008.

[12] M. McGann and J. Moss, "Smart meters, smart justice? Energy, poverty, and the smart meter rollout," The University of Melbourne, 2010.

[13] T. Zhang and W. J. Nuttall, "Evaluating government's policies on promoting smart metering diffusion in retail electricity markets via Agent-Based Simulation," *J. Prod. Innov. Manag.,* vol. 28, pp. 169-186, 2011.

[14] Ofgem, "Smart metering for small businesses and other smaller non-domestic customers," Ofgem UK, Ed., ed. London: http://www.ofgem.gov.uk, 2011, p. 2.

[15] Standing Council on Energy and Resources (Australia): "Privacy for National Smart Meter Program" Aug 2013. Accessed 30 November 2013 at http://www.scer.gov.au/workstreams/energy-market-reform/demand-side-participation/smart-meters/ Accessed 30-11-13

[16] A. Weekes, " The Future in Delivering Energy to the "Smart" Consumer" IBM Relationship Paper 3. 2011, Accessed 30 November 2013 at http://public.dhe.ibm.com/common/ssi/ecm/en/euw03046usen/EUW03046USEN.PDF

[17] M. Valocchi and J. Juliano, "Knowledge is power: driving smarter energy usage through consumer education," IBM Institute for Business Value 2011. Accessed 30 November 2013 at http://smartgridaustralia.com.au/SGA/Documents/Consumer_Behaviour_Report.PDF