Making 'Smart Meters' Smarter?

By Simon Bager and Luis Mundaca*

The importance of energy efficiency in the context of green economic growth, climate change mitigation and sustainable development keeps gaining scientific, policy and media attention. Historically, large cost-effective energy saving potentials have been estimated for the European residential sector. However, despite multiple economic, social and environmental benefits embedded in increased energy efficiency (e.g., reduce greenhouse gas [GHG] emissions, increase energy security, job creation), a number of market failures and barriers have traditionally prevented efficiency improvements due to, for example, information asymmetries (see e.g., Gillingham & Palmer, 2014). In Europe, consumers have inferred knowledge about their electricity demand mostly through billing estimates and infrequent meter readings, meaning that they have had imperfect or partial information on the impact of their energy-use behaviour.

As part of the development of the European electricity grid, and to address information barriers that prevent the diffusion of profitable efficient technologies, the European Union (EU) has decided that by 2020 electronic electricity meters, or 'Smart Meters' (SMs), should be installed in 80% of the households in the EU (Directive 2009/72/EC). The European Commission expects that the introduction of SMs will result in a 10% reduction of energy use in the residential sector (EC, 2011). A central assumption of this policy measure is that the provision of real-time information via SMs will enable end-users to make more rational decisions about their demands for energy services (e.g., lighting). Whereas much attention has been given to technological aspects and the pure provision of information, with and without using SMs, much less is known about the role of behavioural biases and cognitive issues (e.g., loss aversion and salience) associated with SMs and energy use.

In order to contribute to this debate, we examined the potential effects of SMs on behavioural aspects of electricity use. From a theoretical point of view, we departed heavily from behavioural economics. That 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). In order to examine whether and how behavioural biases affect consumers' response to energy-use information, we designed two experiments with SMs and electricity users that were carried out in real-life settings, where consumers actually used and paid for their electricity use.

First, a simple experiment took place: whether the installation of SMs could (or not) yield reductions in electricity use. To that end, SMs were installed in 92 households in Copenhagen (Denmark) and the electricity use data was collected (See Figure 1). No other intervention was made. The rationale behind this experiment was to explore whether the EU prediction of a reduction in electricity use of 10% due to the simple installation of SMs is in any way reflected in electricity use profiles of customers with SMs installed. The second experiment tested the effect of two behavioural biases, namely *salience* (understood as the ease with which data can be understood and processed by humans [Kahnemann, 2003]) and *loss aversion* (seeing a reduction in consumption as reducing a loss should induce a more significant change in behaviour) on consumer behaviour with regards to electricity use and related decisions. In this case, the participating households were divided into two groups. The reference group received information about their electricity in a conventional manner (in kilowatt-hours [kWh]) and how much their consumption aligned with a pre-determined budget (in Danish Krone [DKK] per year), which had been set by the household. The intervention group was subjected to the same information given to the reference group, along with information on the running costs of electricity use and the estimated weekly cost (framed as a *loss*), and the cost of passive and standby electricity use per day and per year (framed as a *loss* and made *salient*) (Figure 2).

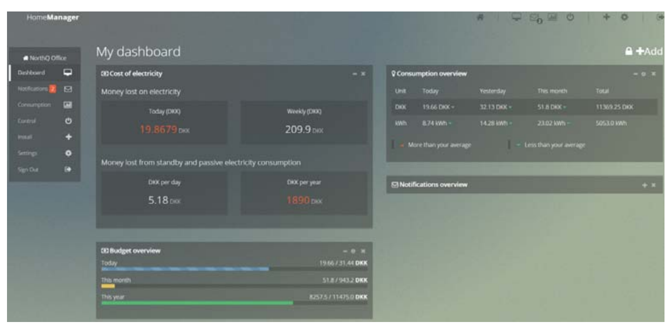

Figure 1 – Snapshot of consumption information available to SM customers online. ©NorthQ and Bager (www.northq.com). The top-left widget ("Cost of electricity")

The results of the first experiment (i.e. installation of SMs without further intervention) generally aligned with electricity use reductions found in previous research (e.g., Fischer, 2008), and indicate that it may be possible to expect a reduction in electricity use in the medium-term (weeks/months) of 6-7% ap-

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Figure 2 – Loss Aversion widget as seen by participants in the second SM experiment. ©Bager & NorthQ.

proximately. However, the large standard deviation (43% [n=47]) underscored the need for large-scale longitudinal studies. Results of the second experiment (i.e., introduction of SMs with and without intervention) show that subjecting participants to loss aversion and salience seemed to affect their behaviour toward more efficient electricity use. Whereas the reference group reduced their daily electricity consumption by 7% on average, those subjected to loss aversion and salience reduced their consumption by 18%. The reduction in standby consumption was 3% for the reference group, but found to be 28% for the intervention group. Setting aside socio-economic factors (e.g., income, household composition, education level) the intervention had a larger effect than when no framing was applied. Findings revealed that reductions in electricity use were also larger than the average electricity reduction found in other studies of feedback on electricity use (e.g., Fischer, 2008).

At the risk of oversimplifying, our results suggest that the delivery of information to energy users needs to take into account not only its pure provision, but also how feedback is designed, framed and presented. In turn, the deployment of SMs should not be conceived only about the provision of the 'right' information, but 'how' information is actually provided within a mix of effective and efficient policy instruments (e.g., market-based incentives, regulatory approaches). Our study supports the hypotheses that increasing the salience and framing reductions as avoiding a loss, rather than obtaining a gain, can trigger behavioural responses leading to conservation and energy efficiency measures. Whether or not the behavioural-based intervention used in the second experiment can actually reduce electricity consumption with the magnitude expected in the EU policy proposal (EC, 2011) hinges to a large extent on the scalability and long-term effects of such interventions (e.g. considerations of the 'rebound effect'). Our research suggests that there is a strong need to conduct large-scale, longitudinal and comparative studies in this area.

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