Sustainable Behaviour Design: Increasing Efficiency of Thai Urban Household Energy Consumption

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Abstract

To date there have been a number of efforts focusing on education and technology to reduce the environmental and social impact of household energy consumption, while user-focused or the usage side of products and services have generally been neglected. As a result of the instantly continuing growth of energy consumption, it is becoming apparent that neither an educational nor a technological interventions alone can hardly achieve sustainable consumption as knowledge and awareness do not necessarily lead to behavioural change while energy-efficient solutions available continue to be used inefficiently in one way or another whether intentionally or unintentionally. Therefore, the actual energy consumption during the use phase undoubtedly has a significant environmental and social impact. This paper presents how a user-centred design approach was used to understand Thai urban household members, their consumption habits, and their behaviours influencing hidden factors, leading to design strategies for changing their existing behaviours of energy use to more efficient ones. Different behaviour influence strategies applied to lead the users to use energy more efficiently will be illustrated and discussed through conceptual design case studies using contemporary technological solutions. The case studies will be used to exemplify how a user-centred sustainable behaviour design could be implemented for other sustainable needs and contexts.

Keywords: user-centred design, sustainable behaviour, behavioural change, Thai urban household, energy-efficient consumption

1. INTRODUCTION

As a result of global economic growth and development, demands for electricity have increased. Unavoidably, the growth of world electricity consumption has contributed to unsustainable environment, economics and society [Bang et al., 2006; Petersen et al., 2007; UNEP, 2008]. To date there have been growing demands for sustainable electricity use. Many efforts have been implemented worldwide at different levels – policy, business, and individual level – to lower electricity consumption and increase energy efficiency [Lehtonen, 2008; UNEP, 2008]. Many governments and organisations have launched different campaigns seeking to raise public awareness of the issue and to persuade individuals to use electricity more efficiently, for instance to buy energy-efficient household appliances; to turn off electrical devices and lights when not using them; and to avoid using appliance in standby mode [IEA, 2010b; UNEP, 2008]. To reduce the electricity consumption of their products and services during the use phase, many manufacturers have increasingly developed and provided technologically energy-efficient solutions [Lilley et al., 2005; McCalley, 2002; UNEP, 2008] whilst some individuals are trying to take responsibility for their share of consumption. However, after all these efforts, the global electricity consumption still continues to raise [UNEP, 2008]. During the last 35 years, the world electricity consumption has doubled [IEA, 2009]. In 2007, electricity usage in residential sector was about 27 per cent of the world total consumption [IEA, 2010a]. The situation of electricity consumption in Thailand during the last two decade is no different, with more than three-time increase of which 22 per cent were from household usage [EPPO, 2009].

Apparently, neither an educational nor a technological interventions alone can hardly achieve sustainable consumption [Designing in, 2008]. Acknowledging the consequence of own unsustainable consumption seems to be insufficient for behavioural change [DEFRA , 2005; O'Keefe and Shepard, 2002; Tang and Bhamra, 2009] as many studies indicate that knowledge and awareness do not necessarily lead to sustainable behaviours [Jensen, 2008; Pettersen and Boks, 2008;]. One good example is a study about lifestyle, dwelling and consumption in Denmark. The study has shown that many families knew that their standby consumption consumed electricity. Nevertheless, they still did not turn off their electrical appliances when not using them [Lilley et al., 2005]. It also becomes clear that a success of technology-oriented solutions in reducing household energy consumption depends greatly on how they are actually used. Possessing energy-efficient appliances is not always equal to electricity consumption reduction as the energy-efficient solutions available continue to be used inefficiently in one way or another [Jensen, 2008; McCalley and Midden, 2002; Pettersen and Boks, 2008; Tang and Bhamra, 2009; Wever, R. et al., 2008]; a salient example being an energy-saving appliance that has been left on day and night whether intentionally or unintentionally [Lilley et al., 2005; Lockton and Harrison, 2009; Lockton et al., 2009].

To date the use phase of products and services has often gained a little attention [Rodríguez and Boks, 2005]. Although this phase of life cycle where the greatest impact on sustainable consumption usually occurs is likely to offer significant improvement [Designing in, 2008]. As actual electricity consumption is significantly determined by consumption behaviours during the use phase [Designing in, 2008; Lilley et al., 2005; Lockton et al., 2008; McCalley and Midden, 2002], therefore, designing user-focused products or services influencing sustainable behaviours is undoubtedly a compliment to education- and technology-led solutions towards energy-efficient consumption [Lilley et al., 2005; Pettersen and Boks, 2008; Wever, R. et al., 2008]. To ensure the behavioural change towards sustainable consumption, a better understanding of users, their consumption habits, as well as hidden factors influencing their behaviours is essential for designing sustainable solutions for changing existing consumption behaviours towards more efficient ones. [Designing in, 2008; Tang and Bhamra, 2009]. Therefore, it is suggested that user study can be done first when designing solutions to reduce environmental impact during the use phase [Rodríguez and Boks, 2005; Tang and Bhamra, 2009].

User-centred design is a design approach that focuses on the usage side of products and services – places people who will use the designed solution at the centre of the design process to increase the likelihood that the design solution will be usable, satisfying, and desirable for the users and that will likely lead to the acceptance and success of the design [Lehtonen, 2008]. Recently, user-centred approach has started gaining attention in many studies for sustainable behaviours design [Bang et al., 2006; Lehtonen, 2008; Lehtonen, 2009; Lilley et al., 2005; Lilley, 2009; Lockton and Harrison, 2009; Lockton et al., 2009; McCalley and Midden, 2002; Petersen et al., 2007; Pettersen and Boks, 2008; Tang and Bhamra,2009; Wever, R. et al., 2008; Wood and Newborough, 2007]. Studies shows that the failure of many efforts towards energy-efficient consumption was often a result of poorly understanding of the

usage side of products and services. Substantial environmental choices made by users are not because of environmental benefit [Lilley et al., 2005], but rather because of other personal benefits like usability, comfort, practicality, convenience, economy, and cleanliness [Jensen, 2008; Wever et al., 2008]. Applying these insightful findings derived from the user understanding to sustainable behaviour design is potentially assure user behavioural change. However, cultural differences may make it difficult to apply an effective behavioural change solution in one culture to another [Pettersen and Boks, 2008].

This paper presents how a user-centred design approach was used to understand Thai urban household members, their consumption habits, and their behaviours influencing hidden factors, leading to design strategies for changing their existing behaviours of energy use to more efficient ones. Different behaviour influence strategies applied to lead the users to use energy more efficiently will be illustrated and discussed through conceptual design case studies using contemporary technological solutions. These case studies were undertaken by undergraduate industrial design students at School of Architecture and Design, King Mongkut's University of Technology Thonburi in 2008 as their "Go Green" studio project seeking to reduce electricity consumption in Thai urban households. Without any particular design strategies of behavioural change in mind, a user-centred approach was used throughout the project – user understanding, concept generation, and design development – to lead to appropriate design solutions for influencing user behviours towards more efficient electricity consumption. In this paper, the case studies will not used to specify the best solution for sustainable electricity consumption since effectiveness of design solution depends on a specific product or service and its context [Pettersen and Boks, 2008; Wever et al., 2008]. Rather the case studies will be used to exemplify how a user-centred sustainable behaviour design could be implemented for other sustainable needs and contexts.

2. METHODOLOGY

2.1 User Understanding

At the beginning of the studio, the students were given a project brief – designing a user-centred solution for influencing user behaviours to lower energy consumption in Thai urban households. After that, they were divided into groups to work on different types of Thai urban households including single house, townhouse and row-house, condominuim, and dormitory. The aim was to expose the students to different user groups and use contexts. Each group was asked to conduct user study using different user-centred methods – observation, think aloud, contextual inquiry, and other appropriate methods – aimed to gain better understanding of actual electricity consumption in own specific household type as well as real user behaviours, experiences, needs, desires, and their behaviours influencing hidden factors related to electricity consumption in actual use context. In addition to the user study, the students were required to do literature research to gain background knowledge of Thai urban household lifestyle; electricity consumption situation in Thailand; existing educational, technological, and user-centred efforts to reduce electricity consumption; technological possibilities; as well as the correct ways to use electricity efficiently. After that, the collected data was analysed qualitatively in a meaningful way and then translated into useful design insights that could be used for designing effective solutions for changing user behaviours towards sustainable electricity consumption [Rodríguez and Boks, 2005].

Based on the qualitative data analysis, insightful issues that should be concerned when designing for better efficiency of Thai urban household energy consumption were derived. Most of the participants have acknowledged the environmental impacts especially global warming cased by human activities. However, it does not have any significant effects on their behaviours. They are unaware of how much their electricity consumption contributes to the current crisis and how much their little efforts could make a difference. This can be because the information received from educational interventions usually focuses on a macro scale which is difficult for many people to relate to emotionally and practically [Lilley, 2005]. Furthermore, the majority whom can be seen as being *pro-self* feel that electricity usage is a privilege of their quality of modern life and are not willing to change their behaviours towards pro-environmental lifestyle just in favour of environmental benefits. This finding is supported by many antecedent studies conducted in Thailand [Lehtonen, 2009] and elsewhere [McCalley and Midden, 2002; Rodríguez and Boks, 2005]. On the contrary, they are more willing to act towards sustainable lifestyle for their own personal benefits like monetary incentive, convenience, comfort, safety, and other quality of life. As a result of this mindset, an advantage of personal benefits over self-sacrifice is generally used as the basis for their decision to act towards sustainable electricity consumption. According to theses findings, apparently to effectively increase efficiency of Thai urban household electricity consumption, the design solutions should be very persuasive or changed to match user lifestyle, needs, and requirement, not the other way round.

2.2 Concept generation and design development

During this phase, each student worked individually on concept generation and design development. The discovered insights from the user study analysis were used as design drivers to generate several design alternatives. After that, all alternatives were communicated and evaluated by the real users to get their feedback for selecting the most promising design solution. Different evaluation methods ranging from in-depth interview, scenario testing, behaviour prototyping, to usability testing were used for validating the design according to their appropriateness. Then the selected solution was developed and evaluated by the users several times to ensure that the design solution could successfully change user behaviours of electricity use to more sustainable ones since it was difficult to predict how the solution would actually influence user behaviours and how it would be accepted by the users.

The design outcomes of this project were entirely driven by users. A role of the author and colleagues in the project was only to supervise as well as give advice and comment when needed. Nevertheless all design outcomes were only conceptual design. They were only tested with the users in terms of acceptability and possibility that is likely to lead the users towards sustainable behaviours. Unfortunately, the actual effectiveness of each design solution in increasing electricity consumption efficiency was not validated as it was not in the scope of this studio project.

3. RESULTS AND DISCUSSION

3.1 Solutions for increasing energy efficiency of Thai urban households

As a result of user-centred approach, a wide range of promising design concepts for household electricity conservation were proposed ranging from *edutainment* – nurturing the right attitude and knowledge towards energy conservation, *eco-feedback* – informing the consequence of the action to persuade energy-efficient behaviours, *no compromise* – maintaining the user lifestyle and easing the troublesomeness of energy conservation, to *by-product* – conserving electricity as an unintended result of achieving other purposes.

The *edutainment* concepts use entertainment and social community as tools to raise users' awareness and nurture their attitude of energy consumption, as well as to educate them energy conservation practices through games and applications on mobile phones and the Internet. The *eco-feedback* concepts give users feedback of their energy consumption as well as inform them the benefits of their energy conservation efforts to persuade the users to change towards more energy-efficient consumption, for example through warning light and sound, real-time metres, and consumption data comparison display. The *no compromise* concepts make energy conservation to be more convenient and feasible for the users without compromising their lifestyle, for instance central remote controls, central switches, a central control panels, and smart systems to perform energy-efficient actions on behalf of the users. When using the *by-product* concepts – smart controllers controlling household appliances and using the most energy-efficient modes at the same time – to fulfill other needs, for instance better indoor air quality, unintentionally the users also save electricity.

Most of the design solutions developed by the students are rather realistic and can be implemented in the short term. They only require little development in terms of technology, engineering, marketability, and their effective influence on user actual electricity consumption. Several concepts can be put into practice right a way as they require only today technology and need no change of any today household infrastructure while others requiring more radical change of household infrastructure can be potentially implemented to new-built or renovated houses and buildings. Following are two examples of the design outcomes developed within the "Go Green" studio project to influence household energy-efficient behaviours in Thai urban context:

3.2 'ovvl eco'
designed by Pannavichaya Somnuk

The research results show that the majority of Thai urbanists know that today we are threatened by environmental problems caused by our unsustainable activities. However, many feel that their daily activities such as using electricity contribute very little to the current crisis comparing to the industries who employ a lot of natural resources and create an enormous amount of pollution. They think that they have not done anything wrong since they have paid for the electricity that they use. Therefore, they should be not blame for and do not have to change their lives. Besides, they value things like convenience, comfort, enjoyment, and safety as their quality of modern lifestyle so they are not willing to compromise on their quality of life just for the sake of the environment. Although, when it is a matter of their personal benefits like reducing their electricity bill, many have tried to save energy by turning off the lights and appliances when not using them as well as using energy-efficient appliances. While trying to save electricity – save their household expenses – it seems that many are unaware of the *vampire power*. Similar to the study conducted in the Netherlands in 2005 [Rodríguez and Boks, 2005] several electrical appliances such as audio and video equipment, kitchen appliances, and office appliances are usually left unplug or on standby when not being used. The similar phenomenon was found in a study done in Thailand in 2004 by Sowantip, Nittaramorn and Noppakoon [Lehtonen, 2008] and another study done in Denmark in 2002 [Jensen, 2008]. Apparently, this can be because of their lack of knowledge of vampire power's consequences; their perception of vampire power as being insignificant for bothering to make any effort; their laziness, inconvenience, and difficulty of constantly plugging and unplugging all the appliances; or their forgetfulness.

Based on the insightful findings similar to what Tang and Bhamra found in their study in the UK [Tang and Bhamra, 2009], most of Thai people are not willing to put any extra efforts to save energy when their direct saving benefits are insignificant comparing to what they have to sacrifice. Therefore, 'ovvl eco' was designed to encourage the users to eliminate *vampire power* by providing them a trouble-less, effortless, and at the same time beneficial solution. 'ovvl eco' consists of wall-mounted sockets and controlling switches for the sockets. To prevent *vampire power* when not using the appliances, the users simply plug their appliances into the 'ovvl eco' wall sockets then they can select a suitable provided digital icon in the 'ovvl eco' controlling switches mounted on the accessible wall to mark each switch for specific appliance. This is to ensure that they will turn on and off the right appliance without any confusion. After that, they can conveniently power off unused appliances with the 'ovvl eco' controlling switches, instead of crawling on the floor trying to pull multiple power cords out of the sockets behind their furniture or bending over trying to turn off multiple switches. Additionally, there are also 'ovvl eco' wall-mounted lighting switches come with the set. When turning off the add-on lighting switches, the controlling switches will assume that the user is leaving the room and will remind the user to turn off their appliances by blinking for about 10 second which is enough to get the user's attention but not annoying the user. Furthermore, the add-on lighting switches also create the united look of all the switches in the room.

Similar to the blind mode on televisions proposed by Rodríguez and Boks [Rodríguez and Boks, 2005; Wever et al., 2008] and the suggested re-design of refrigerator and freezer interior arrangement by Tang and Bhamra [Tang and Bhamra, 2009] aimed to facilitate user lifestyle while at the same time reduce household energy consumption, 'ovvl eco' assists the users to prevent wasteful *vampire power* effectively with less efforts and troubles. The *preserving quality of life* approach – changing the design of products and services to match how they are actually used by the users to assure acceptability and the intended user behaviours – used for designing 'ovvl eco' is somewhat resemble *functionality-matching* [Wever et al., 2008] and *conveyor belts* [Lockton et al., 2010].

There have been several products launched to the market aiming to reduce the *vampire power.* Most of them do not require any infrastructure change so they can be simply plugged to the existing sockets. On the other hand, 'ovvl eco' sockets and switches operating wirelessly, do not require any major electrical renovation but still need to be installed to replace the normal sockets and switches. In this case, the user has to make a tradeoff between convenience and aesthetics. The most common product on the market is a switchable multiple socket which allows users to cut off the *vampire power* by turning off a switch on the multiple socket, instead of unplugging or switching off the unused appliance. Another product is also a switchable multiple socket with a remote control allowing users to cut off the *vampire power* of the unused appliance remotely. More technologically advanced solutions are also available in the market including a product that turns the *vampire power* off automatically when the connected appliance goes into standby; a product that senses when a specific product like a computer shuts down, and then correspondingly turns off the *vampire power* of other products such as a printer and an external hard drive used with the computer; as well as a totally automated system consisting of sensors, switches, and controllers for handling complex sensing and switching. While most of the available products focus on performing tasks on the user's behalf to provide the user a carefree energy-saving solution – *force-functionality* [Wever et al., 2008], *intelligent* [Lilley et al., 2005], *context-based* [Lockton et al., 2008]; 'ovvl eco', a low-tech switchable multiple socket, and 'Plug it off' design by Sowantip, Nittaramorn and Noppakoon [Lehtonen, 2008] try to make energy-saving more convenient and feasible but still leave a decision of turning on and off the appliance to be made by the user. There has been a

discussion about the utility of automation and manual. Undeniably, it sounds desirable and convenient that when we turn off a computer or a television, a smart socket will take care of turning off all the appliances related to the computer or the television for us. Let's imagine what we will feel when we turn off the computer or the television and the smart socket intelligently turns off other accessaries for us but we still want to copy something with an all-in-one printer or listen to the music with a multifunctional DVD player. Apparently, automation being seen as convenient and trouble-less in many cases, can be seen as annoying and frustrating. Similarly, manual being seen as inconvenient and troublesome in some cases, can be seen as controllable and empowering. Petersen et al. debated whether resource conservation by automation is more effective than by humans. While *smart* building can maximise resource conservation by taking charge of the conservation decision making, at the same time it also takes away the opportunity for humans to care for and do more for the environment [Petersen et al., 2007].

3.3 'log-it'
designed by Prin Tanapaisankit

Based on the research insights, young Thai family members, age about 15-35 years old usually stay with their family and spend most of their time in their private bedroom listening to the music, playing computer games, and surfing the Internet. Since their household monthly electricity bill is usually taken care by the mother, most of young family members do not tend to relate their activities to energy consumption. The unawareness of own energy consumption then usually lead them to carelessness of energy use. This wasteful habit is not totally a result of their negligence of how important energy conservation is but partially because of their underestimation of the consequences of their energy consumption. The same mismatch was also found in a study of designing 'PowerHouse', a persuasive computer game to raise teenagers' awareness of domestic energy consumption by Bang, Torstensson, and Katzeff [Bang et al., 2006] and in a pilot study of reducing electricity consumption of dormitory with computer-based real-time socially comparative feedback and incentives by Petersen et al. [Petersen et al., 2007].

As a result of these finding, 'log-it' was designed to increase young family members interest in energy consumption related issues and to motivate them to use electricity more efficiently by probing the users' personal electricity consumption such as in own bedroom, informing how much electricity they have consumed, providing them tips how they can save electricity, and showing them how much they can save electricity as an individual as well as a group. It is a small device accompanied by an online computer application helping to keep track of user energy-consuming activities by recording details of each electrical appliance, time, duration of use, etc. Attached to a socket or the plug on an appliance, the device will transfer the information to the database through a wireless connection in real time. Then in 'log-it' social networking website on the Internet, the user can view the transferred data in his page which can be also accessed by other users added in his network, and compared with the other users' energy consumption. By using 'log-it' through social networking, it is not only expected to trigger individual sustainable behaviours, but also to function as a tool to establish a green community and widespread sustainable habits through the Internet. A similar idea was also used to design 'Green Memes', an online social network where people can visualise their personal energy consumption and compare it to others' [Mazé and Redström, 2008].

Similar to the pilot study conducted by Petersen et al. [Petersen et al., 2007] and 'Energy Meter Relay' campaign aimed to stimulate energy-efficient consumption in Dutch households [Wever et al., 2008], 'log-it' employs real-time actual *eco-feedback* – providing the user with information on the impact of own behaviours to direct the user to take action towards pro-environmental behaviours [Lilley et al., 2005] – to encourage energy conservation – while the 'PowerHouse' uses virtual *eco-feedback* [Bang et al., 2006]. Several studies conclude that immediate feedback of energy consumption can enable residents to lower their energy consumption [McCalley and Midden, 2002; Petersen at el., 2007, Wever et al., 2008]. However, this strategy is rather similar to educational-led interventions as information alone may not be sufficient to lead to desirable action [Lilley et al., 2005].

To increase possibility of user behavioural change, 'log-it' uses online social networking – one of the most popular activities on the Internet – as a *persuasive* agent by persuading its users to express themselves through their electricity-efficient consumption, and allowing them to receive feedback from their virtual community as most of young generation tend to favour these social networking activities. 'Green Memes' also uses social networking with the same belief that sustainable behaviours can start with individual and grow in society though the socioshere [Mazé and Redström, 2008]. Moreover, to assure the sustainable behaviours, 'log-it' also employs other strategies including *surveillance* and *operant conditioning.*

The *surveillance* strategy – own energy consumption data can be monitored online by everyone in the same network – is used in 'log-it' to stimulate the users to lower their electricity consumption. The *mere presence of others* – the presence of other people, in this case being monitored online – can influence a person to act towards desirable behaviours [King and Tester, 1999]. *Operant conditioning* – favourable and unfavourable external stimuli – well-known for its positive reinforcements to alter one's behaviour especially children's [Shaffer, 1999] is widely used in computer games, for example accumulated points, level progressions, high score lists, and game comparison [Bang et al., 2006]. Showing the users a comparison between own energy consumption and others' used in 'log-it', 'Green Memes', and the pilot study by Petersen et al. can be seen as the *conditioning* which can cause the users to change own energy consumption [Lockton et al., 2008]. The *social proof* – approval or disapproval of the user behaviours from the peer group – is one a the key to the success of behavioural change [Lockton et al., 2008]. Rewarding, another way of *conditioning* is claimed to be a very powerful approach [Shaffer, 1999; Wood and Newborough, 2006]. 'PowerHouse' rewards proper actions in the game with virtual money used to buy different artifacts and services [Bang et al., 2006] while 'log-it' rewards desirable actions in practice with virtual money which can be used to buy different virtual products for placing to 'My Room' in the user's own page or can be converted to real money for donation. Besides the virtual rewards, *social commendation* is used in 'log-it' as emotional rewards to create joyful experience about being pro-environmental active when seeing own progress towards energy conservation [Wood and Newborough, 2006], and to create a guilty feeling when knowing own excessive energy consumption [Wood and Newborough, 2006]. Successful result of the pilot study conducted by Petersen et al. is a good evidence of the effectiveness of the *social commendation* [Petersen et al., 2007].

3.4 Conclussion
This paper presents how user-centred approach could lead to promising design solutions for influencing household sustainable behaviours. As cultural difference makes it impossible to apply sustainable behaviour design strategies or solutions successful

elsewhere directly to another context. Two case studies using today technology, 'ovvl eco' and 'log-it' illustrate that understanding the user can be the first powerful step to develop a design solution that is desirable and acceptable for the users and at the same time effective for changing user behaviours towards sustainable consumption. As energy-efficiency of a product or a service depends on how it is used by the users. An energy-efficient solution can become useless if no one uses it, or can even become energy-consuming if it is used inefficiently. It becomes apparent that neither a technology-oriented effort nor a design-oriented effort alone can hardly achieve sustainability. Instead, both need to work hand in hand to develop an effective and efficient solution for sustainable consumption.

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