Motivating Sustainable Energy Consumption in the Home

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ABSTRACT
Technologies are just now being developed that encourage sustainable energy usage in the home. One approach is to give home residents feedback of their energy consumption, typically presented using a computer visualization. The expectation is that this feedback will motivate home residents to change their energy behaviors in positive ways. Yet little attention has been paid to what exactly motivates such behavioral change. This paper provides a brief overview of theories in psychology and social psychology on what does, and does not motivate sustainable energy action in the home.

Author Keywords
Sustainable living, energy consumption, behavior change.

Introduction

The 1960s heralded an increasing trend in world energy consumption, with oil, coal, and gas, as the leading sources of energy usage respectively [4]. As such, significant, long-lasting consequences to the environment due to human impact have now become alarmingly apparent. These include global warming and the climate changes it induces, poor air quality, depletion of fossil fuel reserves, and the disruption and damage of remote ecosystems [8]. Developed countries are the world's largest primary energy users per capita per annum [4], where over-consumption has become the norm.

The need to move towards a more sustainable lifestyle has been recognized by many. In the home context, there is an ongoing focus on creating energy-efficient homes and appliances. However, household residents do not necessarily use them in energy-efficient ways [1]. Thus, though creating energy-efficient technology is the first necessary and important step towards sustainable living, it is only a partial solution [16]. The next step should focus on changing peoples' energy consumption behaviors immediately, durably, and for the long-term [6].

To this end, we are exploring how technology can be designed and employed in the home to encourage sustainable energy usage by its inhabitants. The problem is that household residents currently lack a good understanding or awareness of the link between their home energy use and their monetary or environmental consequences. This lack of understanding is a significant contributor to over-consumption and inefficient energy use. One approach to this problem is to provide residents with feedback of their energy consumption behaviors. Specifically, our long-term goal is to develop and deploy computer visualizations that not only provide residents with real-time, continuous feedback, but that demonstrably changes their consumptive behaviors in a positive way.

While there is other work in this area, most current systems are variations that display the current energy use at the moment and/or over time. They assume that knowing this usage will suffice to motivate the home resident into a significant behavioral change. This is not necessarily the case. Changing consumption behavior is a psychologically, socially and culturally complex problem, requiring drastic changes in how people think about and use energy [16]. If we are to truly motivate behavior change through our technologies, we first need to understand what motivates people. Fortunately, there is a rich literature on motivation theories. The purpose of this paper is to provide a brief overview of these theories, with a focus on what does and does not motivate sustainable energy action.

Simplistic models of human environmental behavior

A reasonable assumption for the design of home technologies for sustainable energy action is that behavioral change will come if the technology shows the actual cost of energy usage, or, if the design reinforces certain attitudes. These assumptions are not necessarily true.

In the past, there have been two central models to explain human behavior in regards to the environment: the rational-economic model and the attitude model. The *rational-economic model* assumes that humans will make pro-environmental decisions based on economically-rational decisions [16]. This model fails in that it does not consider situational factors such as convenience, personal comfort, and other preferences that override the logical rationalizations that are motivated by monetary cost [18]. In addition, it may take decades before prices become so high that people base their decisions solely on cost; even when this is the case, there will still be some who are able to afford (or rationalize) the cost.

The *attitude model* assumes that pro-environmental behavior will automatically follow from favorable attitudes towards the environment [16]. However, there is rarely a strong, direct, or consistent relationship between pro-environmental attitudes and people's subsequent actions. Similar to the rational-economic model, the attitude model

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fails to consider that peoples' actions are influenced by factors other than their attitudes towards the environment, such as situational circumstances, social and cultural contexts, government regulations, to name a few. Even with pro-environmental attitudes, people do not necessarily know which steps are needed to act upon those attitudes.

Basic techniques to motivate sustainable energy action

We now turn to finer-grained techniques that can be used, or combined to motivate sustainable energy action.

Behavior change techniques encompass a wide variety of methods. Two of the most commonly used methods are persuasive prompts and material incentives [6]. Persuasive prompts are relatively successful in the beginning, though they decrease in reliability as their novelty declines. Material incentives, such as rewarding actions with money or material goods, are successful in quickly changing behavior, though their removal likewise immediately terminates behavior [1]. Though there are many more methods, the following focuses on three specific categorizations of behavior change techniques. All have strengths and weaknesses.

Information techniques provide information to the existence of a problem, and the necessary steps to solve the problem [6, 16]. It assumes that people wish to act, but do not know how. Information techniques are generally only successful if people already hold a specific goal to act sustainably based on the information. Yet, information alone does not always motivate, as it does not consider other psychological, social and cultural factors.

Positive motivational techniques use methods of extrinsic motivation such as monetary or social reinforcement to make a behavior seem more appealing [6]. An example of monetary reinforcement is beverage can buy-back centers. Social reinforcement includes social recognition or support, for instance, by socially recognizing the "super-conservers" or "energy stars" of a neighborhood. When positive motivational reinforcement stops, so does behavior. However, positive motivational techniques have a high likelihood of helping individuals discover intrinsic motivations for performing energy actions.

Coercive motivational techniques compel action by greatly constraining an individual's choice both physically or perceptually [6]. This can be achieved through force, fear, intimidation, punishment or threats. Coercive techniques generally should be avoided or used with caution. When one's choice and freedom is greatly constrained, it may provoke people to creatively misbehave to the set rules. However, fear campaigns can be successful in certain cases when they provide people with specific actions to reduce the imposed threat [16].

Psychological concepts

Several psychological theories have implications for design when considered in the context of motivating sustainable energy usage.

Cognitive dissonance is an uncomfortable state that occurs when a person holds two cognitions that are psychologically inconsistent [9], typically an inconsistency between an attitude and the corresponding behavior [16]. Once cognitive dissonance is aroused, an individual is motivated to reduce the uncomfortable feeling, either through a change in attitude or a change in the corresponding behavior. Cognitive dissonance can be used to motivate sustainable energy action by reminding people of the inconsistency between their attitude and their behavior, and encouraging a change towards sustainable behavior.

Utility theory proposes that different people hold different utilities or values. Therefore, successfully motivating someone requires that you motivate them by their personal utility [10]. For example, when deciding the mode of transportation to go to work, a person holding a high utility to be environmentally conscious may be motivated by a different utility than a money-conscious university student.

Psychological, social & cultural functions of energy use

In addition to the basic needs of energy (e.g., heating, light, etc.), people use energy for a variety of psychological, social and cultural functions [16]. As such, different people are motivated by different things. Therefore, a successful campaign in motivating sustainable energy action must develop a *range* of strategies, in order to account for the complexity of reasons of how and why people use energy.

Psychologically, people may use energy to gain feelings of self-esteem [16, 18]. For example, people who grew up in poverty may associate saving energy with a negative connotation such as being poor, or "freezing in the dark". As such, these people may be more receptive to phrases such as "energy star" or "energy efficiency", rather than "energy conservation". Socially, people may use energy for the function of social status or respect as perceived from their peers [16]. An example is purchasing the latest hybrid vehicle for gaining social status, rather than for fuel efficiency. Finally, the customs and habits of a culture can determine how energy is used. For example, the daily bathing routine of the Japanese have deep cultural roots, but are very energy intensive. Even with higher energy prices, this cultural routine will likely still persist [17].

Presenting information about sustainable energy action

There are several known guidelines in how to present information so that it is a more effective motivator.

1. People are more motivated to act when presented with vivid and personalized information [16, 18].
2. When framing information, people respond more seriously to monetary loss than to gain. Specifically, people are more willing to take an energy action to

avoid monetary loss, than to take the same action for monetary gain [16, 18].

3. People have trouble integrating complex information [16] from a variety of different sources, where they often simplify calculations leading to an erroneous solution [18]. Thus, when presenting energy information, one should integrate complex energy variables, such as thermal characteristics of a home, impact of climate and weather, projected energy prices, tax credits, etc. – into a form that helps individuals make the correct and informed energy decision [16].
4. When information is presented in a way that provides individuals with choice, it increases the individual's sense of personal control [15]. This leads to increased levels of intrinsic motivation, greater persistence, better performance and high satisfaction[12].

Influences of social interaction

There are several influences of social interaction that have implications when designing technology to motivate sustainable energy usage.

The concept of *adaptive muddling* occurs when people are encouraged to play a role in bringing about change, by encouraging them to apply local or personal knowledge to a situation [6]. When this happens, people are much more inclined to act, as they perceive a role for themselves and sense that their contribution is not only optional but a necessity.

Next (and related to adaptive muddling) is encouraging household residents to *teach others* about their energy knowledge and experiences [6]. Teaching allows the teacher to better understand their own energy actions. Also, the very act of teaching sustainable energy actions invokes cognitive dissonance: the teacher feels they hold a pro-environmental attitude and therefore, must also engage in consistent pro-environmental behaviors.

Third, the concept of *social diffusion* refers to when people follow the modeled behavior or the successful examples of others [18]. Specifically, when people see others who have successfully adopted a new energy action or innovation, they are more likely to accept and try it themselves [18].

Finally, the concept of *social competition* can have positive effects on performance due to feelings of social comparison or social pressure [1]. For example, a social competition for the person who consumes the least amount of energy can be invoked within members of one household, or between households. However, social competition can have negative impacts on intrinsic motivation when people compete for the sole purpose of winning [7].

Social value orientation

Social value orientations are useful in predicting helping behavior in regards to the environment [5]. There are two types of social value orientations. Individuals with *pro-social orientations* consistently seek to maximize joint outcomes of other people, making choices that benefit the common good. In contrast, people with *pro-self orientations* tend to have higher perceptions of personal costs, and thus choose outcomes that suit their own needs. As the majority of the population are pro-self individuals, sustainable energy action campaigns should primarily target this majority by presenting sustainable energy actions that minimize the personal cost for individuals, rather than maximizing the benefit for the common good. However, within a family, pro-social orientations may be invoked if individual family members are made aware of their energy impact to the home as a whole.

Self-reflection and intrinsic motivation

In order to move towards sustainable lifestyles, peoples' consumption behavior must change for the long-term [6]. Current work fails in this area, as the use of persuasive techniques are forms of extrinsic motivation, and when stopped, so does the desired behavior. One area that has been relatively unexplored is the concept of self-reflection to induce intrinsic motivations for living sustainably. Reflection is the process of turning experience into learning [3]. The stages of reflection include a self-awareness of uncomfortable feelings and thoughts, a critical analysis of the existing situation and knowledge, a synthesis of new information with the old, and finally a perspective transformation where the final outcome is learning [2]. Journal-writing, or keeping a history of energy usage events, can be used to enhance reflective practice [3].

Moving into the home context

Using the motivational strategies described above, we illustrate why current methods of visualizing power consumption are poor motivators of behavior change.

Consider monthly utility bills, which are currently the only way that most households receive feedback of energy use. This feedback is ineffective at motivating sustainable energy consumption changes; at best, it assumes a rational-economic model. It is not accompanied by behavioral change techniques (such as persuasive messages), nor does it provide information as to the existence of a problem or the steps to solve them. Because they come 'after the fact' once at the end of the month, residents cannot explore the link between energy actions with their consequences. Also, energy use is presented in isolation, discounting the psychological, social and cultural reasons for energy usage. Finally, the information presentation is too general: household residents cannot know who in the family or what specific actions contributed to energy over-use or conservation, and with what monetary or environmental consequences.

A new generation of devices is now appearing that seeks to improve on the electric utility bill. From the commercial sector, devices can monitor the total energy consumption of a home (the Cent-a-Meter, Power Cost Monitor, Energy Detective), or a group of appliances at the plug-outlet (the

Kill-A-Watt, Watts Up Pro). Information displayed includes real-time feedback and history of energy usage, actual and projected monetary cost, amount of CO_2 emissions, units of electricity consumption (volts, amps, kilowatt hours), and alarms that sound when energy exceeds the expected usage. Unfortunately, almost all devices present this information using small LCD displays to show specific values either numerically or in bar or line graphs. Though these devices provide more awareness of energy information than a monthly bill, the data presentation does not use any of the motivational techniques mentioned above. In contrast, works from the research sector are generally physical devices that visualize an approximation of a single appliance's energy consumption. For example, the Power-Aware Cord is a common electrical cord that visualizes the amount of electricity it is consuming by varying pulses, flow, and intensities of light through the use of electroluminescent wires[11]. While the designs of these devices do incorporate some persuasive techniques, their usage is relatively rudimentary. In all the above systems, the data itself holds persuasive power or the potential for critical reflection, but it is really up to the home resident to take this step. Finally, all works assume a goal to reduce consumption, though this is not necessarily the case. As such, feedback without a goal has the same effect as no feedback itself [14].

Conclusion

We briefly summarized critical motivational factors that can encourage home residents to change their energy consumption behaviors. The next step is to design actual feedback visualizations of energy use based on a combination of the motivational methods mentioned above. For example, pro-social orientation can be encouraged through an ambient display located in a public area of the home that shows how each family member contributes to the overall home energy use, where social recognition is awarded for energy-efficient behavior. The actual information can be shown in multiple ways, each corresponding to differing utilities or values held by particular family members. Self-reflection can be encouraged by letting family members annotate a visualization containing a history of their energy consumption data, where annotating acts as journal-keeping. These are only some of the many visualization ideas that can be produced around the combination of motivational techniques.

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