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Open Innovation Applied to Smart Metering: a Case-Study into Socio-Cultural Aspects

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Abstract. To date smart meters are not fully implemented in European households to improve energy efficiency. This paper describes a case study on smart metering, carried out within an EU funded project for the design of a novel research infrastructure called Living Lab project, to study the interactions of users with and stimulate the adoption of, sustainable, smart and healthy innovations around the home. To generate ideas that overcome obstacles defined for the implementation of smart metering and that are responsive to socio-cultural aspects influencing acceptance, similar open innovation sessions were arranged in three European countries: Switzerland, the Netherlands and Spain. Furthermore, on a methodological level, the suitability of the sessions for the Living Lab project has been evaluated. Results show that the innovations resulting from the three sessions departed from a common view to engage people in their energy uptake: developing attractive, tangible devices or services, which should be further specified for various groups of people within society requiring different approaches in terms of physical appearance, but also through different ways of social networking. The methods applied in the sessions provided to be a useful method for gathering opinions and actively involving experts and companies in a short period of time, but there were difficulties in both preparation and follow up of the similar sessions.

Introduction

Rising energy costs, growing user demand for environmentally friendly goods, climate change as well as ambitious targets to cut greenhouse gas emissions from European governments lead to the necessity to reduce energy consumption and changes in energy behaviour. This could be achieved by governmental incentives, which are executed by means of technology, for instance power saving lamps and special shower heads that reduce the flow of water.

However, various studies have shown that a purely technological approach to reduce energy consumption often leads to disappointing results, due to unexpected changes in user behaviour, which have been described as rebound effects (e.g. Midden et al., 2007). More direct energy consumption feedback, for instance through a smart meter, could play a major role in enabling people to effectively bring down energy uptake in the home. At its most basic, a smart meter measures electronically how much energy is used, and can communicate this information to another device which in turn allows the customer to view how much energy they are using and how much it is costing them. Immediate direct feedback, which means feedback available on demand from the meter or an associated display monitor, could be extremely valuable, especially for savings from daily behaviour in non-heating end-uses. In the longer term and on a larger scale, informative billing and annual energy reports can promote investment as well as influencing behaviour. Savings have been shown in the region of 5-15% and 0-10% for direct and indirect feedback respectively (Darby, 2006). However, despite growing public attention, many obstacles for reducing energy consumption and the acceptance of smart meters exist and even prohibit the implementation on national scale, something what happened, for instance, quite recently in the Netherlands. Obstacles are, amongst others, the complicated and insufficient incentives from public authorities while there are high investment costs involved, negative user experiences (due to automation problems or usability issues), uncertainty about privacy issues with the data exchange between the users home and the energy company, and prevailing concerns about radiation.

Still, even with proper feedback systems rebound effects may occur (Hertwich, 2005). For instance, in a recent research in the Netherlands, for which questionnaires were sent among 300 households, it was found that households that have an automatic programmable thermostat have a higher energy use than households that manage their heating system manually and houses that are better insulated have slightly higher temperature preferences than older houses (Van Dam, 2010). Apparently, everyday ways of living tend not to be predictable in terms of energy uptake and when devices are introduced it influences daily routines, which in turn may influence other types of resource consumption. There's a rising body of literature, originating from social sciences, into a more

fundamental understanding of people's everyday life to think about environmental sustainability in the socio-cultural context of the home (e.g. Shove, 2008).

In the field of energy design, it is attempted to take this up, for example, in a student design project in the Netherlands (Papantoniou, 2009), in which it was studied how energy awareness changes with feedback through smart metering, how this feedback is taken up by participants, and how daily knowledge is shared and compared between participants. The project aimed to explore how people can shift from practical to discursive consciousness, e.g. Spaargaren (2003), Dahlstrand and Biel (1997), and Lewin's Change theory (Schein, 1996), when they are provided feedback, or in other words when people go beyond energy awareness, and also start acting differently to change their energy uptake. Results showed that people want to understand their house, the energy they use and how the consumption is distributed to their appliances. There is an urge to monitor consumption, and get more information about energy usage and its costs, whenever people want. Moreover, people need benchmarking points that can help them to understand where they are regarding their energy consumption, and set goals about where they want to go, as long as they do not go against people's comfort zone. People also want to share a common understanding within their family about energy, while they are willing to collaborate with their neighbours and friends. Aspects for changing behaviour comprises for example the comparison with a standard household, analysis of own consumption behaviour, visualization of actual uptake reduction as well as identification of 'major electricity users'.

Given the aspects described here to enable people to change their energy uptake in the home, the aim of the present study was to create innovative ideas for smart metering in various climate and cultural regions. The case study was carried out within an EU funded project for the design of a novel research infrastructure called Living Lab project[1], which aims to study the interactions of users with and stimulate the adoption of, sustainable, smart and healthy innovations in the socio-cultural context of the home (Bakker et al., 2010).

Open innovation sessions

General set up

Since the project did not have the possibility for doing extensive, long term studies into people's daily routines and the purpose of the study was also to make an inventory of ideas for innovations, the methodology of open innovation sessions was chosen. Open innovation is a common applied principle, typically

[1] www.livinglabproject.org

involving mixed types of stakeholders, for instance for idea finding, or evaluation. Open innovation is defined as (Chesbrough et al., 2006):

> "Open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. [This paradigm] assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology."

At first, we aimed to organize completely identical sessions following a structured format for different countries, which would make results comparable. The sessions were to be carried out in three different European countries Switzerland, the Netherlands and Spain.

Beforehand issues concerning IPR (Intellectual Property Rights) were settled within participants' official statements that ideas resulting from the sessions were collective property of the participants of the specific session. Participants involved both experts and company executives from various companies in a country. Users of smart meters were not included at this point of the process since there were various user studies available, which defined obstacles and user issues of smart metering. These studies were presented in the sessions.

However, due to organisational and practical considerations, only the sessions in Switzerland and The Netherlands followed the structured format, but the session in Spain was organised differently. The differences in set up will be explained in the following paragraphs.

Methods open innovation sessions in Switzerland and the Netherlands

The sessions were structured into two parts divided by a break. The first part was to inform about the LIVING LAB project and smart metering in general and the second part was the creative part for idea generation. The participants were split into three groups. In the second part, the groups had to generate, select and present ideas related to one of the three central topics: The first topic was about how energy-awareness devices can be widely adopted through increasing the acceptance and overcoming hurdles. The second central topic focused on the user involvement in energy saving and on how the behavioural change can be consolidated, and the third topic dealt with the future of smart grids and smart metering and their possibilities for saving energy.

The sessions have been applied according to the open innovation principle, and techniques applied within the session were borrowed from creativity triggering and codesign methods (see also De Jong et al, 2009). The obstacles for smart metering as well as an introduction to the Living Lab project into social innovation were presented to sensitize participants to the topic of social-cultural aspects of smart metering. However, specific studies on smart metering were presented only in the Dutch session.

The method used to find ideas, called the brain drawing session, was based on idea building. A paper with initial ideas of the first participants is transferred to

the next person. In total 2 rotation rounds (1 round = each participant had all 3 topics) were conducted. Evaluation of the solutions/ideas was performed by the group. Each group had to develop 3 assessment criteria and relate the criteria to the color code given in the poster template.

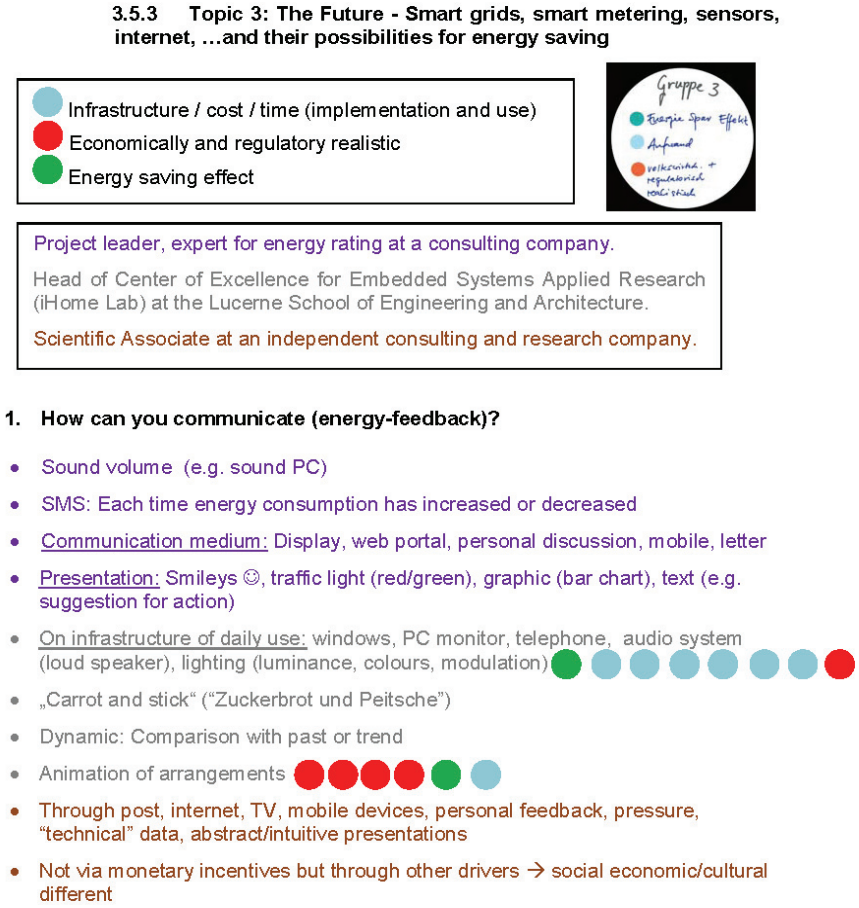

Figure 1. Example of assessment of ideas by colour coded criteria in the Swiss session.

Afterwards, the ideas were assessed by using the assessment criteria. Coloured stickers were used for the evaluation, see example in Figure 1. Finally, each group was given a poster template to be completed.

The session in Switzerland was executed on 7th October 2009 during half a day, see Figure 2. Eight participants from different disciplines as well as from industry and academia in Switzerland took part in it. Location for the session was the Value Lab at the Swiss Federal Institute of Technology in Zurich. The Value Lab is a research and teaching space with five interactive touch LCD panels, a high-resolution video projector and a video conferencing system. This collaboration environment was used during the second part of the session to document ideas and for the poster presentation, see also Figure 2.

Figure 2. Creative Workshop at the Swiss Value Lab (top left), presentations in ESADE Creápolis in the Spanish session (top right), poster presentation in Dim Lab Delft (bottom left) in the Dutch session, and example of creating a poster in the Swiss session (bottom right).

In the session in Delft on 23rd March 2010 (half a day), see Figure 2, 13 participants with different backgrounds from Dutch industry and academia participated. Location for the session was the DIM-Lab at the faculty of industrial design engineering at Technical University in Delft. The DIM-Lab is a research space with a large LCD screen for presentations and recording facilities. A researcher from Delft University was present at each session. The sessions were recorded by cameras and microphones.

Systematic analysis was done by each session organizer who made a list of the issues mentioned for the three central topics, and an inventory of the ideas. The Delft researcher collected the data and performed content analysis of the results of the three sessions. This was done by looking for similar remarks and issues mentioned for the topics and by comparing the ideas within the three sessions. In the Swiss session, a questionnaire was distributed among participants with questions about the use of the facility and the set up of the session.

Method open innovation session in Spain

The Spanish session aimed to promote the benefits and tools of open innovation by facilitating the cooperation between companies on innovation projects. Objectives were to identify different internal business opportunities around smart

metering and to promote quality networks between different public and private organizations.

A local facilitator has been involved to create a setup that was specifically aimed at finding business opportunities for the participants. To create an open atmosphere where participants were stimulated to think beyond current barriers for smart metering, focus was put on how to make smart metering more attractive to both consumers and producers and to find innovative ideas for that. During the start up, trends in smart metering were presented by the organizer. There were no introductions by experts on studies of smart metering since, as was stated before, the session organizers intended to break away from current problems, to avoid limitations in creativity thinking.

The Spanish session was held on 3rd December 2009 during one full day at the ESADE Creápolis in Barcelona, see Figure 2. ESADE Creápolis is a creative business center where various organizations are located with the aim to facilitate and stimulate cross innovation. The session in Spain involved 10 participants from different disciplines, including one with a behavioural background, as well as from industry and academia, of which a couple were located within the ESADE Creápolis center. The participants are persons who belong to organizations that are interested in smart metering, or manufacturers of smart metering etc. For a dynamic group, not only technical profiles are included, but also companies closer to the end customers are invited.

The session was divided in two parts: First, participants were familiarized with the concept of creative sessions, the focus of the session and the project Living Lab. In the second part the participants worked on creating ideas, clustering, and rating ideas, before presenting them in groups.

Before the session, participants were asked to send an email about their previous work. Also calls were made to several participants to see if they could provide some interesting data to the session.

Analysis was done by listing the ideas for innovations that resulted from the session by the session organisers and follow-up activities have been taken up by them to understand the effects of the open innovations session by contacting some of the participants afterwards.

Results

Innovations for smart metering

The ideas for innovations that resulted from the sessions were very similar, despite the different set-ups of the sessions. Detailed information on the outcomes is provided in the documentation of the project available through the Living Lab project website, but due to confidentiality issues (IPR) the results will be summarized here. In all sessions it was clear that an important aspect of

increasing user acceptance and energy awareness is that energy consumption must be a tangible product or service, such as mobile apps or a physical object with interface. To promote energy as a tangible product it should be established through TV, famous people (from music, politics etc.), education for children (schools), as a brand, through an application, or in terms of a competition with your neighbours, friends or similar households through, for instance, social networks.

Users should be engaged not only through a simple smart meter but energy saving should be an integrated part of their daily live and routine. They also indicated that different feedback systems are necessary for different cultures, which however do not necessarily relate to climate regions. For instance, among the promising ideas was the call for a modular visualisation of energy related to the socio-cultural types (player, calculator, green, lazy, demographics etc.) of users, which can also change its appearance over time to remain a trigger. This means users can choose their preferred type of visualisation (playful, very simple, number oriented, colours etc.), but can also have a dynamic system that has a different way of triggering them every month.

Methodological reflection

The follow up activities after the Spanish session showed that the companies struggled to integrate the outcomes in their overall business strategy. Apparently, to achieve the aim of finding and realizing business opportunities, the open innovation session should be carefully prepared, possibly by organising individual sessions beforehand, to select suitable participants who are both willing and capable of going in the next trajectory of realizing the ideas resulting from the session. On a more practical level, the setting of the open innovation sessions in the high tech facility of the Swiss session was not appreciated by all participants, and also comments were given on the high number of presentations before the workshop while participants expected to have more time for open discussions.

Another issue concerns the involvement of stakeholders. Although there is a great body of literature on the need to involve actual users or, at least, potential users in the development process of products, we decided not to do that at this stage of the project. Since we gathered a lot of insights through the user-studies we felt that we could replace the actual presence of users by presentation of these user studies. Since it is difficult to assess whether or not their presence would have made a difference, it is perhaps better to formulate our concerns with involving users at this stage, because even though participation of users can bring a lot, there are a number of challenges ahead. For instance, the organization of a participatory event, albeit a short meeting, requires thorough preparation in terms of expectations, abstraction level, expert language, and familiarity with

techniques. In other studies where we did choose to involve users (e.g. De Jong et al., 2009), we prepared this intensely by organizing similar sensitizing activities of all group members before the workshop to stimulate proper discussions.

In contrast to our initial set-up, we did not manage to organize identical sessions in different EU countries despite the structured template that we set up at the start. This is mainly due to differences in timing of the sessions but also different opinions from organizers about the proper setup and tailoring it to a specific situation or requests in their country. For instance, in the Dutch session, the presentations of user studies were presented by some of the researchers themselves who went into depth of the problems and issues that people encountered when trying to understand and use the smart meters, while the Swiss session was more concentrated on presenting the Living Lab project as such. In Spain, the organizers wanted to start the creativity session without the limitations of the obstacles as found in the user studies, so they chose not to present the outcomes of user studies.

The idea of organizing identical sessions within Europe, if needed at all, could be questioned. Since there are, in fact, great differences between European countries, in terms of climate and cultural differences which apparently also play a role when involving companies and institutes in joint business activities, it may therefore, it requires a more thorough preparation of interests and expectations of companies and institutes to determine the actual need for identical or similar set ups of open innovation sessions within Europe.

Conclusion

Understanding, changing and consolidating people's resource consumption at home is one of the major issues in environmental sustainability that proved to be a wicked problem, even with the use of proper feedback systems such as smart meters. The study showed that smart meters require targeting different social groups through specific types of branding and social networking. Moreover, commitment for energy awareness and action should be accomplished by a tangible product or service.

Future research is needed in the actual context of the home, preferably with prototypes of smart meters, into people in their daily lives to understand the impact of the devices on daily routines and the effects on resource uptake. Such insights can be used in follow-up open innovation sessions, while taking up the challenges of preparing and following up on these sessions.

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