How could smart meters transform household practices?

Grégoire Wallenborn

Centre for Studies on Sustainable Development - IGEAT

Université Libre de Bruxelles

Abstract

Recent studies about the effect of smart meters combined with in-home display show an electricity consumption decrease of 2 to 4% in the best cases. This is much less than anticipated. I explain this unexpected low result by the diversity of consumers and the notion of domestication. The recruitment process of “ordinary experimenters” is crucial but hardly noticed. As I show through the analysis of a qualitative experiment, people who are already interested in energy conservation are willing to get supplementary information, but people who are not interested can hardly do something with new information. I conclude that smart meters might be helpful for users if they are conceived not as “drivers” but as open partners to create practices.

Smart metering and energy conservation

Electric smart meters are rolling out throughout Europe at a different pace in every country. Lobbies of smart meters and promoters of smart grids are strong at the EU level and within most national governments. In the EU-27, the market of smart meters is estimated to at least €50 billions (Faruqui et al. 2009) and the “smartisation” of the grid might cost €500 billions between today and 2020 (COM 2010/677). Even the countries which have repelled the roll-out on the basis of a negative cost-benefit analysis — as the European directive allowed them to proceed — will be nudged sooner or later to deploy smart meters. Besides, there is no clear definition of what is a smart meter and which functionalities it should have (Langenheld 2010). For example, smart meters can be conceived as a tool to help the grid management, as a way to change the electricity (or energy) markets, or as an enabler of energy conservation. These conceptions are related to the interests of different actors and are not necessarily aligned. Many controversies around the smart meter roll-out show that interests are not commonly shared. Many issues question the smart meter roll-out: privacy, data security, electrosmog, who pays the meter, who owns it, necessity to install a smart meter for small consumers, which data to transfer, with which format, at which frequency, effectiveness of paying the ‘real cost of the electricity’.

In this paper I am concerned with the particular controversy of energy conservation with the use of a smart meter. Smart metering is often sold to the largest audience with the argument that they will yield to energy conservation for households. For example, in line with the European Commission, the UK government sees many benefits for consumers: “Improved feedback and advice on energy consumption will give consumers (including those on low incomes) the tools necessary to achieve financial savings at a time of rising prices, as well as helping them to understand the benefits of energy efficiency measures.” (DECC 2012). Up to recently it was often claimed that smart meters, combined with feedback to users, will help households save energy up to 15% (Darby 2006). This affirmation confuses smart meters (which are communicating meters) with in-home displays (energy consumption is then readable in the home).

Furthermore, many assumptions are made about what consumers are and want. Here is a list of some examples. Consumers want to know more about their bills and the energy prices. As energy consumption is invisible, giving consumption curves and instant information will make energy visible. To manage energy, you need to measure it. Feedback is a necessary element to control energy use more effectively: information provided by feedback is clear and self-explanatory. People react to external stimuli in predictable ways. The transaction costs of getting the right information are low, and cognitive saturation happens rarely. When fully informed a consumer makes the best choice. Households can control (or manage) their energy consumption through different simple strategies. Consumers need to measure their efforts in order to be encouraged. Habits can be changed through awareness rising. Once settled, these habits will last. Among the overwhelming quantity of products, energy is an issue for households. Users are interested by increasingly sophisticated devices.

These assumptions are typically framed in the ABC (attitude, behaviour, choice) grammar (Shove 2010) with a technological orientation. In the ABC vocabulary, individual behaviours are caused by attitudes and people can make choices of using or not technologies when correctly informed. In this paper I deliberately use the ABC framework to analyse the appropriation of in-home displays in 21 Belgian households. In using a limited number of variables, I want to show some of the limits of this approach and to suggest other ways of tackling the electricity measurement issue. But before describing the results of the "social experiment" I rest upon, I have to report the last lessons drawn from feedback studies.

Feedback studies: who is recruited?

A common argument for the roll-out of smart meters is based on the energy conservation that people would gain. The higher the gains, the more consumers can pay the system. The issue bears then on the ways to evaluate the effects of the different combinations of tools. It is therefore important to assess correctly what can feedback yield in terms of energy conservation. In a recent report for BEUC (European Office of Consumer Organisations), I have among other things, reviewed with a colleague (Klopfert & Wallenborn 2011) the most reliable studies on smart meters appropriation by householders through their combination with different information tools (instant or historical feedback on electricity consumption, cost, CO_2 emissions, graphs, energy efficiency advices, social comparisons, alerts, etc.). A whole social and political engineering is being developed to recruit consumers into energy management.

We have selected 6 studies that respect scientific standard (statistical analysis, control groups, description of the methodology and of the recruitment) and happened in Northern Europe (UK, Ireland, Germany). The first interesting outcome is that, in the most efficient combinations, householders have been enabled to reduce their electricity consumption by 2 to 4% the first year of use. This is the result of a smart meter (SM) combined with accurate billing, feedback (instant, daily or monthly) and advices. The table below shows some results of the 6 studies. Electricity consumption reduction has been measured after one year of experiment. There is however indication of a drawback effect beyond this first year. Consumption might well come back to the initial level after 2 or 3 years.

Project	Recruitment	Total number	Number of	Electricity

Name	methodology	of households	households with a SM	consumption reduction
EDF-EDRP (UK)	Phone. Opt-in	1979	1879	2.3% - 4%
E.ON-EDRP (UK)	Letter (and then phone). Opt-in	28450	8055	1.7% – 3.9%
SSE-EDRP (UK)	Different methodologies	27887	7106	2.5% - 3.6%
CER (Ireland)	Letter. Opt-in	5028	3858	2.5%
Intelliekon (Germany)	Letter & phone. Opt-in	2091	1114	3.7%
Scottish Power-EDRP (UK)	Visit. Uninformed	3028	1330	No effect

Methodology and results of 6 large European studies on feedback.

The second interesting outcome of the analysis of the studies comes from the experiment led by Scottish Power for which no effect was detected with information tools[1]. In most cases, houses were installed with smart meters but without notification to the householders. Householders were not informed that a smart meter had been installed in their homes since it was done as a business-as-usual visit and had no opportunity to refuse postal interventions. They receive all the relevant information of their consumption and energy efficiency advices. But they did not reduce significantly their consumption, in the average and compared to the control group. This can be elucidated with two explanations. First, the Hawthorne effect refers to behaviour change when people know they are observed. When consumers know they are under scrutiny, they make an effort to look like normal or good people. In the case of Scottish Power, they were not aware of being observed and expected to decrease their electricity consumption.

Even if this explanation is plausible, I prefer the second one because it is not based on alleged uniform qualities given to people and rests upon logic. Knowing that most of people (up to 95%) do not opt in for the “smart energy programmes”, the Scottish Power no effect is explained by the recruitment process. All experiments and pilots for feedback are conducted with users who are interested by the new tools, who declare to be ready to play with the new device. This group however is only a small fraction of the population. When experiments include also randomly non-interested people, “good player” effects are sunk among the general trend.

This result shows that households that have not declared to be interested in devices or tips to save energy do not feel involved in the issue. Analysts of the Energy Demand Response Project (EDRP 2011) have examined the different studies to explore whether

[1] Financial incentives have led to some results but are excluded here from the analysis.

there is some difference between households that have opted in and those that have not. As they do not see any difference in explanatory variables (socio-demographics, localisation, attitudes, etc.), they conclude that both groups are not different. I draw a different conclusion: the intrinsic difference between both groups resides precisely in being or not interested. In fact, the analysis shows that this interest is evenly distributed among social groups and that motivations to opt in are probably diverse. It is thus difficult to tell *a priori* who will be interested in "home energy management" devices.

A social experiment with in-home displays

My interest towards the recruitment methodology was triggered by an experiment I led in Belgium with other colleagues. On the basis of an original protocol that intends to interfere as little as possible with users, we installed in-home displays in 21 Belgian households (Wallenborn & al. 2011). We gathered qualitative and quantitative data in 21 households between September 2009 and May 2010. Participants were recruited through different means, as we tried to extend our sample to "not really" willing people, including poor households. Despite our efforts the sample is certainly biased. For instance, we have compared respondent' consumption with the average of similar households. 8 have a low, 10 an average and 3 a high electricity consumption. Their interest in energy conservation is: committed (8), aware (10), none (3). Their position towards the environment and the future is: sustainable development is possible (14), pessimistic/uninterested (7).

One of the objectives of the study was to understand what people learn with an in-home display. Some respondents have stated that they have learned that some appliances use a lot of energy (dryer, water boiler, halogens, oven, etc.). "Everything that heats up consumes a lot". But conversely, a few have noticed that some appliances don't consume much. "I realized I can use it more". Most of users noticed huge variations in electricity consumption and peaks when some appliances are being used. Perception of energy consumption changed also through the realisation of the hidden consumption (appliances on standby). Some users ranked appliances according to their power (instant consumption). Respondents committed to conservation used the display to hunt the remaining standby and other wasteful consumption. Some played to the suggested "zero energy game": the aim is to switch off every single appliance to achieve zero consumption in the whole household.

Out of the 17 users who changed their perception of energy consumption, 7 changed their behaviour (including the intention of buying more efficient appliances or light bulbs). Six of these seven users are committed towards conservation, five have a low consumption, and all of them heat their living room between 17°C and 20°C. The fact that the ten households who did not change their behaviour while their perception can be explained differently: in 4 households conflicts prevent members of the family to agree on the actions to be taken, 3 consider that they are already well informed about what to do, 1 is tenant and thinks she cannot control her consumption, 1 prefers to invest in more energy efficient appliances rather to change his behaviour, 1 estimates to be in the average and is happy with that. The four who have not change their perception think they are already knowledgeable enough (3) or illiterate (1).

We have observed wasteful behaviours in 8 households on 21. By wasteful behaviours we include statements based on high indoor temperature in Winter (22°C and more), the absence of heating management, the extended use of electric heating, washing at 90°C or often in small quantities, leaving all the appliances on standby, simultaneous use of many lights, acquisition and use of the last power-consuming play station. None of them have

stated that they changed their behaviour as a result of the indications given by the electricity display. However four declared to be thrifty. Their energy consumption is high (3), average (4) or low (1). They comprise a high proportion of people not interested in environmental issues (5/8).

The respondents declare that they have used the display for different reasons: curiosity (8), check if they do the right thing (6), systematic control of what's happening in the house (3), to do service (4). Those who accepted the in-home display "to do service" felt a kind of obligation towards either the researchers, a friend or an institution (the Public Centre for Social Welfare in the case of the illiterate respondent). All these four persons have some "wasteful behaviours". The other people with unnecessary consumption have been interested in the display either to control their consumption (3) or out of curiosity (1). On the other hand, people who seem to be careful in their energy consumption (according to standard advices) have chosen to use the display out of curiosity (7) or for a general check (6).

A household is not a set of causal relations

This description of the causes and effects of the use of an in-home display has been deliberately framed with the limited ABC grammar. It shows several points however.

First, we can observe general relations between identified variables. For instance, no perception change entails always no behaviour change. But a change of perception is either followed by a (limited) behaviour change or not. For instance, people who have changed their behaviour were most of the time already interested in energy conservation. And conversely, people who have stated wasteful behaviours have not changed their behaviours. This remark is important for the recruitment process of smart meters: people have to be first interested in the energy issue before to be able to appropriate relevant tools for them. Other general relations have been identified (e.g. environmental pessimism and wasteful behaviour), but are more difficult to interpret because of their vagueness. In last resort, the explanation lays on psychological variables. And the explanation is asymmetric: success is explained with some variables (interest, environment) and failure with other variables (family context, wasteful behaviours). Respondents' statements have been categorised by the questions asked by researchers, who are obliged to make up for the poverty of the ABC vocabulary.

That leads us to the second point. All the relations that we can make between the variables are singular. They belong each time to a unique family and story that has its own logic and exhibit a range of constraints peculiar to each household. For instance, people whose perception changes but not behaviour have many reasons to do so. These explanations seem to be contingent on many points. This would be even more revealed through a larger sample and deeper interviews and observations, as Hargreaves et al. (2010) show. Singularities are blurred under the abstraction by which some relations are deemed more important. The differences are erased through the statistical analysis that rests upon similarities only. Worse, these similarities are presupposed in the recruitment process, through the performative effect of *a priori* variables. The first studies on direct feedback have begun with small samples and have recruited the most involved users. These studies showed a large potential to achieve energy savings (5-15%). As the number of recruited users increases, the energy savings per household decreases and tends to zero for consumers who did not chose to participate. In the huge diversity of consumers it is always possible to find segments that have a positive reaction to the experiments. The first basic segment is composed of people who chose to be involved in the experiment.

And among consumers who did opt in, the “best practices” that can be found in some places are somehow diluted. When looked in details the behaviours of respondents are constrained by many everyday activities that make more sense for them than any consideration towards energy. Behaviour changes are marginal because most of the practices are non negotiable (Strengers). Household dynamics is first of all multifarious and messy.

Third, displayed are appropriated in diverse ways. Their domestication (Liverstone 1993, Pantzar 1997) depends on pre-existing competences and practices, as well as interests of different sorts (financial, environment, control, etc.). Objects that require interactivity need to be domesticated: right manipulations emerge from a learning process in relation to existing routines and embedded in meanings and intentions. However, learning with a display is rather limited because as an object it is not really integrated into existing practices. It adds up to what people are already doing without modifying relations that constitute practices: either it legitimises current conservation practices or it provides information which is not relevant to what people think they can do. Furthermore, the interest towards electricity consumption figures fades away in some weeks. The *domus* of the display is quickly reduced to a cupboard!

Then, would electricity disaggregation improve the use of feedback? Some engineers are working on devices based on the possibility to relate the use of any appliance with a consumed electrical power. These devices would be able to advise the users about their routines and obsolete stock for example. Would this empower householders to save energy? We can fear that it might be only helpful at the margins of the whole energy consumption when non negotiable practices are considered.

Experimenting with practices

The ABC grammar presupposes a limited set of variables, causally related. With this epistemology, facts are constructed to answer to pre-established questions, as if households behave like laboratories. In-home displays are conceived as the centre of the experiment because it is thought to be the vector of change. Effects observed are small however. These effects are rightly attributed to “behaviour change” since behaviour can be defined as a visible action. But many important elements and performances are invisible, or at least not registered during the conduct of the experiment. Social practices are plenty of dimensions that do not fit well with the idea causal variables explored in a laboratory: embodied habits, messy stuff and infrastructures, implicit knowledge and meanings, reflexivity. Social practices cannot easily reduced to simple elements that make possible a controlled experiment.

Trough their performance, practices actively link heterogeneous elements as competences, material infrastructures, meanings (Shove et al 2012). The smart meter case shows that current experiments address separately the practice elements. Engineers work on the material aspects of practices and dream about a full automation of the energy management of households. Economists search for giving the good signals to people so that they can give proper meanings to their actions, namely be rational. Policymakers speak about educate people, giving them the right competences to act. These implicit models are based on ideas of linear causality (laboratory, signal, teaching) and they cannot relate transversally the different elements.

To conclude I would like to speculate about the sort of experiment that would allow the emergence and observation of new practices. If people have to be first to be interested in the energy issue before a right appropriation of displays, we could argue in favour of reframing the energy issue. Public debates about energy use might be triggered, for instance, by a change in prices, or even a kind of rationing (e.g. carbon allowances), or a combination of both (e.g. progressive tariffs). Public awareness could be directed towards more links between daily practices and environmental impacts. Then for sure, the meanings of energy consumption would change, but we would have hardly learned about how practices are transformed.

Home energy management and smart meters constitute a meeting point between the social and the technological. Marres (2012) shows however that primacy is still given to technology in the conception of the experiments. The design of an experiment *with* practices would mean that all elements of practices are considered on an equal foot, in the same sociotechnical ontology. The experiment is then a reconfiguration of these elements, which outcome is not predictable. As people are also elements of the experiments, they should actively participate in the creation and definition of functionalities, usages and meanings of the devices they try. Collaborative design could help to design new practices as long as the experiment starts with the questioning of singular needs. The following step would be to see practices as activities which always evolve and accordingly to design experiments in which objects would evolve with their usages.

References

COM(2010) 677 final - Communication from the Commission to the European Parliament, the Council, the European economic and social committee and the Committee of the regions, Energy infrastructure priorities for 2020 and beyond - A Blueprint for an integrated European energy network

Darby, S. (2006), “The effectiveness of feedback on energy consumption. A review for DEFRA of the literature on metering, billing and direct displays, DEFRA.

DECC (2012), Smart Metering Implementation Programme Consumer engagement strategy. Consultation document, Department of Energy and Climate Change.

EDRP (2011), Energy Demand Response Project : A final analysis, AECOM, Report commissioned by Ofgem on behalf of DECC, retrived from : http://www.ofgem.gov.uk/Sustainability/EDRP/Pages/EDRP.aspx

Faruqui, A., Sergici, S. and Sharif, A. (2009), “The impact of information feedback on energy consumption – a survey of the experimental evidence”, *Energy* 35, 1598–1608.

Klopfert, F. & G.Wallenborn (2011), Empowering consumers through smart metering, a report for the BEUC, the European Consumer Organisation.

Langenheld A. (2010), Advanced metering and consumer feedback to deliver energy savings – Potentials, Member States experience and recommendations, Report prepared by the Joint Research Centre of the European Commission.

Marres, N. (2012), “On Some Uses and Abuses of Topology in the Social Analysis of Technology (Or the Problem with Smart Meters)”, *Theory, Culture & Society* 29(4/5) 288–310.

Pantzar, M., (1997), “Domestication of Everyday Life Technology: Dynamic Views on the Social Histories of Artifacts”, *Design Issues* 13, pp. 52-65.

Shove, E. (2010), “Beyond the ABC: climate change policy and theories of social change”, *Environment and Planning A* 42 (6), 1273–1285.

Shove, E., M. Pantzar & M. Watson (2012), *The dynamics of social practice. Everyday life and how it changes*, London, Sage Publication.

Silverstone, R. (1993). Time, Information and Communication Technologies and the Household. *Time & Society* 2(3): 283–311.

Wallenborn, G., M. Orsini & J. Vanhaverbeke (2011), « Household appropriation of electricity monitors », *Journal of Consumer Studies*, 35 (2011) 146–152.