HOW SMART ARE ELECTRICITY USERS WITH 'SMART METERING'? A BEHAVIOURAL ECONOMICS EXPERIMENT

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Overview

As part of the development of the European electricity grid, the European Union (EU) has has decided that by 2020 electronic electricity meters, or 'Smart Meters,' should be installed in 80% of the households in the EU, where this is deemed a net benefit as assessed through cost-benefit analysis (CBA) (EU Directive 2009/72/EC). The EU expects that the introduction of Smart Meters (SM) will result in a 10% reduction of energy use in the residential sector (EC, 2011); a policy approach that is based on an 'information-deficit model' that assumes a more rational behaviour by consumers if information asymmetries are reduced. A central assumption in this approach is that provision of real-time information via SMs enables end-users to make more rational decisions about their energy service demands (e.g. lighting). However, even if there is some evidence that real-time feedback to consumers drives a more efficient use of energy (Raw et al., 2011), the magnitude of this reduction has been debated, raising doubts about the effectiveness and economic efficiency of introducing SMs in the residential sector. Whereas much attention has been given to technological aspects and the pure provision of information (Fischer, 2008), less is known about the role of behavioural biases and cognitive issues (e.g. loss aversion and salience) associated with SMs and energy use.

This paper aims to contribute to filling this knowledge gap by examining the effect of behavioural aspects of electricity use. Two real-life experiments with SMs and electricity users was conducted in Copenhagen, Denmark (details in next section), and this study thus provides an empirical analysis of how behavioural biases affect consumers' response to electricity-use information. From a theoretical point of view, the aspects analysed in this paper depart heavily from behavioural economics. The central tenant of behavioural economics is that cognitive, emotional and social factors influence how information is understood and limit the possibility to display purely rational behaviour, in turn affecting human (economic) decision-making (Kolstad et al., 2014). However, the research and findings are also framed and supported by different schools of economics, including neoclassical and institutional economics (e.g. Mundaca et al., 2013).

Method

To meet the objective, experimental research was conducted through two residential SM experiments: First, a simple experiment took place: whether the installation of SMs yielded (or not) reductions in electricity use. To that end, the electricity use data of 92 households in Copenhagen, Denmark with SMs installed was collected, with no other intervention being made. To approximate and thus assess the potential effect of installing a SM, the consumption from the first week after installation was taken as a starting point, assumed to be the 'normal' consumption from which an effect should be discerned.

Second, a residential SM experiment was conducted in collaboration with NorthQ, a producer of SMs. In the experiment, electricity use in the participating households was monitored, and BE-inspired feedback was provided. The experiment tested the effect of two behavioural biases, namely *salience* and *loss aversion*, on consumer behaviour with regards to electricity use and energy-related decisions. SMs were installed in a group of households (n=16) of approximately the same size having the same type of electricity and heating system, all located in the same part of Copenhagen, Denmark. The group was divided into a reference group (n_{No} = 5), who received information about their electricity in a conventional manner, and an intervention group (n_{LA} = 11), who were subjected to loss aversion and salience. The intervention period lasted for 6 weeks in July and August 2014. The change in electricity consumption as a result of the intervention was analysed using two different methods: one tracking the absolute change from first to last week; and the other calculating the relative change over time using the average consumption in the first week as baseline. The knowledge generated from the experiments was used to determine whether behavioural insights could be applicable when providing consumers with information using SMs. A comprehensive literature review was carried out to compare the effect of providing information feedback as found in previous studies to the results obtained in this study, taking into account sample size and intervention period.

Results

The results of the first experiment were roughly consistent with the reductions found in the literature, as an effect of -6.7%(±41%) was seen, which falls within most of the studies reviewed. The second experiment showed that end-users are prone to behavioural biases when faced with decisions relating to electricity use. The group not subjected to loss aversion and salience (reference group) reduced their daily electricity consumption by 7% on average, while those subjected to loss aversion and salience (intervention group) reduced their consumption by 18%. Using the method of relative change, the change in electricity consumption is -5.2% on average for the loss aversion meters, and 2.2% for the non-loss aversion meters. The reduction in standby consumption was 3% for the reference group, but 28% for the intervention group, which was subjected to salience and loss aversion. Using the method of relative change, the change in standby consumption -13% on average for the loss aversion meters, and 3% for the non-loss aversion meters (Table 1). However, and with due limitations, the findings are still consistent with the results found with the first method: the loss aversion framing has a larger effect than when no loss framing is applied. Compared to related research, findings revealed that reductions in electricity use were also larger than the average electricity reduction found in other studies of feedback on electricity use.

Daily consumption	Intervention group	Reference group
Method 1	-18%	-7%
Method 2	-5%	2%
Standby consumption	Intervention group	Reference group
Method 1	-28%	-3%
Method 2	-13%	3%

Table 1 – Changes in electricity consumption as a result of information feedback.

The SM experiment took place in a real-life setting where consumers used and paid for their electricity. Assuming previous large-scale trials using comparative feedback provide any indication of what can be expected with behavioural feedback, effects in a population of applying individual feedback with loss aversion and salience suggests that feedback should thus result in reductions of 4-6% in daily consumption and 6-8% reduction in standby consumption. In any case, the indication of an effect in both instances (daily and standby electricity use), and the likelihood of replication in real-life situations, calls for large-scale trials to further test this.

Conclusions

As a whole, it is concluded that feedback information can encourage efficient electricity use and thus contribute to meeting the goal of reducing household energy consumption through the use of SMs. However, the (expected) effects may heavily depend on how feedback is designed, framed and presented. Results related to behavioural biases suggest important implications for the way in which information is understood and acted upon as the salience and framing of the information affect the response seen. Therefore, the deployment of SMs should not be conceived only about the provision of 'right' information (i.e. reduction of information asymmetries), but 'how' information is actually provided. This implies that the reduction in energy consumption as a result of SM roll-out depends on how information feedback is designed and may possibly be less than expected, which has implications for the CBA underlying the policy. At this stage it is possible to conclude that there is an enhanced effect on efficient electricity use as a result loss aversion, but further experimental research, such as large scale randomized controlled trials, is needed for more conclusive and statistically significant results.

References

European Commission (2011). Press Summary: "Next steps for smart grids: Europe's future electricity system will save money and energy," Brussels, Belgium: The European Commission, 12 April 2011.

Fischer, C. (2008). Feedback on household electricity consumption: a tool for saving energy? *Energy Efficiency*, *1*(1), 79–104. doi:10.1007/s12053-008-9009-7

Kolstad C., Urama, K., Mundaca, L. et al. (2014). Social, Economic and Ethical Concepts and Methods. In: *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge, UK: Cambridge University Press.

Mundaca, L., Mansoz, M., Neij, L., & Timilsina, G. R. (2013). Transaction costs analysis of low carbon technologies. *Climate Policy*, *13*(4), 490–513. doi:10.1080/14693062.2013.781452

Raw, G., Ross, D., & Cripps, A. (2011). *Energy Demand Research Project: Final Analysis* (p. 179). Hertfordshire, UK: AECOM.