# Smart electricity meters! And their users?

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2016



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Smart meters provide real-time feedback about electricity use and its costs. This should be enough for economical people to reduce their consumption, but it requires more explains Jonas Sonnenschein

Are electricity consumers irrational fools? They keep their devices in stand-by mode, forget to switch off the lights when they leave the room, purchase halogen light bulbs (instead of LEDs) because their light is supposedly more beautiful, and they do not even think about replacing their 15-years old fridge freezers. While this kind of behaviour may sound familiar to many of us and reminds us of the difficulties of being an environmentally conscious consumer, it is quite obviously not economically rational. Indeed, there are countless studies and reports that quantify the energy efficiency potential in private households and its economic benefits.

The (in)famous McKinsey Curve, which compares the costs of different technologies to reduce GHG emissions, shows for example that energy efficient technologies mostly have negative costs. They pay for themselves. Moreover, the potential for cheap (or even beneficial) emissions reductions is also large, when the focus is on behaviour and not on technology as such. In the US, emissions reductions of 20% are reasonably achievable within 10 years through behavioural change in the household sector, which roughly corresponds to the total emissions of France.

In the EU energy savings of 20% by 2020 are targeted, and the EU parliament calls for a binding energy efficiency target of 40% by 2030. However, targets and potentials do not reflect reality. The gap between the status quo and the economically beneficial use of energy efficient technologies is often referred to as energy efficiency gap, whose size is debatable and may differ between different sectors, but whose existence is undisputed.

The mainstream policy response to the energy efficiency gap is to strengthen markets for energy efficiency. The gap is framed as a market failure. If energy prices do not reflect the 'true costs to society' of energy provision, carbon-energy taxes are there to internalize these costs (e.g. costs related to GHG emissions). Consumers have to pay higher prices for energy and are hence expected to reduce their energy use. Similarly, if people just knew how beneficial it is to buy a new fridge, switch to LEDs or even insulate their attics, they would more likely engage in these energy saving behaviours. So information campaigns are run to fix this market failure ('information deficit').

### Smart meters

One particularly promising information technology with political backing is smart metering of electricity use. Smart meters (SM) in Europe are promoted by the EU Energy Efficiency Directive (Articles 9-11), which requires utilities to offer SMs to their customers (i.e. electricity meters that provide time-of-use information and allow for billing based on actual consumption). This intervention aims to achieve up to 10% reduction of electricity use in the EU's residential sector.

There are justified doubts whether the mere provision of information will result in such significant reductions. Reviews of various SM schemes find average reductions of 6-7%, but variations between studies are large, the number of participants in most studies is very small, and saving effects tend to diminish over time. Hence, there is a considerable risk that actual effects of SM feedback on energy use are even smaller than the average effect found in the schemes that have been evaluated so far.

### Behavioural economics

An explanation for the modest success of SM feedback is that many people are quite simply *economically irrational*. Fixing market failures (in this case the lack of information on electricity use) works as long as market actors (=people) act according to the economic model (in this case minimize the electricity use for a certain energy service when they get the information they need and the 'right' incentives). But in reality they mostly don't! While there is little evidence for purely economic behaviour in the context of energy efficiency, it does not mean that people make completely random decisions.

The field of behavioural economics investigates *systematic* deviations from economically rational behaviour and their drivers, which include values, norms, attitudes and various sub-optimal decision-making approaches, so called heuristics. There are several examples for behavioural failures in the context of energy efficiency. People tend to reduce their energy use when they are informed how their level of consumption compares to the consumption in their neighbourhood. This illustrates the effect of social norms on economic decisions. Moreover, people tend to be biased towards the status quo when it comes to energy renovation of their homes or the purchase of a more efficient car. Due to loss aversion, uncertainties about future developments (energy prices, actual performance of the car, driven kilometres) are perceived higher than they actually are. This leads to underinvestment in energy efficient technology.

### Case studies

With respect to the application of SMs researchers at the IIIEE, Lund University, investigated behavioural aspects in two pilot studies, namely how various moral, socio-economic and contextual aspects influenced the effectiveness of real-time feedback in a large field study in Sweden; and how reference to people's loss aversion and an increase of the salience of certain SM data influenced the effectiveness of SMs in an experimental study in Danish residential buildings. In both cases the researchers also investigated the effect of installing SMs without further behavioural interventions. The Swedish case is based on energy use data of 1753 households over four years and survey data from 543 respondents. The Danish case is based on 92 households from Copenhagen that participated in the experimental study over a period of about two years.

The results of providing households with real-time feedback were in line with previous studies (about 2% reduction of electricity use in the Swedish case and 5-7% in the Danish study). Moreover, the Swedish study showed that the effect of feedback depends not only on the information as such, but also on the person receiving the information and the context in which information is received. The results of econometric analysis indicate that households with greater perceived behavioural control and moral responsibility were those that actually reduced their consumption.

Our research of the Danish field experiment shows that the framing of SM data indeed matters. On the customer interface of the SM, the cost of electricity use was explicitly presented as economic loss in order to take advantage of people's loss aversion. Moreover, the cost of current standby use per year was displayed. Finally, only few outstanding (or 'salient') values were presented to customers, rather than the full array of data. As a result the households in which SM feedback took into consideration loss aversion and salience decreased electricity use much more than the households in a reference group (-5% vs +2%). The result was even more drastic for standby consumption, which was reduced by 13% compared to a 3% increase in the reference group.

### Policy implications

The results of our studies and previous research on the behavioural economics of energy efficiency have significant implications for the choice and design of policy interventions:

- Real-time SM feedback only leads to marginal reductions in electricity use if implemented in isolation.
- Hence, the SM mandate of the EU Energy Efficiency Directive is not sufficient to tap the potential of SMs.
- Careful design of the information context and the user interface increase the effect of SM schemes.
- A mix of different policies and interventions is needed to make the application of SMs more effective.
- More (and longer) studies (with more participants) are needed to get robust results of SM schemes.

### Are we fools?

It remains the initial question whether we are irrational fools when we use too much electricity. Yes, we are often irrational (from a strictly economic perspective); but no, we are no fools but humans. In contrast, policy interventions that are designed for perfectly rational market actors are foolish. Effective interventions have to be based on evidence about how people actually make (economic) decisions.

*This policy brief is based on two publications of researchers at the IIIEE:*


- Bager, Simon, and Luis Mundaca. "How Smart Are Electricity Users with 'Smart Metering'? A Behavioural Economics Experiment" 2015 (available here).
- Tedenvall, Mats, and Luis Mundaca. "Behaviour, Context and Electricity Use: Exploring the Effects of Real-Time Feedback in the Swedish Residential Sector" 2016 (available here).


*Find more information about the research project 'Behavioural economics for energy and climate change policies and the transition to a sustainable energy system' on the project-website.*


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