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Valuing smart meters

Guido Pepermans *

KU Leuven, Faculty of Economics and Business, Center for Economics and Corporate Sustainability, Warmoesberg 26, B-1000 Brussels, Belgium

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ABSTRACT

This paper assesses to what extent consumers are willing to make use of the features and capabilities offered by smart meters. Via a choice experiment households are offered the choice between a set of smart meters, described by six attributes: impact on the comfort and privacy level, functionality, visibility, cost savings, and investment outlay.

We estimate a main effects conditional logit model and a main effects random parameter logit model, including interactions with socio-demographic characteristics. The results show that households have heterogeneous preferences for some attributes but not for others. The estimates are used to assess marginal willingness to pay values. From a policy perspective, our findings suggest that sufficient effort should be devoted to designing the smart metering devices and to informing households. Without careful preparation, a mandatory or voluntary roll-out of smart meters risks to be unsuccessful because device characteristics do not meet consumer needs.

1. Introduction

Lack of demand response is seen as one of the major challenges in the electricity system as it exists today. It is however expected that, driven by technological evolution, demand response will be introduced on a large scale in the next decade or so and that a crucial role in this evolution will be played by ‘smart meters’.

A smart meter is a device installed at the consumer's premises, that measures real-time electricity consumption in greater detail than conventional meters do and allows two-way communication with the distribution system operator or any other operator that is granted access. This information can then be used for monitoring or billing purposes or to help maintain the quality of different services provided by utilities (e.g. detection of power outage control, meter reading, simplification of the billing procedure, identifying unauthorized bypass of the meter) (Neenan and Hemphill (2008), Faruqui et al. (2014)). But, perhaps most important, smart meters can also contribute to a more efficient electricity market by conveying information on real-time prices and load to customers, allowing them to respond by increasing or decreasing demand. The magnitude of the response will depend upon the price and/or load information that is communicated, but also on the capabilities of the smart meter and the respondent's willingness to make use of these capabilities. The response itself could be initiated by the consumer, could be automated, or could be left to a third party, for example the distribution company, that remotely controls the usage of electric appliances via the smart metering devices.

Policy makers have recognized the potential benefits of smart meters and have taken several legislative initiatives to increase their market penetration rates. For example, in the US, the Energy Policy Act 2005 and the Energy Independence and Security Act 2007 are at the basis of Federal demand response and smart metering policies. Next to these Federal initiatives, many states have also taken their own initiatives. See Pietsch (2012) for a survey. The Federal Energy Regulatory Commission (2013) reports a US (survey based) penetration rate of just over 30% in 2013, coming from 4.7% in 2007. However, penetration rates vary widely from State to State (Federal Energy Regulatory Commission (2012)). In 2012 the three highest penetration rates were found in the District of Colombia (87.1%), California (70.5%) and Idaho (66.1%). Nine states had a penetration rate above 50%, while 26 (15) states had a penetration rate of less than 10% (5%).

In the European Union, the Directives providing the basis for the introduction of smart metering devices are the Energy Services Directive 2006/32/EC, Directive 2009/72/EC, being part of the so-called Third Energy Package, and Directive 2012/27/EU on energy efficiency (Hierzinger et al. (2013)). In summary, these three Directives i) mandate the installation of smart metering devices in all Member States, provided that a roll-out of the devices is assessed positively via a cost–benefit analysis, and ii) expect a positive impact on energy consumption of a timely, clear and frequent communication to customers of their

* Tel.: +32 16 37 62 33.
E-mail address: guido.pepermans@kuleuven.be.

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energy use and the related energy cost. Obviously, this presupposes behavioral responses.

In 2013, most Member States had carried out this cost–benefit analysis and a majority was in the process of introducing smart meters in their energy markets, although not all countries have made equal progress (ACER (2013), Hierzinger et al. (2013) and Giordano et al. (2013)). Italy and Sweden have already completed a full roll-out, while other 11 EU Member States have officially decided to go ahead with the roll-out[1]. Three countries have decided not to proceed, based on a negative cost–benefit analysis (Belgium, Czech Republic and Lithuania)[2]. Eleven Member States did not reach a final decision yet[3].

The outcome of these cost–benefit assessments crucially depends on the magnitude of demand response that is triggered. Faruqui and Sergici (2010), Faruqui and Palmer (2012), Newsham and Bowker (2010) and Stromback et al. (2011) survey the results of recent pilots and field experiments of smart metering and dynamic pricing, both in the US and worldwide. They all conclude that households do indeed respond to higher prices by lowering demand, but also that the magnitude of the response, measured as the percentage reduction of peak demand, depends on a number of elements of which the type of pricing scheme is only one[4].

Another element, also mentioned as important, is technology. The same survey studies report that the magnitude of demand response significantly increases when enabling technologies such as, for example, two-way communication, smart thermostats or in-home displays are used. This is confirmed by Joskow (2012), who concludes that technologies and information that make it easier for consumers to respond to price signals lead to larger responses to any given price change, suggesting that the functionalities of the smart metering device are important. Furthermore, Giordano et al. (2013) also conclude from the pilots they survey that long term sustainable change in electricity usage can only be achieved when enabling technologies and automated systems are used.

However, Giordano et al. (2013) and Stromback et al. (2011) stress that, next to enabling technologies, a successful roll-out of smart meters will also crucially depend on consumer engagement. They note that consumer resistance can be a significant barrier and thus remains a key issue. Violations of privacy and fear of losing control over electricity usage are two examples that could feed this consumer resistance (Krishnamurti et al. (2012) and Joskow (2012)).

The importance of consumer engagement is illustrated by Faruqui et al. (2010). They estimate that the present value of the net benefits of rolling-out smart meters in the EU could be in the order of magnitude of €50 billion, on the condition that dynamic pricing schemes are successfully introduced and used on a large scale. When dynamic pricing schemes are not offered by suppliers or not used by the customers, then much of the potential benefits of smart metering will however not be realized. This could make the difference between negative and positive net benefits for the EU smart metering project as a whole.

In this paper we concentrate on the link between enabling technologies and consumer engagement. Our question is to what extent consumers are willing to make use of the features and capabilities offered by smart meters. Thus, we do not focus on the role of dynamic pricing schemes, as it is done in many pilot studies and field experiments, but rather on the impact of the features and capabilities of the devices as such. Essentially, we want to find out to what extent households are willing to use the capabilities offered by smart metering devices.

A choice experiment was set up in which smart metering devices, differing in terms of 6 characteristics, are being offered to consumers. Based on their stated choices, we then estimate the value of each of these attributes and of the devices as a whole. The choice experiment was carried out in Flanders in the first half of 2011 and was part of a master thesis project done in the context of an exploratory market study for a small technologic firm. We think that, despite the relatively limited number of respondents and the deficiencies of the sampling approach, the conclusions are valuable and useful for both public and private policy making as the policy debate regarding a mandatory or voluntary roll-out of smart metering devices is ongoing in many countries. The results allow for identifying the positively and negatively valued attributes of the metering devices, and may thereby increase the likelihood of a successful roll-out.

Whereas in the past revealed preference approaches were mostly used to assess preferences, we now observe that, for many applications, more and more use is being made of stated preference techniques. A stated preference method, more specifically a choice experiment, will also be used in this paper. To our knowledge, a similar exercise has not been made before in the context of smart metering devices.

Choice experiments have however been used in other energy related areas. For example, Bergmann et al. (2006) use a choice experiment to investigate the WTP for green electricity, where green energy is described in terms of its environmental attributes, such as, landscape impact, wildlife impact and air pollution. Longo et al. (2008) have set up a choice experiment in which four potential effects of a renewables policy are being considered: GHG emission reductions, short term security of supply (blackouts), employment effects and the price impact. Scarpa and Willis (2010) investigate the households' WTP for renewable micro electricity generation technologies in the UK, while Borchers et al. (2007), use choice experiments to focus on the input side of green electricity rather than on the output side. Revelt and Train (1998) use a choice experiment to assess the relative value for households of refrigerators with different efficiency levels. Banfi et al. (2008) focus on the WTP of households, either owners or tenants, for air renewal systems and improved window and facade insulation, while Shen and Saijo (2009) use the choice experiment approach to assess the impact of energy efficiency labels on the consumer's WTP for air conditioners and refrigerators in Shanghai. In the context of short term security of supply or power outages, choice experiment applications can be found in Beenstock et al. (1998), Carlsson and Martinsson (2008) and Pepermans (2011).

The following section briefly introduces the choice experiment methodology, some relevant literature and the techniques used in this paper to estimate the preference structure. Sections 3 and 4 then describe the Belgian and Flemish electricity market and the data, respectively. Section 5 discusses the estimation results. Finally, Section 6 concludes.

2. Methodology

The basic idea of a choice experiment is quite simple: respondents are asked to evaluate sets of hypothetical items (goods, services, options, projects…). Each item is described by a number of typical characteristics or attributes and within each set, the respondent then has to indicate the item he or she prefers. These stated choices reveal

[1] These countries are Austria, Denmark, Estonia, Finland, France, Ireland, Luxemburg, Malta, Spain, The Netherlands and the UK.

[2] Based on data collected from the National Regulatory Authorities, the Council of European Energy Regulators (2013) reports on the results of the assessment exercises in the European Union. 18 countries carried out a CBA, 13 of which resulted in a positive outcome and 3 in a negative outcome. For two countries (Denmark and Portugal) the outcome is unknown.

[3] These countries are Bulgaria, Cyprus, Germany, Greece, Hungary, Latvia, Poland, Portugal, Romania, Slovakia and Slovenia.

[4] Note that research on (the magnitude of) demand response is ongoing, as is illustrated by the EU FP7 ADVANCED (Active Demand Value ANd Consumers Experience Discovery) research project (http://www.advancedfp7.eu/). This project aims at drawing lessons from the analysis of available data of four real live demonstration projects, the VaasaETT database and many other active demand databases with secondary data. Other research projects in the field of smart grids and smart metering are the European FP7 ADDRESS project (http://www.addressfp7.org/) and the Meter-ON project (http://www.meter-on.eu/).