

Improving long-term Persuasion for Energy Consumption Behavior: User-centered Development of an Ambient Persuasive Display for private Households

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Abstract. This doctoral research examines how residents, while monitoring forecast and feedback, use ambient persuasive technology to address behavior change regarding energy consumption. The most needed information is not presented in the context when interacting with the home appliances. Therefore, the monitoring lacks a direct and tangible link to the consumers' behavior. Current mechanisms frequently also have shortcomings with regard to long-term effectiveness, as initial results tend to wear off once the novelty effect is over. To accomplish this, requirement studies for the design of the persuasive ambient display and a long-term in-situ study and completed reflection workshops after the period of six months have been set up. Various online surveys and have analyzed the data about the visual cues, i.e., the forecast and feedback modalities have been conducted. The results of the research will inform the design researcher, the community of persuasive technology, and the psychology.

Keywords: Ambient Persuasive Display, Long-term Household Study, Energy Behavior Change.

1 Research Motivation

Research has shown that detailed feedback on domestic energy consumption can substantially contribute to achieve durable effects on energy savings in private households, e.g. [2], [4], [17], [18]. However, existing solutions such as regular energy bills or conventional home energy displays provide untimely feedback or in a way that is difficult to understand. It requires the user to make mental efforts to translate the available information into appropriate actions. Furthermore, the information is not presented in the context where it is needed most (i.e., when interacting with the home appliances). Therefore, the feedback lacks a direct and tangible link to the consumers' behavior. Current mechanisms frequently also have shortcomings concerning long-term effectiveness, as initial results tend to wear off once the novelty effect is over. The PhD thesis, therefore, aims at improving the communication of energy forecast and feedback by seamlessly integrating it in the environment of the user and providing it where and when it is most useful and efficient. Such an integration of a monitoring tool could increase the comfort of the

users, as no abstract translation and explicit attention towards achieving the goals is needed. Moreover, positive effects on the sustainability of behavior change are expected. The concept of behavior change through support of technology and appropriate interfaces can also be referred to as persuasive technology.

2 Research Background

Persuasive systems can change behavior in various ways, as to influence individually [1]. From the Personality System Interaction Theory (PSI) [13] we know that the relationship between depth of self-activation and intensity of negative affect is expressed and coped with on the basis of a spread of activation model. The greater the affective energy that is aroused, the deeper or more extended are the associative networks that can be activated. The core of PSI is volitional action, and linked with motivation it is essential for the Human Computer Interaction (HCI). A lot of research was done on the topic of energy reduction. There are important parts for a successful behavior change. One has been highlighted, the design, as interaction tool (e.g. [5], [6], [10], [14]). It is an essential part of persuasive applications to change attitude or behavior. The concept of a behavior change support system (BCSS) was developed [15] and is seen as the core of research in persuasion, influence, nudge, and coercion.

Summarizing the above-mentioned studies, a lot of work has already been done in order to influence consumption behavior with respect to energy. However, only little work exists in long-term studies, e.g., [9], [19] of actual behavior changes in real households have been conducted which try to understand the influences of such ambient displays over a longer period of time. The value and need of short-term studies in order to improve the design of a system and identify major issues, such as usability, was clearly acknowledged. However, we claim that in order to gain an understanding of how our persuasive systems need to be designed to have a sustainable persuasive interface, long-term studies in the field with actual and representative users are required. Thus, we conducted a half-year study in 24 households, which was accompanied by several different questionnaires at various points of measure to identify, which aspects change after which period of time.

3 Research Question

The central question of the doctoral thesis is: *How does a persuasive ambient display need to be designed to sustainably support activation or inhibition of behavior to change energy consumption in households?* To answer the central question a research agenda has been set up that investigates the following supporting questions:

Technology Appropriation. What is the current role of technology in supporting user to address behavior change? How are local residents appropriating technology?

Community Engagement. What are similarities and differences in various levels of dynamic forecast views (grid status vs. green power) and the feedback?

Design Principles. What are best strategies for designing technology that empowers user and encourages them to address energy issues on the long run?

A working definition which is used in this research about persuasive systems is “any system successfully and intentionally designed to influence attitudes or behaviors of its users” [8]. It was chosen to study residents because energy consumption, particularly at home as living area, is most prevalent there where energy reduction and energy prevention is important to quality of life.

4 Research Goals and Methods

In this section, the studies that addressed the above research questions were described.

Study I: Understanding Providers. The goal of the first requirement study was to understand what are the current topics and the future beliefs for a display of energy consumption from the perspective of energy providers (experts). We conducted a study that combines knowledge of experts about energy consumers. We wanted to get insights how technology should be appropriated to support behavior change, an example of pro-active action. We interviewed experts using a developed semi-structured interview guidelines to retrieve information (i.e., date, subject, 19 items) that was substantiated by audio recording and making notes. The data from Study I using a thematic clustering approach was transcribed and analyzed [11].

Study II: Exploring Future Consumer Engagement. In the second study, we investigated the opinion and design solutions for future consumers. We intended to use the expert data from Study I to gain knowledge about ideas future consumers have about the usage and the design of a display. In a small sample, data was gathered from an interactive co-design workshop based on the inspiration card technique [8] and create a poster presentation of their discussed idea. The data for Study II was analyzed; various parts of the results are already published [11], [12], [16].

Study III: Designing and Using Community Technology. The objective of this study was to create design principles and best practices for community technology that allows residents to engage in decision-making processes. In the project all these studies are related and intended to create and deploy a system [11], [12], [16]. Results from Studies I and II informed the design of the technology in Study III. The system was used for six months in 24 private-situ households and allowed each resident to be informed more widely. It triggers through cues linked with persuasive strategies and colour inducing to action or inhibition of behavior. The FORE-Watch (see Fig. 1) consists of two views: The forecast view shows a clock, a timeline “today” and a timeline “tomorrow”; the feedback view consists of a visualization of the average consumption, the consumption per phase, and the reward icons.



Fig. 1. The tablet App FORE-Watch: the Forecast (*left*) and the Feedback (*right*).

I measured if/how the system supports residents to act or inhibit their behavior. The qualitative (questionnaires surveys) and quantitative (kWh consumption) data was gathered and the proposed analyses are yet to be determined.

During the long-term study, we also researched the location of the persuasive ambient display over the period of six months. We were interested to understand the necessity to present an ambient device permanently and constantly, which is essential for the success of sustainable change and to demonstrate the importance of long-term studies to understand placement requirements of ambient persuasive displays [12].

Study IV: Evaluating the Technology. In the forth study, which was at the end of our six-month in-situ study, the participants were invited to a reflection workshop to gain insights about their opinion, the advantages and limitations of the display, and the study itself. We used the DwI Method [14] to create items and cards. We used transcribed audio recordings and notes for the data analysis for improvement suggestions, implications, and guidelines for design of ambient persuasive systems for sustainable behavior change. The data has to be further analyzed and interpreted.

5 Expected Contribution

The research done in this PhD thesis makes several contributions for the research field and community of Persuasive Technology. First, this research builds on current knowledge about ambient persuasive displays in in-situ households to change energy consumption by investigating how technology is used to support sustainable behavior change. Second, the findings provide HCI designers and researchers with principles and guidelines for designing persuasive technology. These provide researchers with the focus on persuasion and encourage them to address behavior issues for long-term behavior change. Second, the research deepens our understanding of the role of technology in supporting users to act or inhibit their behavior. Third, the connection of the development of technology from the HCI perspective and the area of research of behavior change from the psychology discipline is very seldom possible to investigate simultaneously.

6 Research Situation

I am a 2nd year Ph.D. candidate in the HCI and Usability Unit of the Information Communication Technology and Society (ICT&S) Center at the University of Salzburg. I have a background in communication science, educational science, and psychology; however, after two years in the field of persuasive technology, I consider myself as a HCI researcher. My future plans are to analyze and evaluate Study III, i.e., the data during the period of six month as well as Study IV, which means to present implications and guidelines for future systems. Afterwards, I have to bring together these studies in a balanced way towards the end of the year.

Taking part in the doctoral consortium would be very helpful for me to improve the data analysis and interpretation of Study III and IV. Furthermore, discussing my PhD research with the community, the refinement of the taxonomy, and re-examine

and re-evaluate the guidelines that were derived as results of my findings. It will be beneficial to improving the overall storyline of my thesis.

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References

1. Berkovsky S., Freyne J., Oinas-Kukkonen, H.: Influencing individually: Fusing personalization and persuasion. In: Proc. of INTERACT (2012)
2. Crabtree, A., Rodden, T.: Domestic Routines and Design for the Home. In: Proc. of CSCW, pp. 191-220 (2004)
3. Darby, S.: The effectiveness of feedback on energy consumption. A review for DEFRA of the literature on metering, billing and direct displays. Environ. Change Institute, (2006)
4. Elliot, K., Neustaedter, C., Greenberg, S.: Time, Ownership and Awareness: The Value of Contextual Locations in the Home. In: Proc. UbiComp, pp. 251-268 (2005)
5. Fogg, B.J.: Creating Persuasive Technologies: An Eight-Step Design Process. In: Proc. of PERSUASIVE (2009)
6. Fröhlich, J.: Promoting Energy Efficient Behaviours in the Home through Feedback: The Role of Human-Computer Interaction. In: Proc. of HCIC (2009)
7. Halskov, K., Dalsgard, P.: Inspiration card workshops. In: Proc. of DIS, pp. 2-11 (2006)
8. Kaptein, M., Markopoulos, P., de Ruyter, B., Aarts, E.: Persuasion in ambient intelligence. *J Ambient Intell Human Comput* 1, pp. 43-56 (2010)
9. Karapanos, E., Jain, J., Hassenzahl M.: Theories, methods and case studies of longitudinal HCI research. In: Proc. of CHI. Workshop (2012)
10. Kim, T., Hong, H., Magerko, B.: Designing for Persuasion: Toward Ambient Eco-Visualization for Awareness, In: Proc. of PERSUASIVE, pp. 106-116 (2010)
11. Kluckner, P.M., Weiss, A., Sundström, P., Tscheligi, M.: Two Actors: Providers and Consumers inform the Design of an Ambient Energy Saving Display with Persuasive Strategies. In: Proc. of PERSUASIVE, Workshop paper (2013)
12. Kluckner, P.M., Weiss, A., Tscheligi, M.: Where to Place my Ambient Persuasive Display? Insights from a Six-Month Study. In: Proc. of PERSUASIVE (2013)
13. Kuhl, J.: The volitional basis of Personality Systems Interaction Theory: applications in learning and treatment contexts, *Intern J of Educational Research*, pp. 665-703 (2000)
14. Lockton, D., Harrison, D., Holley, T., Stanton, N.A.: Influencing interaction: development of the design with intent method. In: Proc. of PERSUASIVE (2009)
15. Oinas-Kukkonen H.: A foundation for the study of behavior change support systems. *J Personal and Ubiquitous Computing* (2012)
16. Schrammel, J. Gerdenitsch, C., Weiss, A., Kluckner, P.M., Tscheligi, M.: FORE-Watch – The Clock That Tells You When to Use: Persuading Users to Align Their Energy Consumption with Green Power Availability. In: Proc. of AmI, pp. 157-166 (2011)
17. Taylor, A., Swan, L.: Artful Systems in the Home, In: Proc. of CHI, pp. 641-650 (2005)
18. Tolmie, P., Crabtree, A.: Deploying Research Technology in the Home, In: Proc. of CSCW, pp. 639-648 (2008)
19. Vaughan, M. and Courage C.: SIG: Capturing Longitudinal Usability: What really affects user performance over time? In: Proc. of CHI (2007).