A SOCIAL APPROACH TO ENERGY METERING: THE ENERGY MENTOR

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Abstract

Industrial designers are used to applying their skills to modify or change user's behaviour, inducing attributes to the product to empower/inhibit the use into a certain direction (e.g. scripts). These approaches might bring the desired results, and modify behaviour to one that favors sustainability. Such approaches, however, have a major defect, because they diminish the agency of the user. As a result they cannot help the user to shift to a discursive level and actively start thinking about energy.

This paper presents a qualitative study of 8 Dutch households, whose occupants used a clip-on energy-meter for a month and made significant changes to their practices in order to be more environmentally responsible.

The primary aim of the study was to explore how energy feedback and social learning affect people's understanding, attitudes and behaviour. A participatory approach followed applying conventional ethnographic methods in order to gain insights on what people "say, think, do and know" about energy consumption in their day-to-day practices.

The meters had a dramatic effect on the participants' understanding and awareness of the electricity they use and showed conscious changes in how the participants take showers, cook, wash and so on. Nonetheless, the meter's novelty effect faded soon. In probes and focus groups the participants indicated the need to feel more in control of their energy usage and the will to collaborate with others to share knowledge and ideas. Based on these findings a concept of social software that complements the smart meters is proposed.

Keywords
Energy Feedback, Social Learning, Participatory Design, Social Practices

1. Introduction

Residential energy consumption is the second most rapidly growing area of global energy use after transport, contributing to total energy use generally between 15% and 20% (EEA, 2005). The adopted policies and measures to cut back greenhouse gasses attributed to households, aim to do so mainly by: increasing the use of renewable energy (solar, wind, biomass, geothermal) or by improving the energy efficiency of houses and households.
The latter, is the focus of this paper. If we want to improve the energy efficiency of households, we have to deal also with the consumer's behaviour as a significant determinant on the household's environmental impact.

In the field of industrial design, designers are used to use their skills to modify or change user's behaviour; inducing attributes to the product to empower/ inhibit the use into a certain direction. One such case is the use of affordances in design (Norman, 2002). The concept of affordances explains how artifacts facilitate or afford an action, while can constrain another. Hence the use of affordances might be used also for behavioral interventions in which technologies are designed to disrupt and reshape habitual behaviour and general behaviour modification through design.

Another approach is the use of scripts in design. Behavioral scripts or 'user logics' are defined by cognitive psychology as the mental connection in users between characteristics of objects and specific actions, artifactual or design scripts are methods where designers attempt to inscribe behaviors into the objects which in turn are subject to the user's behavioral scripts. According to Jelsma (2006) designers can script morality to technology by enforcing certain behaviour. For example, airplane bathroom sinks have buttons that require the user to apply continuous pressure to release water, intentionally designed to prevent wasteful behavior. In this way design triggers the sustainable use by either creating obstacles for unsustainable use, or by making sustainable behaviour so easy, it is performed almost without thinking about it by the user.

Last but not least, the use of forced-functionality refers to either intelligent products (Lilley, 2005) that adapt automatically to changing circumstances, or to designing in strong obstacles to prevent unsustainable behaviour. An example of forced functionality is the

change of tabs of soft drink cans, which happened in the1980s. Before this the tabs came loose from the can entirely. These loose tabs were notorious for ending up littered and causing harm to people and wildlife. Then a redesign was implemented with a stay-on tab that automatically prevents the sharp closure from being littered (Wever et al., 2008).

These approaches might sometimes bring the desired results, and modify behaviour to one that favors sustainability, however they have a major defect. They diminish the agency of the user. The user keeps on acting without thinking, functioning in a practical level. As a result they cannot help the user shift to a discursive level, in order to start creating a mental model about energy.

2. Goal

This paper is an attempt to pave the way for a solution to this problem. It is the result of a study carried out for the White Rose Foundation (Stichting de Witte Roos), an independent, Dutch organization with a single objective to give to urban sustainability a concrete and challenging face that can inspire and support the citizens of the city of Delft to make choices that lead to sustainable behaviour. The primary aim of the study was to explore how energy feedback and social learning affect people's understanding, attitudes and behaviour. A participatory approach followed applying conventional ethnographic methods in order to gain insights on what people "say, think, do and know" about energy consumption in their day-to-day practices. The following section acknowledges the absurd and complex, domestic environment in which people have to make choices to economize energy. Section 4, refers to the behavioural theory and models that have shaped this study, while section 5 describes the method that was followed. The following two sections 6 and 7 present and discuss the results of the study, closing with the final conclusions in section 8.

3. The absurd context of domestic energy consumption

Despite the energy and resource-efficiency of domestic appliances, domestic energy consumption has risen due to the more affluent and luxurious lifestyles we are accustomed to. We live in luxurious homes, equipped with multiple appliances. We build larger homes for fewer people and use more energy in our homes, both for heating and electricity. The total amount of energy use for space heating continues to grow, due mainly to the increase in the number of households and the size of the average dwelling, while electricity consumption is also on the rise (EEA report 11, 2005).

Nevertheless, even when people want to economize it is very difficult for them to do so in their houses. Firstly, we assume that people do no not want deliberately to harm the environment or consume and spend more energy than they need. They do not actively consume energy, but as a consequence of their actions with some other purpose. Hence, instead of blaming and accusing people for their wasteful domestic behaviour, the causes have to be investigated. Looking carefully at the domestic context, one can quickly realize that people lack knowledge of precisely how much energy is being used when performing an action. Most houses -till now- do not provide any feedback to the people for their actions whatsoever. Consumers do not get any insights on their energy consumption mainly due to the obsolete domestic context. The energy meter, installed in their houses, is hidden in a closet, while the data displayed on the meter are hardly interpretable by most of the consumers.

Moreover, despite the fact that today energy meters have been redesigned, substituting the turning wheel with digital meters with LED pulse, the information remains the same while the meter remains hidden in the closet. One of the main reasons that energy meters do not meet the consumer's needs is that they have been designed primarily for the energy companies to measure domestic energy consumption, ignoring people's need to monitor and track by their own consumption.

The absence of any kind of energy feedback, when people use their appliances has resulted to the lack of a mental model that explains the finite amounts of energy and the ways energy is consumed. The only feedback the consumers get is through their monthly –or even yearly- energy bill. This feedback is too delayed to enable reflecting on their actions, and understand the reason their consumption is so high or low. Kempton and Layne, (1994) very aptly state that: "It is like equating consuming electricity to shopping in a grocery store, where no individual item has a price marking and the shopper receives a monthly bill on aggregate price for food consumption."

How can the grocery shopper economize under such a billing regime? The same counts for energy usage, where the consumer has no idea how much, when and by which appliances electric current was used. Nor is informed whether his consumption is relatively low or high, or whether it has increased or decreased to understand if his actions had any effect. Even when the consumer does the "right" thing, switching off an appliance, presuming he is not wasting any more energy, there is still a small amount of energy consumed in a stand-by mode. This contradicts, with the mental model "appliance on-energy on, appliance off-energy off".

If we really want to assist people with conserving energy, we should understand the limitations and barriers they face in their daily life concerning energy use. By empathizing with the consumer, we can design strategies and concepts that really fit to people's lives and can bring effective results.

Gaver et al. (2003) call for a constructivist approach and the apparent need to give to the consumer the chance to experiment with energy, and reflect on his action. By impelling people to interpret situations for themselves it encourages them to start grappling with systems and their contexts and thus to establish deeper and more personal relations with the meanings offered by those systems. Darby (2006) supports that feedback and sophisticated energy meters that are widespread developed nowadays can assist the consumer to understand the energy he consumes and the cause and effects of the actions he performs. Feedback covers a wide range of practices and these are best analyzed and understood in context. The overall idea is to look at feedback in terms of its contribution to the building up of a body of 'tacit knowledge' or know-how about the supply and use of energy. In this, people take in information concerning their energy use, they act and they gain understanding of what has happened by interpreting any feedback that is available. As a result, feedback can influence people's attitude, change the way they think and feel about energy and eventually have an effect in people's behaviour.

4. Consumer behaviour theory

In line to the constructivist approach, the current study was shaped by the ideas of Structuration Theory (Giddens, 1984) and Social Practices (Spaargaaren and van Vliet, 2000).

Giddens makes a distinction between "practical" and "discursive" consciousness. The first refers to the everyday knowledge that people have about how to do things. For Giddens much behaviour in day-to-day life is "not directly motivated", but beneath deliberation, being driven by practical consciousness. It depends on a huge wealth of commonly accepted knowledge concerning how to go about things. According to Giddens the bulk of human agency rests in using this kind of practical consciousness in the context of familiar, routine situations and behavioural contexts. Discursive consciousness, on the other hand, consists in everything that actors are able to say about the social conditions of their action. The central recursive process in structuration called 'reflexiveness' describes a continual monitoring of our own behaviour and that of others, based on which we adapt our behaviour accordingly. Again, according to Giddens, accounts of intention are generally produced during or after action, rather than before it. For instance, it is practical consciousness that

allows to somebody to identify the where about of the rubbish bin faultlessly (until it is moved), whereas it is discursiveness that explains the action.

Structuration theory can assist to understand domestic consumer behaviour as it connects the daily life habits with consumption. As Stern, (2000) states;

"Many environmentally significant behaviours are matters of personal habit or household routine...and are rarely considered at all."

Using the structuration theory as a starting point, and stepping one step further addressing also pro-environmental behaviour, Spaargaren and van Vliet (2000) suggested a model of consumption as a set of social practices influenced on the one hand by social norms and lifestyle choices and on the other by the institutions and structures of society. The writers - suggest that:

"Shifting consumption patterns requires 'raising' routine behaviours from the level of practical consciousness to discursive consciousness."

Most everyday, routine action is performed in practical consciousness. But there is evidence to suggest that intentional or goal-oriented behaviours require elaboration. People are locked in behaviors, and patters that seem resistant to change. However in a longitudinal approach, behaviors and routines change. If only, we think of the adoptions of so many technological inventions like the cell phone, the Internet and so many others, and the ways they have changed our lives the last years. Thus, the term "dynamic lock-in" describes better how the consumer locks into new practices with time, and unlocks from others.

Hence starting from Giddens' model and structuration theory a logical step is to look for a behavioural model where the agent is in the center of the model and the notion of shifting from practical to discursive consciousness to break bad habits prevails. Such models are the model of Spaargaren and van Vliet (2000) as well as the model of Dahlstrand and Biel (1997) and Lewin's Change theory (Figure 1). These models can help to break the "bad habits" consumers have in their households and freeze more sustainable behaviours.

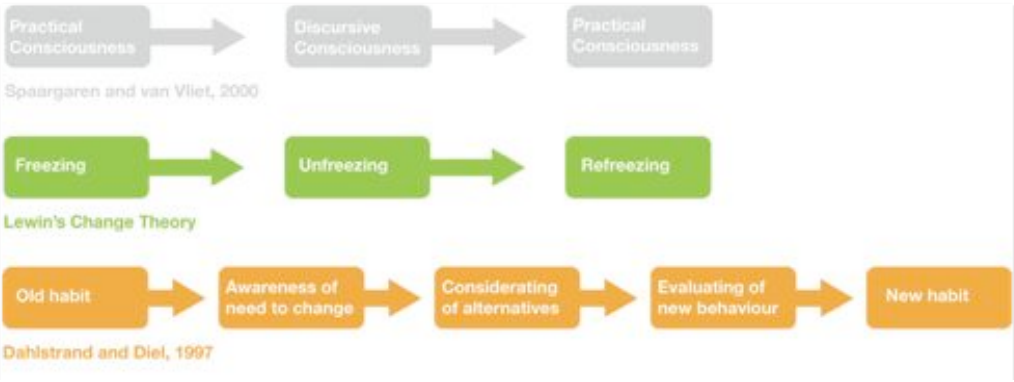

Figure 1: Behavioural models of changing consumer's behaviour and breaking bad habits.

5. Method

To understand domestic energy consumption from people's point of view, a qualitative research was carried out, applying conventional ethnographic methods such as interviews, observations, probes and focus groups. The research aimed to understand, come closer and engage the people during the process. What people "say, think, do and know" (Sanders, 2006) was of primary concern. The use of design probes was selected as the most appropriate method as it elicits rich information from the daily life of the people, who are actively participating in the research by documenting their daily activities, thoughts and worries.

The design research consisted of two phases, a preliminary, more exploratory one with the name "My house, my energy and me" and a more focused and specific one, inspired from the results of the first, with the name "ActReact".

The preliminary probes of "My house, my energy and me" allowed introducing the purpose of the project to the participants, building a relationship and engaging them for the follow up of the project.

To recruit people for the research, an advertisement was placed in the local newspaper, on the first place. After two weeks with no responses, the participants were recruited from acquaintances of the people from the White Rose Foundation. Hence, in total 12 households were recruited: eight households from one neighborhood in Delft (neighborhood A), and four from another one (neighborhood B). All of them very new and energy efficient houses built in 2005 and 2006 in correspondence. In the one neighborhood, all of the participants were couples, while in the other neighborhood the participants were families. The participants

varied in occupation, in age, and in gender. However all of them were middle class, of higher education more likely to adopt more environmental friendly behaviours.
Participants worked on the probes, in their homes for a week. The probe was accompanied with a brief personal explanation and instructions on how to use the booklet. After one week, the probes were picked up from the participants' homes. This offered a great opportunity for short chitchats with the people that helped to get deep, personal insights about their lives.
The probes' tasks typically aim, at one hand, describing today's contexts and practices and on the other hand exploring design opportunities for the future. The booklets included questions and small daily assignments for the participants to fill in every day, for five days in a row.
The scope of the follow up study, "ActReact!", was on awareness, energy feedback and social learning; areas that were defined by the analysis and the results of "My energy, my house and me". Aim of the ActReact! research was to capture knowledge on how can people learn about energy and develop an understanding on its substance and its consumption, which ultimately can lead to changes in people's doings.

For the purposes of this study, eight households (out of the initial twelve) were given a clip-on smart meter and were asked to document on a workbook their experiences for a period of four weeks. At the end of the research the participants were asked to discuss about their experience during a group session.
The meter that was selected was the Wattcher (Figure 2), designed by Marcel Wanders Studio. The Wattcher is an energy meter that displays the total electricity consumption of the home in a beautiful and meaningful way, as the manufacturer promises. When an electrical appliance is switched on, the Wattcher displays that extra power consumption. The Wattcher shows the energy consumption both in exact numbers and in a visual way. The display pulses slowly when energy usage is low, and faster when energy usage is high.

Figure 2: The Wattcher energy meter

More specific, the Wattcher has three functions that show:

1. The current power consumption (Watt): how much energy is being used at the moment.
2. The daily energy consumption: the total electricity consumption of the last 24 hours.
3. The target energy consumption: how is your daily consumption compared with your own target. Are you really saving energy?

The Wattcher consists of a sensor, a sending unit and a display. The sensor can be placed on any electricity meter (analog meters with a turning wheel, digital meters with LED pulse and smart meters). The sensor is connected to the sending unit. Both are placed in the meter closet. The sending unit sends a radio signal to the display unit, which can be placed in any (Euro standard) electricity socket. The Wattcher can be self-installed by the consumer. However, to avoid any mistakes during the study the Wattchers were installed for the participants.

6. Results

6.1 The results from “My house, my energy and me” probe

The preliminary study, “My house, my energy and me” elicited rich insights from the booklets and inspiring stories from the short interviews with the participants that were conducted when picking up the booklets (Figure 3).

Figure 3: Sample pages from the booklet, “My house, my energy and me”

Discussing with the participants, one could understand that they are aware of the need to consume energy more efficiently and that they try to save energy by curtailment measures such as; switching off the lights, devices etc. However, they are completely unaware of the energy they consume, the energy they save with their actions as well as the bill they have to pay. There were good intentions by the participants, but not a plan or a way to save energy consciously and effectively. The lack of feedback about their energy usage hindered all their conservation efforts. In the end, a lot of the participants stated to feel helpless and demotivated to do more; relying only on the purchase of appliances with an A-energy label, and living in a new built house with high efficiency standards.

Next to this, the interviews revealed details about the participants' daily social life with their neighbors. It was insightful to see that in both neighborhoods a community feeling had been developed, as all of the participants had moved in the neighborhood in the same period, when the houses were newly built. Therefore, they knew each other, and small daily interactions were common (in the elevator, to borrow something).

In neighborhood B, where families with kids were living, the social connection was even stronger as neighbors had come closer because of the kids. For instance, sometimes they would leave the kids to a neighbor to take care and look after them. Moreover, the residents of the street in a collective action to make their streets safer drew and placed together with their kids, traffic limit signs on the street. This was an initiative in neighborhood B, about which all the participants were proud of talking and showing it off.

Furthermore in both neighborhoods an early adopter (Rogers, 1995) was identified, who was an expert on conserving energy. These early adopters could be better characterized as mavens; meaning people who accumulate knowledge, serve as data banks and are willing to educate and help other people (Gladwell, 2000). In our case, these mavens were enthusiastic people, with knowledge on how to be more energy efficient, and willing to share their knowledge and know-how in a vision to get energy-neutral.

The maven of neighborhood B -let's call him Piet for convenience- had already installed solar panels on the roof and was exhibiting them with pride. Piet would like, as he often stated, to see his neighbors doing the same and would like to help them sort things out in their heads with selecting and installing energy panels; a painful process as he stated. During the private conversations, with the rest of the participants, the solar panels were a point of discussion as people were interested or thinking about installing ones. Piet was an inspiration and motivation at the same time for his neighbors to take action. After all, it is not a coincidence that in the question of the booklet, 'Where would you invest 3000 Euros to make your house greener?' participants from neighborhood B mentioned in solar panels, in a consensus.

Summing up, "My house, my energy and me" suggested two promising directions for further investigation:

• the need people to acquire a mental model about energy before asking them to save energy. Energy meters and energy feedback have the potentials to make consumers more aware, but also help them see their practices in a more conscious than practical level that can help them understand energy and possibly change some of their practices as well.

• the influence and power of early adopters or mavens to their neighbors. These exceptional, and knowledgeable persons can provide a supportive and safe environment to people, who want to learn how do their home appliances work, or how energy is consumed.

These two directions recommended three topics for further exploration in the next phase of the research with the “ActReact!” study (Figure 4):

1. Energy awareness, and how does it change once people get feedback from an energy meter
2. Adoption of the energy meter in people’s lives and potentials for improvements.
3. Social learning, and how can knowledge dissemination happen in the level of a neighborhood.

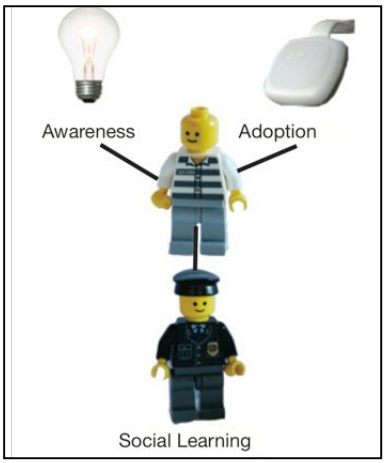

Figure 4: Scope of ActReact!

6.2 The results from the “ActReact!” probe

“ActReact!” elicited valuable insights for the way people raise energy awareness with the help of an energy meter, and the interaction they have with such a device. In this section, first it will be discussed how householders’ energy awareness and behaviors were affected by the Wattcher. Next, will follow how an energy meter (aka the Wattcher) fits to people’s lives, what the possibilities but also limitations from such a device are. Finally, a short discussion on social learning will follow, concluding with three main insights out of the research that are crucial for changing energy behaviour.

6.2.1 Raising general awareness and understanding

Providing a clip-on energy meter like the Wattcher to the participants proved to be helpful to raise general awareness and understanding about the electricity they use in their daily lives and activities. “I think them most important thing is that you become more aware (with the Wattcher), participant Jessica proudly stated. By watching the meter blink continuously the electricity consumption, the participants became more aware, started experimenting, and altering their behaviors for resource efficiency. The most common behaviors were turning lights off when not in use, unplugging devices when not in use or placing them on standby. Minor but conscious changes in the way people use their appliances and the way they perform their practices. For instance, some participants warned by the high-energy consumption of the kettle started paying more attention to the amount of water they poured in, while others tried to reduce or even stop drinking tea. Similarly, participants adopted more energy efficient practices with the washing machine by washing less frequently, setting lower washing temperatures or using more efficient washing programmes. Such conscious changes ware noticed in every daily practice from cooking to showering and teeth brushing, where some participants tried to do so in the dark (Figure 5).

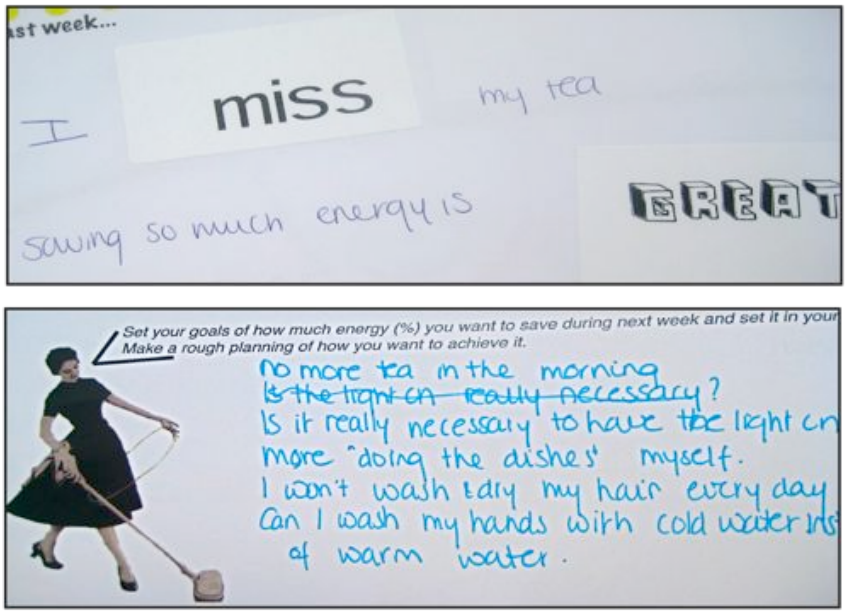

Figure 5: Changing daily practices.

In addition, participants started to think and talk in terms of Watts and KWh, be aware of what it costs for instance to make a tea or bake bread, and show some expertise that had not shown during the preliminary interviews of “My house, my energy and me”. The participants had been transformed in a very short time, from complete unaware to conscious

consumers, able to tell about the efficiency of their washing machine by the energy it consumes and not only by the sound it makes (as it was observed at the beginning of the study). Moreover, the participants discussed about house modifications, and possible solutions although they had not done any in their houses. All in all, making energy more transparent to the people proved to be a key insight for changing consumers' attitude and behavior towards saving energy.

Summarizing, householders did try to modify and change actions of their daily behavior in an effort to conserve energy. The energy feedback gave people some insights and hints on what to change, and a trial-error process was initiated. It goes without saying that people did not want to move far out of their comfort zone, when changing their behaviors. Nevertheless, a feeling of accomplishment and satisfaction often followed frustration and inconvenience when participants could save some energy or were finding new ways of doings (Figure 6).

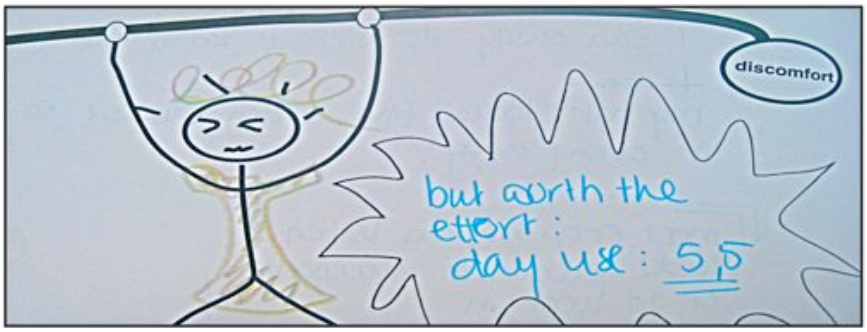

Figure 6: Satisfaction followed frustration of modifying daily practices.

6.2.2 Adoption of the energy meter

Living with an energy meter that tracks the total electricity consumption in the house, and indicates it in real time, was a total new experience for all the participants. As a result, during the first days of use, all of the participants presented a novelty-effect. They were excited by their new "toy", the Wattcher, and were continuously experimenting, trying to discover their energy consumption. But this excitement fades out soon, and people only check occasionally the meter to monitor the energy consumption. As one of the participants stated about the energy meter in a group session, "I think it wears out. You look at it the first days and it's very exciting, but then it becomes like a trigger to see if there is something too high, just to check [...]"

During this period, people got excited with getting feedback, curious about the ways to minimize their energy consumption, obsessed with checking out the meter's indication, frustrated when they could not identify energy suckers, angry with not recognizing energy

patterns over time, and even weird as the meter made them feel geeky sometimes as they often mentioned (Figure 7).

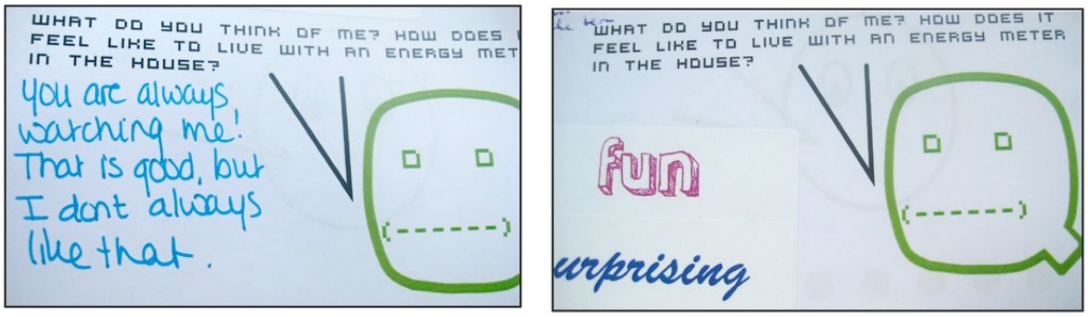

Figure 7: Feelings and reactions from living with an energy meter in the house.

Nevertheless, the information that clip-on energy meters offer seemed to be rather limited. After people have gained an overview of their energy consumption, they are constrained by the energy meter to dig deeper, discover patterns, analyze and understand them. Users get frustrated and puzzled, as they cannot discover the sources that continuously suck energy in their house, and cannot explain why their energy usage varies day by day. As a participant stated “Well it was not clear for me what to change, because I didn’t understand why I had this amount one day and a different another day […] The information is not very detailed, you don’t know what causes it.” To learn more about their energy consumption, participants tried to use the energy meter complementary with other tools, like the energy box in the house, the energy bills or even energy meters that measure the energy consumption of a single device.

However, these practices not only cost a lot of effort to the participants, but also do not bring any significant results, as users remain confused. What they want, as they often stated, is to be able to monitor their usage over time, and identify the behaviors and appliances that consume more energy.

Another problem was the fact that as the energy meter depicts the picks of energy consumption in real time, the users can easily be disorientated by these picks and forget the low, but continuous energy consumption of other appliances. For instance, people were frightened by the energy consumption of the water kettle, which picks at 2000W but lasts only for 2-3 minutes, while they ignored devices that suck little amounts of energy but constantly. In the group discussion, participants showed their frustration of feeling helpless and being ignorant of their energy consumption and how they can affect it.

In short, participants asked for more control over their energy consumption, being able to track and monitor it, having the power to influence it.

6.2.3 Social learning and knowledge dissemination

As far as it concerns social learning, the participants failed to interact during the experiment (Figure 8). This can be attributed partially to the holidays (Queens' day period), which was a barrier for the research, as well as to the difficulty people had to compare the measurements of the Wattcher, as the meter was planned to be the trigger that would bring people to interaction. Moreover, some of the participants stated that they did not feel the need to do it as they considered it an extra effort in their already busy lives. They waited for the final group session to discuss and share their experiences.

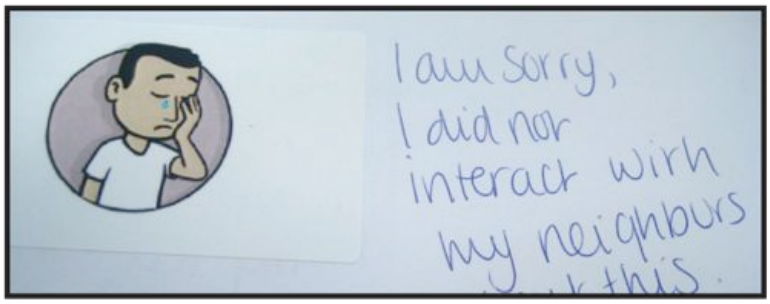

Figure 8: No interaction occurred between the participants from the same neighborhood.

Once participants came together, and sat around a common table, they stated that found these discussions very helpful and the whole ActReact! intervention very rewarding. They liked to talk about different practices they tried out, and compare their own experiences with those of others. The participants found also very useful to talk about technological solutions or barriers in their effort to conserve energy.

Another point that came up from the study was the need for a common understanding within the household's members. Some members of the family, often, are more aware or interested in saving energy than others. This often leads to misunderstandings and arguments for minor issues like for instance the temperature of the thermostat, or having the lights on unnecessarily. The presence of an energy meter helped to gain a common understanding within family members, without having to prove who is right or wrong.

Summing up, participants' discussions with family members or neighbors (during the group sessions) on issues related to energy conservation helped them to gain a better understanding of how their house works, what its inefficiencies are and how they can

improve them. Collaboration proved to be another key element on changing domestic energy consumption.

7. Discussion

7.1 Three essential factors for changing domestic, energy consumption

ActReact! started with an aim to explore how can people shift from practical to discursive consciousness when they are provided with feedback, and how can they change their energy consumption to a more efficient one. The scope was to explore three main topics; Awareness, Adoption and Social Learning. A very ambitious aim and scope, for such a short time, which in the end at least scratched the surface of these three very broad topics and gave some insights, hints and inspiration of how things work with feedback and what is still lacking. During this research it has been presented how does energy awareness change with feedback, how do smart meters fit to people's lives and how the daily knowledge is shared and compared between participants.

ActReact! together with "My house, my energy and me", revealed some of people's needs and desires. People want to understand their house, the energy they use and the individual consumption of their appliances. To be aware of their energy consumption, they need more access to information regarding the energy they use. Smart metering and energy feedback is an effective tool to give contextual information about energy use; making energy transparent from invisible is a priority to bring up awareness.

The smart meter that was tested during the research, the Wattcher, achieved in "unfreezing" people and making them more aware but its effectiveness over time is questionable. Although people had the opportunity to try it over a month, the meter lost its novelty character during the first two weeks. After having identified the most energy consuming appliances, the meter failed to trigger the participants more. The participants in a very short time had developed competence that could not be supported anymore from the rather limited functions of the meter.

To have the power people to influence the energy consumption, there is a need to make one more step forward; a step from awareness to control. Once people get feedback, there is an urge to monitor consumption, and get more and richer information about energy usage and its monetary costs, whenever people ask for it. There is a need for recognizing behavior patterns over time and identifying the most energy consuming practices and appliances. Moreover, there is a need for benchmarking points that can help people to understand where they stand regarding their energy consumption, and set goals about where they want to go.

In this way, people can feel more powerful and certain about their actions and make choices about their energy use that comply with their beliefs and fits to their comfort zone.

Last but not least, people want to share a common understanding and awareness within their family. This helps them to deal with the daily life easier, as they develop rules and norms that are acceptable by all family members. In addition, a common ground offers a ground for fertile discussions within the family or even in the level of a neighborhood for exchanging ideas and practices. People are willing to participate in collective experiences as well as these do not disturb in a great extent their daily lifestyle.

Summing up, three factors are key for changing domestic, energy consumption: Transparency, Control and Collaboration (Figure 9):

• Transparency. To make people aware of energy, it is important to make energy tangible and visible. There is a need for information about energy use. People want to know how much energy they consume, where and when.

• Feel in Control. By this we mean the power to influence or direct the course of an event. People need to feel powerful and be able to make choices about their energy use. They want to have the possibility to influence it across their daily practices easily and quickly.

• Collaboration. It can be a catalyst on change. Disseminating knowledge, experiences, practices and ideas about energy consumption within the family but also between enthusiasts and novices can be a very effective way to make the transition happen. Internet and social networking might be very powerful tools to support collaboration.

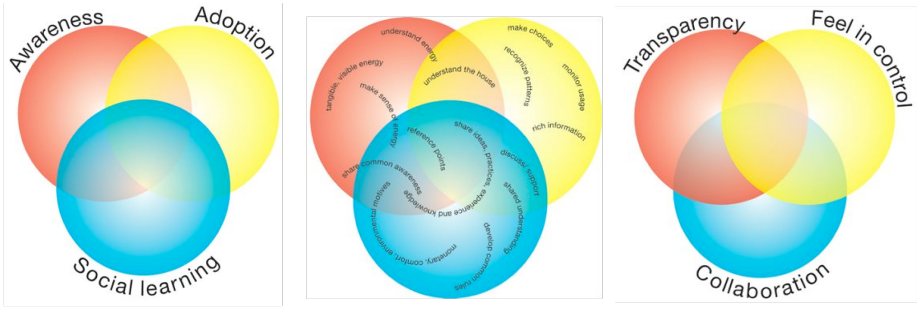

Figure 9: From the initial scope, to the identified needs and wants, and to the final three key insights

7.2 A social approach to energy metering: The EnergyMentor

The use of the design probes, the interviews, the observations and the focus group that were conducted during the study proved very valuable to understand the people; the skills they have, their behavior and attitude towards conserving energy and the problems they face in their daily practices. Although the focus was on changing domestic energy behaviour through feedback and social learning, a broader understanding was gained about the

participants. They have different needs and priorities in their life, which also prescribe their behavior. In the path towards transition some still are in the beginning, some in the middle and some have reached quite far. Hence, we should not talk about pro-environmental behaviours as this suggests that there are people with conscious behaviours against the environment, which is unreasonable. On the contrary, there are just different people in different phases of learning and changing, as Lewin suggests in the Change model (Figure 10).

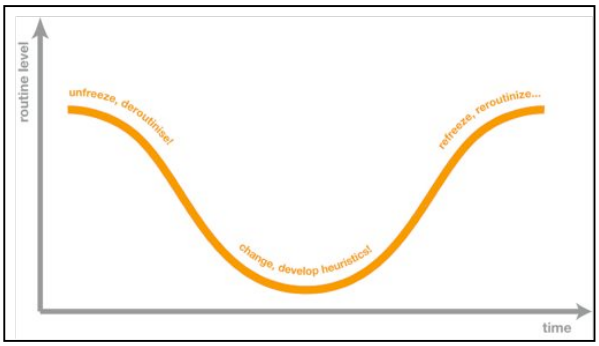

Figure 10: Unfreezing, changing and refreezing practices with time, (Lewin's Model)

Inspired by the findings of the study, three personas were created (Figure 11), each one with different goals and priorities in his/her life that helped to create a common understanding for the people, and move forward to the development of a scenario and concept on how to bring about change on domestic energy consumption.

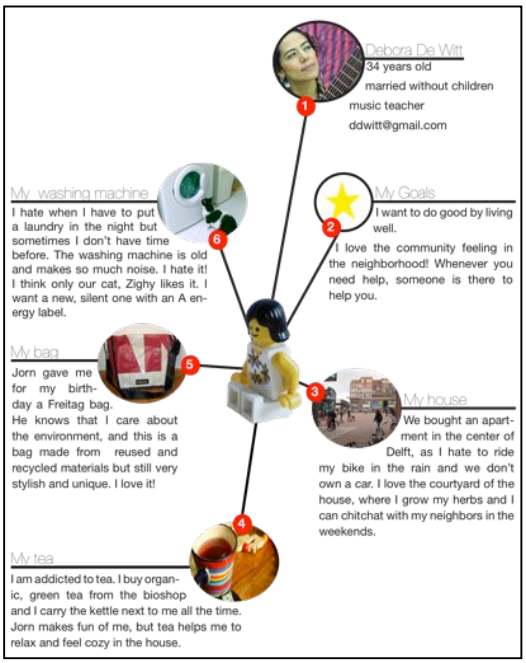

Figure 11: Debora, one of the personas developed during the design phase

The final concept that was developed is the EnergyMentor. The EnergyMentor is social software that brings together people that want to learn or teach alternative ways of conserving energy and minimizing their environmental footprint. The EnergyMentor, complementary to an energy meter, can create great potential to save energy as it transforms the sterile indications of the energy meter into rich suggestions and tangible actions. The EnergyMentor creates a network of experts that can be called upon at a moment's notice to answer questions about energy and sustainable living (Figure 12). By integrating the EnergyMentor in people's existing workflow of using a cell phone or a computer, one can easily and quickly ask questions and get personal, precise answers. Listening to real stories of people that have already taken on the challenge to minimize their energy consumption can be more engaging and fascinating than browsing endless lists on the web. People can text ideas and solutions to each other or even send a video of them, for instance, making home energy improvements. Last but not least, the EnergyMentor offers the opportunity to find other local users who are trying to live a more sustainable lifestyle. This can create great dynamics on a local level; fostering more chances to grow grassroots movements and bottom-up, social innovation schemes.

Figure 12: Debora asks a question to the EnergyMentor, which sends the question to the cloud, screens the potential Mentor-candidates and chooses the one who can answer Debora's question the best.

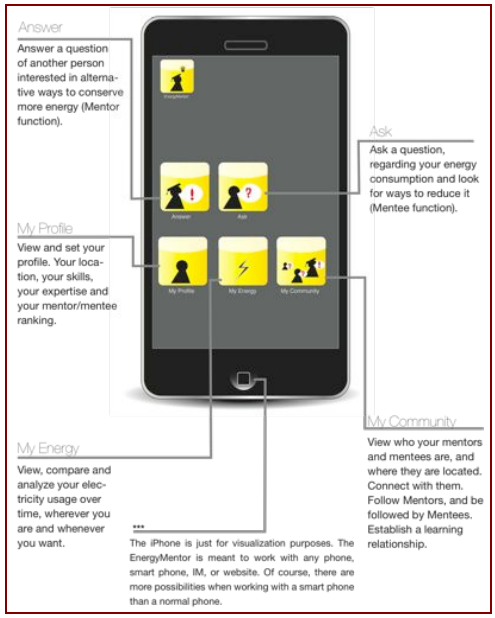

Figure 13: The five key functions of the EnergyMentor

7.3 Shortcomings and limitations

The current study was carried out for the White Rose Foundation, in Delft; hence the recruitment of participants was limited only on citizens of the city of Delft. Both neighborhoods that participated in the study were from the city of Delft. Furthermore, part of the study was carried out during the spring holidays for the Dutch, around Queen's Day (30th of April). This hindered the study to get more results on the section about "social learning", as some of the participants were on holidays and started the study with a delay of some days or a week.

Moreover, for the purposes of the study only one energy-meter was tested, the Wattcher. The Wattcher was the most up-to-date, clip-on, energy meter in the Dutch market; hence it was selected for the purposes of the study. To generalize the results and insights of the study, more energy meters should be tested.

In addition, no quantitative results to compare were gathered during the study. The Wattcher does not store data for more than 7 days, while the participants failed to note down the data of every week.

Last but not least, the EnergyMentor was designed with three archetypes-personas in mind that represent three different types of users. To fully design and develop such a concept a more detailed analysis and research of the different kind of users is needed.

8. Conclusions

To improve the energy efficiency of households we have to deal also with the consumer's behaviour as a significant determinant on the household's environmental impact. In this study we tried to address this issue better by following a participatory approach and applying conventional ethnographic methods such as interviews, observations, probes and focus groups. In particular, the use of design probes helped to look at the user's personal context and perceptions and outline human phenomena and users, as well as introduce the user's perspective to enrich design.

The pilot design study pinpointed the need to bring the consumers closer to their daily practices, give them insights on their effects and help them develop a mental model about energy. The follow up study that probed the participants to interact with an energy-meter and their neighbors-participants for a month, resulted to three key insights for changing energy consumption: Transparency, Feel in Control and Collaboration. The first is well addressed by smart meters, which transform energy from invisible to transparent, raising general awareness to people. However, what do people do, after they get aware of their energy consumption is often overlooked. During the user studies with the energy meter, participants' interest faded after 2-3 weeks. Although they were might still checking the energy meter, they did not find the indications competent enough. What they needed was to feel more powerful and certain about the choices they make and the actions they take to reduce their environmental footprint in daily life. They needed to feel more in control of their energy usage. Furthermore, discussing about their experiences, comparing their energy consumption, sharing knowledge, practices and ideas helped the participants to identify problems and seek for solutions that would improve their domestic energy usage.

Towards this direction the concept of the EnergyMentor was developed to complement the sterile indications of the energy meter with rich stories and suggestions from other people that have already taken the challenge to minimize their energy consumption. In this way, energy meters can have a more lasting effect engaging and fascinating people with new challenges. Therefore, the development of social applications and software that complement the energy meters and become part of the domestic ecology is a direction that needs more investigation from researchers and creativity from designers to design relevant applications that matter to people.

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