Energy Efficiency

Making energy visible: Socio-psychological aspects associated with the use of smart meters

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Response to Reviewers:	We have included a separate table addressing each of the comments made. Please see attachment.

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Abstract

This study aims to improve the understanding of the socio-psychological and technological aspects that influence the use of smart meters - innovative electricity meters that provide real-time data on consumption and are instrumental in increasing energy efficiency. Few studies have examined the socio-psychological factors that influence their use. We argue that the Theory of Reasoned Action (TRA), the Technology Acceptance Model (TAM) and other specific factors from the social psychology literature, such as perceived procedural justice and risk perception, can help understand what determines the use of smart meters. To empirically examine that, first a quantitative survey was conducted with 515 households with smart meters installed. Results indicate that smart meter use is influenced by subjective norms, perceived utility, health-related risk perception, procedural justice and time of usage. In a second study, internet blogs discussing smart meters were analyzed. This study corroborated some of the results of the first study and suggested additional factors - such as perceived distributive injustice and loss of control and privacy-related risk perception - that may influence the use of smart meters.

Introduction

Energy efficiency is crucial in addressing two of the most important challenges of present-day industrialized societies - the climate and the energy crises. Whereas fostering low carbon energy production is an important way to tackle both climate change concerns and energy security ones (Renewables Directive -2009/28/EC), measures taken in the consumption side of energy systems arguably yield the most efficient results in addressing those concerns (Stern 2000). The household sector has been described as a sector where, despite all energy efficiency measures, consumption continues to increase (Bertoldi &Atanasiu 2007). Indeed, residential appliances and equipment use about 30% of all electricity generated in OECD (Organisation for Economic Co-operation and Development) countries, producing 12% of all energy related CO2 emissions (IEA, 2003). Europe is one of the most vulnerable regions given its external dependency; by 2030 the EU will largely depend on imported fossil fuels - 90% of oil and 80% of gas if the current trend continues (Dahlbom et al. 2009).

The need for more efficient energy systems - Smart grids and smart meters

For the above mentioned reasons, several efforts are currently being made at European and international levels (Electricity Directive – 2009/72/EC) for making electricity grids smarter. “Smart Grids are high-efficiency infrastructure for electricity transmission and distribution that employs automated and semi-automated consumption management, integrated communications, real-time information sharing, and advanced sensor and measurement technology” (Stern 2011).

Consumers might have a key role in these new smart systems – they may be responsible for energy production (e.g., through micro generation solar PV) and for managing their consumption (by adopting energy saving behaviours). Large investments have already

been made in several European countries and in the USA with the installation of electricity meters – or smart meters – in households. Whereas smart meters are being installed primarily as a product and service that allows enhancing metering efficiency, electricity's price competitiveness and operating costs (Federal Energy Regulatory Commission, 2008); they can also be regarded as a great opportunity for household consumers to be more aware of their energy use and to adopt more environmentally sustainable practices (Electricity Directive – 2009/72/EC).

Smart meters - the user's interface with smart grids - are innovative electronic meters, which provide consumers with more detailed information than traditional electricity meters. Bills are no longer based on estimates, but rather on actual consumption, improving the quality of billing that is often the target of customer complaints (Zhang & Nuttal 2012). There is a wide range of devices being used, which vary from simple displays that show consumers their consumption, to more advanced meters that automatically interact with the utility, sending readings remotely and showing other types of consumption information such as the monetary costs or equivalent CO2 emissions (Zhang & Nuttall 2012).

The potential of smart meters – the role of the consumer

In terms of energy efficiency, there are numerous advantages associated with this type of technology. By providing direct information on electricity spending, the smart meters make energy consumption more visible and tangible to the user, allowing users to monitor consumption and thus make changes in their practices and routines (Faruqui, Sergici & Sharif 2010; Hargreaves, Nye & Burgess 2010). Besides, smart meters can be an important instrument to implement energy-saving behavioural change (Abrahamse, Steg, Vlek & Rothengatter 2005), either when antecedent strategies are

used (e.g., using smart meters to implement a goal-setting strategy) or when consequence strategies are implemented (e.g., using smart meters to provide feedback about consumption).

Thus, electricity users can have a key role to play in these new smart systems, which highlights that more energy efficiency in consumption requires not only technological solutions but also socio-psychological ones. To achieve substantial reductions in global energy consumption, changes in individuals' behaviours are needed towards managing energy consumption in a more efficient way (Darby 2006; Stern 2000). Besides, the very process of implementation of smart meters is not straightforward from a socio-psychological perspective either. Like any technological innovation, smart meters are subject to a process of scrutiny by users - the process of acceptance of new technologies is usually long and often involves resistance. This is especially the case if one of the main frameworks for its use and acceptance are, among others, financial motives, pro-environmental concerns and practices (Bauer 1997; Devine-Wright & Howes 2010). The information and involvement of the users in the implementation of technologies is crucial for their acceptance (e.g., Gross 2007; Lima 2006). However, and despite the evidence of social sciences' research on the impact of these processes in the acceptance of technologies, smart grids and meters are already being deployed, with or without users' acceptance. Directives 2009/72/EC and 2009/73/EC postulate that EU Member States must "ensure the implementation of intelligent metering systems that enable consumer participation in the electricity and gas market". Furthermore, the Directive 2009/72/EC states that 80% of all electricity meters in the EU have to be replaced by smart meters by 2020, but currently only 10% of European households have smart meters (Giordano et al. 2012).

Some European countries – Sweden, UK and Italy – have deployed smart meters on a large scale, but overall diffusion of these technologies has been slow in Europe (Pyrko & Darby 2011). According to the European Commission's own assessment, the key barriers to smart grid deployment appear to be social, policy-related or regulatory, rather than technical (Giordano et al. 2012). Demonstration projects are still on a restricted scale and have been delayed mainly by limited customer participation (Heffner 2011).

This highlights the relevance of understanding how individuals and groups make sense of this techno-scientific innovation (Bauer 1997). But it also signals the importance of analyzing to what extent smart meters are accepted in the larger socio-political context where they are deployed and expected to be used. These devices are being implemented in the context of the above mentioned EU directives, namely in the context of the more overarching social change processes towards environmental sustainability (Castro 2012). It is thus also essential to take into account the socio-political specificities of different societies – *e.g.*, energy market liberalization, role of government in their implementation - and the distinct contexts and communities that also shape how citizens will accept and use smart meters. However, as noted by Stragier (2010), so far the role of electricity users, their beliefs, attitudes, and practices, have often been neglected in the design and implementation process. The few studies conducted to date have, in their majority (for an exception see Kerrigan et al., 2011), only assessed individuals' intention to use smart meters (e.g.,Stragier 2010, Kranz et al. 2010), mostly based on a mere description of their features (Zhang & Nuttal 2012), without having any kind of lasting interaction with these devices, which raises questions about the applicability of the research results for people's everyday practices with real technologies.

In this context, the present study intends to contribute to a better understanding of the determinants of and barriers to the use of smart meters in households. Departing from this general goal, two studies were conducted in the context of a pilot project of an Electricity Company (from now on referred to as EC), which consisted in the installation of smart meters in every household of a Portuguese city. The first study was based on a survey to a representative sample of the Évora city population and was aimed at investigating the socio-psychological aspects associated with the use of smart meters using different environmental and social psychology models such as the Theory of Reasoned Action or the Technology Acceptance Model. Through a qualitative analysis of weblogs, the second study aimed to explore other factors not included in those proposals that may influence the use of smart meters.

Socio-psychological and technological aspects influencing acceptance of smart meters

For a better understanding of what may promote the use of smart meters, it is useful to take into account both the socio-psychological factors that may influence pro-environmental behaviours, as well as those that may be associated with technology acceptance. Stragier (2010), in a study about individuals' perceptions of smart meters in Belgium, concluded that the factors included in the Technology Acceptance Model (TAM) proposed by Davis (1989) - *Perceived Ease of Use* and *Perceived Usefulness* - positively influence attitudes towards smart meters, which in turn positively influences the intention to use them. Another study by Kranz, Gallenkamp and Picot (2010) in Germany, using the same theoretical framework to explain the intention to use smart meters, arrived at very similar conclusions. The TAM is often used in consumer behaviour studies to predict acceptance of new technologies (Wang, Fang & Lo, 2008)

and has been extensively validated in the literature. *Perceived usefulness*, according to Davis (1989), is the degree to which the user evaluates whether the technology is useful and advantageous compared to the previous technology, while *perceived ease of use* is the degree to which the consumer evaluates technology as being easy or difficult to use. In the present study we use the TAM to examine the factors influencing the use of smart meters, because previous studies that have applied this model (Stragier 2010; Venkatesh 2000) demonstrated that although perceived usefulness is a better predictor of the use of new technologies than perceived ease of use, the model has an overall good fit. These studies also demonstrated that perceived ease of use has a strong influence on perceived usefulness, which in this case may indicate that people consider smart meters useful if they are easy to use (Stragier 2010). These results and the fact that this model is specific to the use of new technologies suggest the importance of considering these two factors to examine the acceptance and use of smart meters.

Another group of studies have assessed the acceptance of smart meters using the Theory of Reasoned Action (TRA), (Fishbein & Ajzen 1975) which has been frequently used to assess the determinants of pro-environmental behaviours (Bonnes & Bonaiuto 2002; Stern 2000) and assumes that behaviour is determined by the individual's *intention* to perform it. The intention, in turn, is determined by the attitude towards the behaviour and subjective norms. *Attitude* is the degree to which a person evaluates whether the behaviour in question is positive or negative. The *subjective norm* refers to perceived social pressure to perform (or not) the behaviour in question. Later on, in their revised version of this theory – the Theory of Planned Behaviour (TPB) (Ajzen, 1991) – the authors introduce a construct that assesses the perceived self-efficacy and control over the behaviour – the *perceived behaviour control (PBC).* This latter aspect is somewhat similar to the *perceived ease of use* used

by the TAM. However, so far, the studies using the TRA/TPB (Zhang & Nuttal 2012) or TAM (Stragier 2010; Kranz et al. 2010) to assess the socio-psychological aspects associated with smart meters have only studied the acceptance and the attitudes towards them, rather than the actual behaviour of using this equipment, or just examined the latter using a computer simulator. Therefore in none of the studies performed so far, have individuals had any real experience with the smart meters, which is an important limitation that our study seeks to overcome. Moreover, the present study will also combine the proposals both of the TAM and TRA to study the factors associated with the use of smart meters – an approach that had not been used before - together with other factors that may be important determinants of the acceptance of smart meters, namely risk perception and perceived justice (e.g., Lima 2006).

Risk perception is commonly referred to as the way non-specialists think about risk. It refers to the subjective evaluation of the degree of the potential threat of a particular event or activity (Lima 2005). This means that the assessments people make about risk are in accord with their perceptions rather than with a scientific or objective assessment of the situation (Renn 1998). The risks perceived to be higher are usually those associated with hazards viewed as involuntary, uncontrollable, potentially catastrophic and created by technology (Lima 2006). Considering smart meters, we envisage that these devices have certain features that can arguably be perceived as involving risk. First of all, it is a technology based on wireless networks, and the emission of remote signals may be perceived as risky, as it happens with other wireless devices, associated with exposure to radiation, and thus adverse health effects (Moser, Bruppacher & Mosler 2011). Besides, Kruse (1981, cited by Moser et al. 2011) drew attention to the risks of lower security on data protection and privacy loss. Hence, risk perception has been described as an important factor for the acceptance of

technologies. Luo Li, Zhang and Shim (2010), for example, show that risk perception influences acceptance of innovative technologies such as wireless internet platforms, whereas Kleijnen, de Ruyter and Wetzels (2004) conclude that risk perception is the most important factor in the acceptance of mobile telecommunication based on wireless networks. Indeed, Stragier (2010), in his study about individuals' intention to use smart meters in their homes, identifies the perception of control and security as variables to consider in future studies. Risk perception – regarding health risks, loss of control and privacy, but even other factors such as financial risks - can then be a highly relevant determinant of the use of smart meters.

Several authors have also stressed the importance of perceived justice in the acceptance of technologies viewed as dangerous (Lima 2006) and different dimensions - mainly procedural and distributive justice - have been examined in various areas (Clayton & Opotow 2003). Regarding the use of smart meters, procedural justice specifically can be an important determinant – as Stragier (2010) emphasizes, "if we want to change energy consumption patterns and make them smarter, we cannot do it from a top-down perspective" (p. 135). Procedural justice refers to the processes of decision-making being fair and appropriate (Clayton & Opotow 2003), which is often based on the fact that relevant stakeholders are able to participate in decision-making (Clayton, 2000). The theory of procedural justice proposes that if the decision process is perceived as being fair, people are more likely to accept the final outcome (Syme, Nancarrow& McCreddin, 1999), even if this is not what they wished (Tyler & Lind, 1990). According to Lind & Tyler (1990), this happens because procedures have their own psychological significance, giving a sense of dignity, voice and respect if they are open to affected parties' participation. Therefore, the perception people construct about the justice of a given decision-making process becomes resistant to change (Syme et al.

1999). Feelings of injustice are difficult to overcome because they become a threat to the confidence individuals place in the institutions and can even cause the cancellation of an ongoing project (Lima 2006). In sum, issues about the perception of justice regarding the process of implementation of smart meters in individuals' homes can become barriers to the acceptance and use of these devices – which, in turn, may undermine the potential benefits that smart grids can bring. Hence, the implementation of smart meters may happen with or without the users' permission, but much of their potential will be unfulfilled if they are not part of the process (Feinberg 2009).

Aims and scope of the paper

The overall goal of this paper is to contribute to a better understanding of the socio-psychological aspects that influence the use of smart meter appliances. As this is a complex topic virtually unexplored in Portugal, a methodological triangulation approach (Denzin, 1970; Flick 2009) was designed to validate the relevant predictors involved. In the first study, people's use of smart meters was analyzed based on the results of a survey that included as predictors the factors proposed by the TRA (attitude and subjective norm) by the TAM (perceived ease of use and perceived usefulness) and also risk perception and procedural justice perception.

However, the understanding of what may promote or constrain the acceptance and, mainly the use of smart meters, has barely been addressed in the literature, thus there might be other factors, not considered in our first study, which might influence the use of smart meters. Indeed, the aspects that have been assumed to influence the use of smart meters are mostly based on the resemblance between smart meters and other new technologies. It is essential then to analyze also the problems and concerns associated specifically with smart meters. Hence, in the second study we examined the contents of

weblogs written by smart meter users, and the discourses conveying those contents. This should allow us not only to triangulate through qualitative information the conclusions drawn in the first study, but also to find new information that is impossible to obtain in a quantitative study.

Study 1: Background and Design

This study focuses on the Project InovCity - a pilot project led by a Portuguese Electricity Company that carried out the installation of smart meters (Energy Box, as it was called)[1] inside the homes of all electricity users in the city of Évora, Portugal (thus replacing the traditional electricity meters). Figure 1 shows the Energy Box and outlines some of its main features.

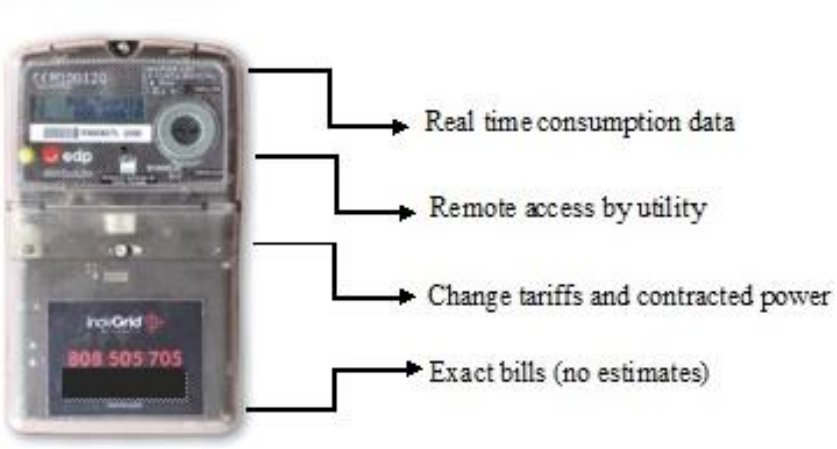

Figure 1 - Energy Box

Évora Inovcity is the first urban area in Portugal to integrate an intelligent energy grid with the aim of becoming a model in sustainable energy consumption by facilitating energy efficiency. As part of this project, smart grids where installed to serve the entire

[1]Currently called EDP Box.

Évora municipality and Energy Boxes installed on every home of the 30.000 EDP clients. Here the specific operational aim, as communicated by the electricity company, was to decrease energy consumption by reducing energy grid losses and by giving consumers more control over their own energy consumption. Energy Boxes were installed voluntarily with the client consent and, at the time of the study, part of the clients in Évora had Energy Boxes in their homes for at least 6 months, and another part for less than 6 months. Despite this difference, over this period all clients had the new metering installed, monthly bills based on actual consumption, an online service with detailed information about consumption (e.g., daily/weekly/monthly overtime consumption), and the ability to perform remote changes in the energy contract. Although some clients in Évora have been targeted with interventions like the installation of in-home displays or training, the clients in our sample only received generic information on the smart meters and a contact number for help on the time of installation. Still, just like all the clients in Évora, the clients in our sample were also exposed to generic events aimed at promoting Évora InovCity (e.g., regular visits of political public figures).

Regarding the hypotheses for this study, and according to what the literature suggests, it is postulated that the behaviour of using smart meters is:

- Positively influenced by the attitude towards smart meters (H1a) and by the subjective norm (H1b), according to the Theory of Reasoned Action;

- Positively influenced by the perceived usefulness (H2a) and perceived ease of use (H2b) of the smart meters, according to the Technology Acceptance Model. Still according to this model, we posit that the perceived usefulness is positively predicted by the perceived ease of use (H2c).

- Negatively influenced by risk perception (H3) and positively influenced by procedural justice perception (H4), according to the other literature reviewed. (see Figure 2)

We will also include socio-demographic factors– age, gender, education - and time of usage (number of months since the installation) as control variables.

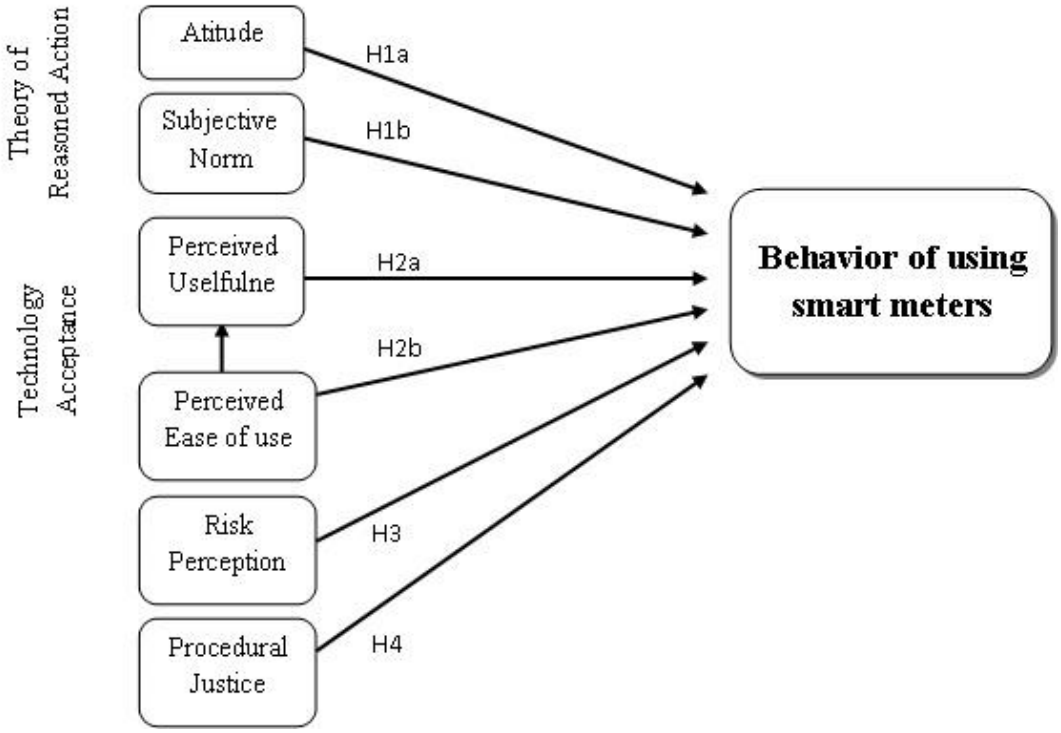

Figure 2: Model of the socio-psychological factors that are associated with the use of smart meters

Methodology

Participants and procedure

The sample consists of 515 residents in the city of Évora, 263 (51.1%) with an Energy Box installed at home before December 2010 (old users) and 252 (48.5%) with an EB installed after January 2011 (new users). A non-random sample selection by quotas was used, based on the time of installation: before December 2010 or after January 2011.

The survey was conducted between the 13th May and the 12th June 2011, using direct, personal interviews at the respondents' homes, through structured questionnaires applied only to the electricity contract holder.

Participants are between 19 and 92 years old (M = 56.45, SD = 16.65), with 56.7% women. Regarding education, most respondents only have the four grades of schooling or less (46%). 17% of respondents in our sample have completed secondary school and 16% completed undergraduate studies. This study was part of a larger study for a Portuguese Electricity Company aiming at better understanding people's perceptions towards Energy Box and the larger smart grids project within which it was proposed – Évora InovCity.

Instrument

The survey included questions intended to assess respondents' attitudes about Energy Box, if they had ever used the EB installed at their home (Criterion variable), as well as to examine the other factors proposed by the TRA, the TAM and risk and procedural justice perceptions. Items were developed by the research team to tap all the variables, although due to constraints to the dimension of the survey, some of the variables were only assessed by one item measures. A summary of the variables and examples of questions included in the survey and analyzed in this study are presented in Table 1.

Results

228 individuals (43.4%) reported they had already consulted the information on the display of the Energy Box, while the majority (287 respondents - 56.7%) declared they had never done so. The mean, standard deviation and correlations between the variables were calculated and are presented in Table 2. Results show that in the overall sample the

attitude towards EB is neither favourable nor unfavorable (*M*=2.87). Regarding the subjective norm, respondents tend to think that other residents in Évora neither agree nor disagree with the EB (*M*=2.85). Analyzing the two variables of the TAM, respondents, on average, considered that the EB is neither more nor less useful than the previous meter (*M*= 3.09) and that its use is neither easy nor difficult (*M*= 3.03). Users tend to perceive low levels of risk associated with EB (*M*= 2.59) and, on average, they evaluate the implementation process of this equipment (device?) as having been fair (3.79)[2].As results show, all predictors are correlated with the dependent variable (use of the EB), with risk perception having the highest correlation. However, it should be noted that, although significant, the correlations are generally weak. Perceived usefulness and perceived ease of use are the predictors with the highest correlation with the use of the EB.

To identify the predictors of the use of Energy Box a logistic regression was conducted (Field 2005). Considering the proposed theoretical model, a hierarchical logistic regression was performed in four phases, to allow the distinction and the comparison of the influence of each theory and set of variables in the dependent variable. Initially, only socio-demographic variables (gender, age and education) and time of installation (in months) entered the analysis as control variables. In a second phase, subjective norm and attitude towards EB were added to these variables. In the third step, perceived usefulness and perceived ease of use were introduced in the model. And in the fourth and final phase risk perception and procedural justice were added. Table 3 shows the results of the final logistic regression model, with all predictors included.

[2] Most variables have a mean at the centre of the scale (3) which, given the fact that none of the distributions is bimodal, may indicate that people do not yet have a clear position about the EB. These results are discussed in the following section.

The first set of results significantly explains the use of the EB (χ^2 (4) = 23.874, p <0.001), with gender and time of usage positively and significantly influencing the likelihood of a consumer consulting or not the Energy Box. This indicates that men are more likely to have consulted the EB and that the longer since the time of installation of the device, the more likely it is that users had already consulted it. This first set of variables explains 8% of variance in the dependent variable (as per Nagelkerke'sR^2 = 0.080).

For the variables proposed by the TRA and included in the second block, only subjective norm significantly positively influences the dependent variable. The inclusion of this second block did not substantially improve the variation of the dependent variable, which increased to 9.7% (Nagelkerke'sR^2 = 0.097). The third block of results, now with the variables from the TAM, significantly increases the ability to explain the use of the EB (χ^2 (2) = 6.596, p = 0.001), although only the perceived usefulness is a positive significant predictor. At this stage the model explains about 12% of the variation of the behaviour of using the Energy Box (Nagelkerke'sR^2 = 0.118).

The results of the fourth and final phase of the hierarchical logistic regression revealed that the model, as a whole, is statistically significant (χ^2 (10) = 49.969, p<0.001) and explains about 16% of the variance of the dependent variable. Regarding the predictors, we found that none of the social demographic variables included in the model significantly influences the dependent variable. However, the time of use was found to be a positive significant predictor (B = 0.139, p = 0.003).Considering the variables drawn from the theoretical models - TRA and TAM - only subjective norm and perceived usefulness were found to be positive statistically significant predictors of behaviour (B = 0.257, p = 0.056, B = 0.512, p = 0.049, respectively), confirming hypotheses H1b and H2a. These results suggest that the more favourable participants

perceive the position of the other members of the local community and the greater the utility they see in the EB compared with the old meter, the greater the likelihood of them having actually used the device. However, the hypothesis that the perceived usefulness mediates the relationship between perceived ease of use and the behaviour of consulting the display of the EB (H2c) was not confirmed, because perceived ease of use has no significant effect on the dependent variable. Still, perceived ease of use is highly associated with perceived usefulness, as evidenced by the significant correlation between the two variables (Table 2). Finally, results also show that the last block of variables that we added to the theoretical models - risk perception and procedural justice perception - significantly influences the behaviour of consulting the display of the EB (χ^2 (10) = 49.969, $p < 0.001$). Risk perception negatively influences the dependent variable (B = -0.384, p = 0.044), suggesting that the greater the perception that these devices pose a risk to the individuals the less they are likely to be used. The lower value of Exp (B = 0.681) corroborates this and thus confirms hypothesis 3 (H3). Similarly, the perception of procedural justice was a significant predictor of the use of EB (B = -0.461, p = 0.002), which confirms hypothesis 4 (H4). However, contrarily to what we expected based on the literature, it has a negative effect on the dependent variable which means that as the perception of justice increases, the likelihood of respondents having consulted the EB decreases, a result confirmed by the value Exp being lower than 1 (B =0.631).

Discussion

The first relevant result of this study is the high number of respondents (57%) that have never consulted the smart meter display installed inside their homes. The fact

that more than half of the respondents have never even consulted a system installed in their homes that was designed for people to use seems an evident problem.

The first set of hypotheses arising from the TRA confirmed the positive and statistically significant influence of the subjective norm on the behaviour of using the EB (H1b), demonstrating the importance of the perception that respondents have about the position of other community members. Although it has been suggested in the literature as a variable to take into account (Martiskainen & Coburn 2011), previous studies (Kranz, Gallenkamp & Picot 2010; Stragier 2010;) had not included the subjective norm as a predictor and thus this result is particularly relevant because it reinforces the importance of normative dimensions even for behaviours that take place in private, domestic settings. The fact that the attitude towards the smart meter did not significantly influence the behaviour (H1a) may be due to the fact that the respondents did not have had sufficient contact with the object of the attitude to have a clearly favourable or unfavourable position. . We remind that, although all participants had the smart meters available (and some of them for more than 6 months), a high percentage of respondents (57%) have never used the EB and thus did not had direct experience of it. This result suggests that residents may need more time and/or external stimulation to interact with the EB.

As a whole, the variables from the TAM significantly contribute to explain the dependent variable. Yet, only perceived usefulness positively and significantly influences the use of the Energy Box, confirming the hypothesis H2a. Contrarily to what the literature suggested, perceived ease of use was not found to be a significant predictor. This result corroborates previous studies (Stragier 2010; Venkatesh 2000), showing that perceived usefulness is a better predictor of the behaviour of using smart meters than the perceived ease of use. Moreover, the fact that in previous studies

(Kranz, Gallenkamp & Picot 2010; Stragier 2010) perceived ease of use positively influences the intention to use a smart meter (the dependent variable in those studies) may have a simple explanation: respondents received only descriptions and images of smart meters, never interacted with the equipment, making it difficult - if not impossible - to accurately assess the ease of use.

As some literature hinted, risk perception and procedural justice perception seem to be associated with the use of the smart meter. Although, on average, individuals do not perceive high risks associated with this new technology, we found that the greater the perceived risk, the lower the probability that they used the Energy Box, which confirms hypothesis H3. It is important to note that the perception of individuals about the technology changes considerably over time (Venkatesh 2000) and that some time after the installation the results may be different. This is particularly relevant if we consider that this is a pilot project, so this technology was not known in Portugal and these were the first electricity users to have real contact with these intelligent metering systems. Finally, it was possible to confirm hypothesis H4 but not in the direction we initially expected, given that, as justice perception increases the probability of respondents having already consulted the EB decreases. What we interpret from this outcome is that respondents who perceived the process as being fair feel less need to "control" this new equipment and the company responsible for its installation.

Study 2: Blog analysis from EB users

Context and goals of the study

The first study was an important step towards an examination of the social-psychological factors that can facilitate or constrain the use of smart meters. However, and taking into account the lack of research on this subject, we considered that it was essential to explore other factors, possibly associated with the use of smart meters. Apart from being a new technology and barely studied in the literature, the study just discussed was based on a pilot implementation of smart meters in Portugal, and for this reason the results obtained can be context specific. Moreover, it was important to validate the socio-psychological aspects identified in the literature review and included in Study 1 through methodological triangulation (Flick 2009).Qualitative methods are particularly adequate to attain these goals and identify, in a more open way, the dimensions, concerns and barriers that may be associated with smart meters use and that have not been grasped in the survey (Flick 2009). Weblogs about the Energy Box installed by the EC in Évora were the material used in the second study. Data was collected roughly one year after the conduction of the first study, thus also allowing to capture people's perspectives on the EB after some more months of experience with it. Moreover, if we consider that those who write in these blogs may be more unsatisfied with the new smart meters – or they wouldn't have created blogs to discuss them - then this data becomes even more relevant to understand which factors may limit the use of this equipment.

Method

Data collection

The collection of blogs to be analyzed was performed using the search engine "Google blog search", with the following key words: “Contadores inteligentes + Évora” (“smart meters + Évora”); “Energy Box + Évora”; “Contadores inteligentes + EDP” (“smart meters + EDP”).

Since we were interested in collecting direct consumer opinions, only original blogs were considered, i.e., we did not include blogs whose content consisted of copies or full citations of news’ media or those that did not have a component of original comment. The collection of blogs ran until March 31st 2012 and resulted in a corpus of data comprising 16 posts and 96 comments (N = 112), drawn from seven different blogs. We were not able to identify how many different bloggers authored those posts and comments. Each post and respective comments were saved in word files in ascending chronological order and imported to the software Atlas ti (version 6.2).

Data analysis

The material collected was analyzed following two procedures. Firstly, a thematic analysis was performed, as this method "allows identifying, analyzing and reporting patterns (themes) in the information gathered" (Braun & Clarke 2006, p. 6). The exploratory nature of this study justified the use of a flexible method that allowed organizing and describing the corpus of data in detail and simultaneously allowed interpreting the various aspects of the research topic (Boyatzis 1998). The procedure consisted on reading the material, developing codes and combining them into potential main themes and sub-themes or arguments, that is, through identifying which arguments

were put forward by participants to position themselves in relation to the main themes (see van Bavel & Gaskell, 2004).

The analysis was performed according to the steps proposed by Braun & Clarke (2006): (1) familiarization with the data through reading and rereading the material; (2) creation of codes, consisting on the coding relevant aspects of the data in a systematic way throughout the corpus of data; (3) Search of themes, which involved re-focusing the analysis on a broader level. Using the tools in *Atlas ti*, we aggregated the different codes into potential themes, collecting all the relevant data extracts for each theme. (4) Reviewing themes and verifying if these matched with the coded extracts throughout the entire corpus of data. The goal was to have internal coherence within themes and a clear distinction between the different themes. (5) Naming and defininig themes, with clear definitions for each theme; and (6) Construction of a logical narrative around the selected themes, presenting vivid and illustrative extracts for each one. The codes created are mutually exclusive, i.e., there should be clear differences between each identifiable code, but the same extract may contain more than one code (van Bavel & Gaskell 2004). A code was only considered if it had at least three quotes in the corpus of data.

Coding was assisted by the software Atlas.ti (Version 5.2). The first author coded all the data and then the second author checked the coding at every stage of the process, that is, for all the identified codes, themes and sub-themes. Any discrepancies were solved through discussion between the first two authors.

At a second moment, a discourse analysis was performed, based on the thematic organization of the data previously developed. This second analysis aimed at exploring the rhetorical mechanisms and functions of the discourses (Billig 1997; 1985) that constituted the themes identified through the thematic analysis, based on the assumption

that discourses do not provide just a factual description of the situation or object, but are used instead to present the issue in particular ways. Discourses are made through formulations that cannot be captured only by its underlying semantic meaning as they have a certain inexplicit intentionality (Cronick 2002), critical to understand the motivations behind certain sentences and what they try to achieve. Considering the nature of blogs and posts - many from individuals that expressed being unhappy with the EB - it seemed important to analyze then those discourses and understand some of the arguments and discursive strategies that they use to justify and maintain their position towards the EB and the project InovCity.

Results

The analysis resulted in a series of codes – single units of analysis – that allowed organizing the bloggers' discourses into two major themes - Being against the EB and Being in favour of the EB (Table 4) - and in several sub-themes or arguments – Increase in consumption/financial risk, Distributive justice, Technical problems, Health risks, Risk of loss of privacy and control, Actions against the EB, Reliability and security of the EB and Individuals' energy efficiency - that were put forward by the participants to position themselves in relation to the main themes. We will next present the main sub-themes/ arguments constituting the two main themes, along with analyzing in a detailed way the discourses used to put forward those arguments.

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Main theme – Being against the energy box

A high number of discourses mention an increase in consumption or higher bills and are accompanied, in some cases, by the discussion of the larger social and economic consequences from increased electricity bills: "*There are people who now pay double or*

triple. I want to see what happens when this system is extended to the rest of the country and the people with fewer resources (which barely have enough for food and medicines) have to pay double for the electricity bill". These reported increases in electricity bills[3] and the consequences resulting from them seem to elicit a perception of distributive injustice. Distributive justice has not been analyzed in the first study, but now appears as a central aspect in the bloggers' discourses and some seem to believe that the underlying objective of this new system is to increase the Electricity Company's profits at the expense of the users:

"*what they want is money ...The meters are not working properly and until there is a second phase, these ones will pay their implementation... ".*

"In sum, if I "rob" them by not paying my electricity bill I'm penalized, prosecuted, etc. If they rob the people, then they are rewarded by their achievement".

The arguments and language resources used by bloggers often accentuate the dichotomy between "we" and "they" (Castro & Batel, 2008; Cronick, 2002), reflecting the existing power relations in the context of the electricity scenario in Portugal: "*It is yet another fraud by EC - the company that has been making millions and millions at the expense of the Portuguese!"*. It is important to note that the electricity company deploying these smart meters has had, at least until 2012 - when the Portuguese electricity market started to be fully liberalized - the monopoly of the electricity market in the country, and has often been accused of being able to indiscriminately increase electricity prices and their profit at the expenses of Portuguese citizens (for an example, see:http://armacaodepera.blogspot.pt/2011/11/edp-uma-vez-mais-apelo-de-resistencia.html). The use of this type of argumentative resource, which accentuates the

[3] Normally, these are not real increases in the electricity bill, but instead can reflect the fact that the EB measures the actual consumption of users (and not an estimation) and moreover its deployment was mainly performed during the winter, when more electricity tends to be used; the fact that in the first bill after the EB's are installed, users pay the non-paid consumption of the old meter plus whatever they have consumed with the EB; or also some actual technical problems that affected metering with some EB's.

distinction between 'we' and 'them' by highlighting the historical power imbalance of that relation, allows the speaker to try to undermine the credibility - or ethos (see Leach, 2000) - of 'them' and, in an associated way, of the deployment of the smart meters.

Besides, the fact that smart meters were initially publicized by the company as a way to increase energy efficiency and consumer savings and that, in the end, resulted in higher billing, accentuates the lack of perceived justice: "*What was supposed to be a system to create smarter houses with a reduced investment for consumers ultimately became an unbearable cost."*

Irony is also a resource often used in discourses to criticize smart meters while trying to elicit the support of the audience (Sperber & Wilson 2003), in this case from other bloggers. This strategy is visible in some comments, such as the ones below:

"*These meters are so smart, that they make "mistakes" in favor of the owner ..."*

"*The meter only makes mistakes upwards ... or right into the pockets of those who do not understand anything ... ".*

One of the causes of these mistakes seems to be technical problems with the Energy Box. According to some bloggers, these new meters have interference problems that alter the telemetry system which causes erroneous readings and excessive billings, a situation which, according to some users, benefits the EC and enhances then the sense of injustice (*"certain peaks or interference on the electricity grid cause poor metering ... but never for less, of course. This is a hoax!"*).

Apart from the financial risk (perception that it is possible to lose money with the smart meter), individuals who participate in these blogs also mention other risks. According to bloggers, these smart meters are presented as comprising health risks as well as risk of loss of privacy and control. Below we present some extracts that

illustrate this, while suggesting smart meters aim to monitor private behaviour and control citizens, which constitute an offense to the privacy of individuals:

"*There are plenty of sources that demonstrate convincingly that prolonged exposure to high levels of radio frequencies increases the rate of cancer, nervous system damage"*

"*The state or the private sector does not have the right to come into our home, controlling our behaviour; these are issues of privacy and sovereignty."*

The risks of the EB are also described based on metaphors (Lauri & Lauri, 2005) that suggest the controlling and invasive nature of these systems, such as the "spy meter" or "Gestapo meters here smart grids are compared to the Nazi secret police ("*...it would be a concentration camp, an eternal imprisonment at home. A CONCENTRATION CAMP – GESTAPO METERS*"). The use of this type of metaphor is based on pathos as a communication technique (Leach, 2000) or, in other words, is trying to persuade other people not to accept smart meters by appealing to their emotions, namely, fear and even horror.

The arguments against the new smart meter also often take the form of action discourses against the Energy Box and the EC itself. We find references to formal complaints having already been addressed to the EC, mainly due to technical problems. An important aspect in this analysis is the normative dimension associated with the large number of complaints that bloggers refer to:

"*If it was just one person complaining it could be a mistake, but everybody that I speak to is complaining*".

"Me and everybody else is complaining, even the company's technicians confirm it"

Some bloggers take a more interventionist stance, rejecting the EB and asking for the return of the old meter ("*I demand my old meter back.*") and even suggesting the same to other citizens *("Call [them] and demand that they to remove it! ...*"). These action discourses take the form then of direct calls to action, with bloggers reporting actions and encouraging other consumers to perform concrete actions, such as signing petitions, filing complaints against the EB to the EC or the Consumers' Association ("*This is the time to put forward petitions, complaints to the EC, notify neighbours and friends (...) who have not yet noticed this situation"),* informing the media and the community or creating a civic movement against the EB and the InovCity project *("it should organized a movement against it"*).

Main theme - Being in favour of the energy box

Despite being much less frequent, some bloggers argue in favor of the new smart meters. Some comments highlight the reliability and security of the EB, pointing out the accuracy of the meter readings and arguing that these equipments would not have been installed if they had not been tested beforehand: "*So I find it hard to believe they are being cheated in terms of consumption as a device of this kind must undergo many accuracy tests."*

Some discourses argue that the problem was that the old meters were less accurate than the current smart meter, and therefore users were paying less than they should. One blogger attempts, through rhetorical questions *("As for the evilness of smart meters, are they really that bad?"*) to deconstruct the arguments against the EB used by other bloggers, questioning the real health risks of the electromagnetic waves of smart meters and remembering our daily exposure to other sources of radiation. It is interesting to note that there are a few bloggers who emphasize individuals' energy inefficiency rather

than the actual metering equipment, arguing that the smart meter simply measures what is consumed ("*Because the reality is that the meter reads in real-time the consumption made and bills it. So save!*"). One blogger clearly puts the responsibility on the consumer and not on possible flaws of the smart meter, suggesting the invisibility of electricity, the difficulty of becoming aware of the domestic consumption and the consequent importance of more immediate forms of feedback than the traditional monthly bill: *"This story of smart meters that read more than what is spent is a bit strange (...). I still have an old meter, one of the stupid ones, and yet last month I had around € 160 to pay. I'm not as smart as the new meters, but not as stupid as the old, so I thought about it and concluded that in fact this winter was cold (...) and it felt good to have the heater on (...).Anyway, things we only remember when the bill comes*". In this vein, this speaker uses logos instead as a rhetorical technique (Leach, 2000). This technique, instead of appealing to the credibility (or lack of it) of the actors involved, or to emotions - as we have seen before in the posts of people against the smart meters - tries to persuade other people to support the smart meters by relying on logic and rationality to show them that if bills get higher it is not the smart meter that is to blame.

Discussion

The analysis of the weblogs mostly corroborated the results found in the first study. Yet, it is important to recognize that this second study has some limitations, mostly related to the nature of the data. The anonymity of the bloggers means that the source of the quotes is unknown and it was often impossible to determine if a certain theme is referred by several bloggers or if it is the same individual introducing the same idea in different posts and comments. As a consequence, the number of bloggers is inevitably

unknown and thus the sample considered in the study is the total number of entries in blogs, as in fact was suggested in the literature. Whilst this poses methodological problems, it also provides the material a richness that would be difficult to obtain in the presence of a researcher. The language in the blogs is crude and often ordinary, but allowed us to access, without any filters or social desirability concerns, the real opinions and beliefs of users.

An overview of the extracts and codes emerging from them conveys the idea of negative attitudes towards the Energy Box. This second study reinforced the idea that the subjective norm is a key variable for understanding acceptance of smart meters and consequently their use. Many bloggers referred to "what everybody in the city" is saying about the smart meters, mentioning conversations with neighbours and friends about this new system and conveying the idea that people's responses to and use of smart meters is significantly influenced by what others relevant to them think about this device. As Jones & Alony (2008) emphasize, this aspect is even more important if we consider the outreach and consequent impact that these discourses may have on current and future users of the EB elsewhere in the country.

We can also infer from the content of posts and comments that bloggers perceive low usefulness and several disadvantages in the new EB compared to the old meter. Indeed, contrary to what was promised by the Electricity Company, the participants' state that bills have increased, the meter has more technical problems and poses, as perceived by users, a number of risks. The analysis of bloggers' discourses allowed a better understanding about risk perception, which was analyzed in a more generic way in the first study. In fact, in this second study, risk perception has emerged as a key aspect to consider, demonstrating it can be an important barrier to the acceptance of smart meters and its subsequent use. This analysis identified the specific concerns of people

regarding this technology. In addition to the financial risk - that the EB may lead to an exponential increase in the electricity bill -two other types of perceived risks were clearly discussed: health risks and loss of privacy and control risks. Here, it is interesting to note the discursive strategies that individuals use to emphasize and reinforce the risks of this technology. The use of strong images like "Gestapo meters" or "concentration camps" appeals to the emotions and to the rejection of this technology by other individuals. It is worth reminding that although the relationship between risk perception and the use of the EB in the first study was negative – i.e. the higher the risk perception about the EB, the less likely it is that people use it - on average respondents perceived low levels of risk associated with this equipment. The fact that the second study suggests the opposite may be because some time has passed since the installation of the meters and users have had the chance to form and share these perceptions but also because the bloggers may represent a more unsatisfied set of EB users.

Another important result that emerges from the analysis of the bloggers' discourses is the fact that they are often structured around the 'we vs. them' distinction. This is a powerful discursive strategy for resisting change (Castro & Batel 2008), while positing smart meters as a symbol of "them", and highlights an underlying perception of lack of distributive justice in the relation between citizens and the electricity company.

In fact, whereas issues of procedural justice were generally absent from the bloggers' discourses, perceptions of distributive injustice were often discussed. Distributive justice refers to comparisons about the distribution of socially valued goods and resources, such as money, information or status (Clayton & Opotow 2003) in society, based on a set of standards – equity, equality and need – to assess the distribution of those goods (Tyler & Smith 1997). The structuring of the bloggers' discourses through the dichotomy "we vs. them" is often used to emphasize the unjust distribution of the

financial costs with electricity, echoing the traditional power relations in the Portuguese electricity regime that, until recently, was monopolized by the company in question. And this seems to have been even more exacerbated with the installation of the EB, due to the fact that this device was initially presented as a way for users to save on their electricity bills but that the result was the reverse (an increase in the bills). This is particularly important because violations of distributive justice may increase the desire to retaliate and impose negative consequences to an alleged offender (Skarlicki & Folger 1997), which may undermine the whole process of implementing the smart meters in Évora, but also in the rest of the country. In turn, and according to Folger (1987) feelings of distributive and procedural injustice are often interdependent. In face of these results, future studies should include both perception of distributive justice and trust in the Electricity Company (see Karlin, 2012) as other potential important factors influencing the use of smart meters.

Finally, the negative arguments presented against the EB also materialize in specific action discourses against these metering systems. There is, however, another set of arguments – although in much smaller number – that not only defend the reliability and safety of these devices, but place the emphasis of the 'problem' on individuals' behaviours rather than on issues related to the equipment itself. The analysis of these arguments stresses the importance of changing the focus of the message that underlies the concept of smart grids - the solution to reduce energy consumption should not be purely technological; smart meters have the potential to turn the consumption visible, but the responsibility of its reduction rests upon the individuals.

General Discussion and Conclusion

Smart grids and, specifically, smart meters are high on the energy agenda. They have been receiving increased attention from researchers, as they can be a key piece in addressing climate change issues, since these new energy systems will allow both a more efficient use of energy and also a better integration of renewable energies into electricity grids. However, concerns with technological and market aspects of smart meters have prevailed so far (Verbong, Beemsterboer & Sengers 2013). The socio-psychological aspects associated with the introduction of these new devices have only recently begun to gain the relevance they deserve (Jensen et al. 2012). Yet, despite recent progress, the body of literature about the factors that motivate or limit the use of these smart systems is still in an embryonic state. Therefore, the overall aim of this study was to increment the knowledge about these aspects and namely to examine if the proposals of the Theory of Reasoned Action, the Technology Acceptance model and on perceived risk and justice could be helpful for that. Two studies were conducted, within the context of a pilot project of smart meters' installation in a Portuguese city and developed by a Portuguese electricity company. The results of the survey demonstrated the influence of subjective norm, perceived usefulness of the smart meter, risk perception and procedural justice in the behaviour of consulting this device. The second (qualitative) study was conducted through examining posts in blogs about smart meters in Évora. Despite the sample differences in terms of the experience with smart meters, this study triangulated the importance of the normative aspects, added the relevance of distributive justice issues and allowed us to discriminate between the different types of risk perception – financial, health, loss of control and privacy - that can influence the use of smart meters.

Given the timeliness of this theme, EU's Energy Efficiency and smart meter deployment targets and also the fact that the Portuguese EC intends to expand the project to other Portuguese cities, this paper is of particular importance as it may allow drawing important lessons for the immediate future. Moreover, this work represents an important advance for research in this area, given that it assessed the reported behaviour of using smart meters and not merely the intention of using these devices, as other studies have done to date (but see Kerrigan et al., 2011). In our study, electricity users had some contact with this technology, which is a clear advantage compared to earlier studies in which respondents had received only a brief description about the smart meters with consequent inconclusive results (Stragier 2010). Kerrigan and colleagues (2011) have actually examined the interaction of members of households with smart meters, but they focused only on how the characteristics of the smart meter itself can impact on its use, not on how other socio-psychological aspects can also impact on that. In fact, this work was also innovative in the way it combined two theoretical models extensively validated in the literature - Theory of Reasoned Action and the Technology Acceptance Model - that despite having been used in this context before, were never employed in a complementary way to study the use of smart meters. Moreover, we have conducted two studies, one quantitative and another one qualitative that importantly complemented each other, although the second one was based on a different sample. This strategy allowed us to triangulate the results obtained in the first (survey) study. In fact, the order in which the studies were conducted can be seen both as a limitation but also as an advantage. If on one hand we were unable to use the results of the qualitative study in the construction of items for the survey, on the other hand the individuals' discourses present in the blogs allowed us to understand and inform the conclusions of the first study, sometime after the installation of the smart meters - which as we have

seen is an important aspect to their use -and even to identify other aspects to take into account in future studies. However, it is also important to note that this was part of a larger study for the Electricity Company, which posed some challenges, namely in constructing the scales for the survey. Despite being very thorough and with a solid theoretical basis, the survey was not designed to assess the specific combination of theoretical models used in this paper. The subjective norm could have been assessed through a larger number of items and thus tap directly into the behaviour of consulting the Energy Box, if the survey had been designed from scratch specifically for this purpose. Another limitation was the use of a self-report measure as the dependent variable (use of smart meter) and not the behaviour itself. Hence, one suggestion for future studies would be to use the actual electricity consumption data as the dependent variable and thus gauge the impact of the installation of smart meters in real consumption. Another limitation of this study related with the use of a survey instrument, is that in the area of energy conservation behaviours – as in other pro-environmental behaviours, for that matter – as well as in the use of new technologies, responses to questionnaires often tend to be affected by a social desirability bias (e.g., Gamberini et al., 2014). Thus, and even if this did not seem to affect attitudes towards the smart meter – as these showed up as not being neither favourable or unfavourable – it might have affected responses regarding the use of the smart meter. In other words, the number of participants who have actually used and experienced the smart meter may be even lower than that reported through the survey.

Nevertheless, our study revealed other important results. It made evident the relevance of justice issues, both procedural– which will require better communication strategies and user engagement in the future (see Karlin, 2012) - and distributive justice which suggests the importance of the Electricity Company raising consumer awareness

about possible increases in billing and ensuring the reliability of the equipment and the correct metering, avoiding the situations reported in the blogs. Electricity companies should avoid promising too much and creating false expectations of immediate reductions in consumption and billing. Rather, the solution should be to put the consumer - and not the technology - in the center of this new energy system. Nevertheless, improvements in the smart meter interface, making it "user-friendly", more intuitive and its features evident to the user are undoubtedly aspects that should also be improved in the future (see also Hargreaves et al. 2010). As we have seen, risk perceptions - financial, health and loss of control and privacy - can be major barriers to the adoption and use of smart meters. However, it's worth noting that after some time and increased contact with the technology in question, individuals' risk perceptions tend to be normalized (Lima, Barnett & Vala 2004), which doesn't exempt electricity companies and governments from implementing good communication strategies and consumer engagement strategies, before and during deployment, targeted to tackle these risks. In turn, this will be an important contribution to the stabilization of attitudes and to, eventually, create more favourable attitudes towards smart meters in the future.

Active user participation is key in this new energy system. It involves a switch in mentality and in existing social norms, from "passive consumers" to active energy users/managers/producers. Successful policies for smart grid implementation will have to go hand in hand with thorough assessments of the public's uptake of these technologies, or they are at risk of creating an implementation gap, and these technologies will not fulfill their true potential. However, it is also relevant to take into account that successful policies need to overcome individualistic-only perspectives on the acceptance of smart meters, but also be seen "as supportive of householders efforts" (Hargreaves et al., 2010, p. 6118). In other words, if governments, policy contexts and

companies only deem individual citizens as responsible for making efforts to 'tackle climate change', and dismiss their own role in doing so, energy efficiency initiatives will probably not be successful. In the same vein, and as highlighted by the results from our studies on the importance of the subjective norm in influencing the use of and positions about the EB, it is also crucial to take into account the social contexts and groups where individuals are embedded and how those influence energy efficiency practices. As Hargreaves and colleagues (2010, p.6112) put it, the use of these technologies is "a social process of questioning and re-negotiating pre-existing and well-established household values and habits", which makes it particularly relevant then to consider the social contexts and practices that shape the use of smart meters.

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Complicance with Ethical Standards

We hereby confirm that this manuscript complies with the ethical rules applicable to the journal Energy Efficiency. All the relevant funding bodies and conflicts of interest were identified and the research involved human participants, whose participation was always performed with informed consent.

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Comment	Reply
Argumentative analysis	
Besides mentioning some rhetorical resources such as metaphors and irony, the description of results of the blog analysis is very far from adopting the standards of discourse analysis, and is instead a collection of glossed verbatim extracts from the blogs for illustrative reasons, excerpts that are not really analyzed. I would then downplay the claim of having used discourse analysis.	We agree with the reviewer in that the analysis performed is not an in-depth discourse analysis. However, we also consider that, by examining and identifying the main rethorical resources used by the bloggers, such as irony and metaphors and the we vs. Them accentuation, we are also conducting a rethorical analysis (in line with Billig, 85; 97; and Leach, J., 2000. In M. Bauer and G. Gaskell, Qualitative Researching with Text, Image and Sound (pp.207-226). London: Sage) and, thus, more than just an argumentative analysis (e.g., as in Liakopoulos, M., 2000. In M. Bauer and G. Gaskell, Qualitative Researching with Text, Image and Sound (pp.152-170)). In this vein, and in line with the reviewer's suggestion, we have now replaced 'discourse analysis' by 'argumentative and rethorical analysis'.
Instead I would recommend to include in Table 4 the list of argumentative resources (irony, metaphors, etc) found and their occurrence. This would also solve another related issue: the authors have supported two statements that in the original manuscript were not backed up by data ('The arguments and language resources used by bloggers often accentuate the dichotomy between "we" and "them"' and 'Many bloggers referred to "what everybody in the city" is saying about the smart meters, mentioning conversations with neighbors and friends about this new system and conveying the idea that people's responses to and use of smart meters is importantly influenced by what others relevant to them think about this device.') with two examples…this seems a very poor evidence to support statements that general.	Following the above, we do not consider that for this type of analysis it is crucial to examine and report the occurence or frequency of the argumentative and rethoric resources identified in the data, but instead mainly to identify what type of resources are used and with what function (see Leach, 2000). Nevertheless, and taking into account the reviewer's comment, we have now examined more in-depth the data, through argumentative and rethorical lenses of analyses (see pages 24, 25 and 27). As for the reviewer comment regarding the occurence of the "we vs them distinction" and the "what everybody in the city thinks", we agree that if we state that several bloggers have used those resources, we should at least provide two examples/quotations for each discursive resource. We have now added one more example for each in pages 24 and 26.
Triangulation	
- It should be made clear early on in the method description how the results of the two studies are meant to triangulate. Currently, only the difference in method is addressed, but the relation with the two samples should be also elaborated. (Study 1 is composed of people who were not preselected based on their attitude towards	Reviewer #2 also expressed some concerns about the way the triangulation was described. In this version, we clarified in the reason for using a methodological triangulation (p.10) and explicitly referred to it in the discussion (p. 31). Besides, the differences between the samples are now mentioned in the text (pages 18 & 31).

this installation, while Study 2 sample is composed of people mostly complaining about the smart meter; also, the two data collections are one year apart, meaning that participants was more advanced in their familiarization with the newly installed smart meter.) I'm also confused by an apparent inconsistency. At one point the authors explain that "at the time of the study, part of the clients in Évora had Energy Boxes in their homes for at least 6 months, and another part for less than 6 months. Despite this difference, over this period all clients had the new metering installed, monthly bills based on actual consumption, an online service with detailed information about consumption (e.g., daily/weekly/monthly overtime consumption), and the ability to perform remote changes in the energy contract" (p. 11/12). However, this seems inconsistent with an argument used several pages later: "The fact that the attitude towards the smart meter did not significantly influence the behavior (H1a) may be due to the fact that the respondents did not have had sufficient contact with the object of the attitude to have a clearly favorable or unfavorable position. We remind that a high percentage of respondents (57%) have never used the EB and thus did not had direct experience of it."	
Minor issues	
Context: how was the smart meter installation promoted and presented? At p. 11 it is said something that indirectly could describe the way Energy Box was promoted, but this is just my interpretation ("Here the specific operational aim was to reduce energy consumption by reducing energy grid losses and by giving consumers more control over their energy consumption."). Only several pages later, when discussing the results of the second study is there a more explicit reference ("the fact that smart meters were initially publicized by the company as a way to increase energy efficiency and consumer savings", p. 24). It would be very informative for the reader to have a few explicit notes about this early on at p. 11.	We have taken the reviewer's comment into consideration and amended the section on page 11 to explicitly mention how the smart meters and smart grids were promoted by the electricity company.
- The authors explain that it was not possible	We have now added, in page 20, and after

to define how many different people wrote the blog posts. I was not able to find where this was mentioned as a study limit and/or as part of the sample description. Please point me at the right line.	"The collection of blogs (...) drawn from seven different blogs", the sentence: "We were not able to identify how many different bloggers authored those posts and comments".
- Is subtheme a synonym for argument? Which ones are subthemes in Table 4?	Yes, we are considering a subtheme to be the same as an argument. In the resubmission we had not changed table 4 accordingly, but now we have performed the necessary changes, namely, where it read 'Codes', now it reads 'Subthemes'
Abstract comments	All comments made regarding the abstracted were taken into account and changes made accordingly
- p. 3: The smart meter is presented as the users' interface with the smart grid, but the smart grid side of energy efficiency is not explained in the text. The text only considers how smart meters could improve energy efficiency on the users' side.	A full definition of smart grid has now been added

Table

Table 1 – Characterization of the variables included in the model (Study 1)

Variables	Example	Response	Sources	Internal consistency (Number of items)
Use of smart meters (Criterion Variable)	e.g.: Have you ever consulted the information that appears on the screen of your Energy Box?	Yes or No		(1)
Subjective Norm	e.g.: From what you have recently heard from other people, what do you think is the opinion of most people in Évora about the replacement of old electricity meters for the Energy Box?	1 "[They] Totally disagree" to 5" [They] Totally agree".	Adapted from Krueger & Clement (1994); Lima, Marques, Pereira & Loureiro (2009)	(1)
Perceived usefulness	e.g.: As compared to the old electricity meter, saving electricity with the Energy Box will be...	1 "Much harder" to 5 "Much easier"	Lima, Marques, Moreira, Pereira & Loureiro (2009), adapted from Feinberg (2009)	0.888 (13)
Perceived Ease of Use	e.g.: Let's talk about your experience of using the Energy Box. Please indicate your level of agreement with the following statements: Using the Energy Box is a clear task	1 "Totally disagree" to 5" Totally agree"	Adaped fromVenkatesh & Bala (2008)	0.654 (3)
Attitude towards the smart meter	e.g.: To what degree the replacement of the old meters for the Energy Box is a good thing.	1 "Very bad" to 5 "Very good"	Adapted from Cabral (2000); Lima, Lopes e Garrido (2009)	0.733 (10)

Risk Perception	e.g.: The EB may bring more risks to my health and my family	1 “Totally disagree” a 5” Totally agree”	Adapted from Lima, Lopes & Garrido (2009); Lima, Marques, Pereira & Loureiro (2009); Feinberg (2009)	0.518 (3)
Procedural justice	e.g.: The truth is that everything about the replacement of the old meters was decided without asking the residents about it.	1 “Totally disagree” to 5” Totally agree”		R=0.64 1 (2)

Table 2 – Study 1: Means, Standard-deviations and correlations between the main variables (N=515)

	M	**SD**	1	2	3	4	5	6	7
1. Attitude towards EB	2.87	0.66							
2. Subjective norm	2.85	0.95	0.314***						
3. Perceived usefulness	3.09	0.58	0.289***	0.372***					
4. Perceived ease of use	3.03	0.72	0.160***	0.340***	0.444***				
5. Risk perception	2.59	0.64	0.073	-0.081	-0.190***	-0.201***			
6. Procedural Justice	3.79	0.88	0.262***	0.192***	-0.098*	-0.125**	0.069		
7. Use of the EB			0.125**	0.108*	0.128**	0.100*	-0.166***	-0.103*	

*p<0,05 ** < p<0,01 *** p<0,001

Table 3 – Results of the hierarchical logistical regression (full model)

	Predictor variables											
		B	S.E.	Exp (B)	B	S.E.	Exp (B)	B	S.E.	Exp (B)	B	S.E.	Exp (B)
Block 1	Sex / Male	0.486*	0.218	1.627	0.445*	0.221	1.561	0.442	0.224	1.525	0.367	0.229	1.443
	Age	-0.006	0.009	0.994	-0.007	0.009	0.993	-0.005	0.009	0.995	-0.002	0.010	0.998
	Education	0.055	0.080	1.057	0.074	0.081	1.077	0.081	0.082	1.084	0.113	0.084	1.120
	Time of usage	0.158***	0.044	1.172	0.152**	0.044	1.164	0.149**	0.046	1.161	0.139**	0.047	1.149
Block 2	Altitude towards EB				0.075	0.176	1.078	-0.030	0.184	0.970	0.171	0.197	1.187
	Subjective norm				0.241*	0.120	1.273	0.165	0.128	1.180	0.257*	0.135	1.293
Block 3	Perceived usefulness							0.601*	0.238	1.824	0.485*	0.246	1.625
	Perceived ease of use							-0.136*	0.186	0.873	-0.303	0.197	0.738
Block 4	Risk perception										-0.384*	0.191	0.681
	Procedural Justice perception										-0.461**	0.152	0.631
	Nagelkerke's R^2		0,080			0,097			0,118			0,163	

*p<0,05 ** < p<0,01 *** p<0,001

Table 4 - Frequency of themes and categories analyzed in the weblogs

Themes	**Subthemes**	**N**
Being against the EB		**80**
	Action Discourses	29
	Perception of distributive justice	14
	Increase in consumption/higher bills	11
	Risk of loss of privacy and control	10
	Health risks	9
	Technical problems	7
Being in favor of the EB		**10**
	Reliability and safety of the EB	6
	Consumers' energetic inefficiency	4