Mobile Designs to Support User Experiences of Energy Conservation in Hotels

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Abstract

In the U.S., hotels are a heavy energy-consuming sector. Yet they sometimes prioritize customer satisfaction over lower energy use. In this study, we discuss how mobile designs can help to motivate energy-saving behaviors while maintaining users' satisfaction. We conducted a diary study of 13 participants and an interview study of 20 participants to understand user experiences around energy consumption in hotel and motel rooms. We found that people unnecessarily consume energy because they are *unfamiliar* with the hotel room environment and they want to *be catered to* by the hotel. We suggest two mobile design ideas: *location-based energy conservation*, and *blending lights*, and discuss the opportunities of mobile designs to balance personal controls and automation to support user experience and satisfaction yet decrease energy use in hospitality settings.

Author Keywords

HCI; user experience; satisfaction; energy conservation;

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction

In the United States, hospitality is the 3rd largest energy consumption sector [8]. Many reasons make hospitality stand out in energy consumption. First, unlike hotels in other countries, hotels in the United States do not have a smart key card system that automatically turns off the electricity after customers leave their hotel rooms. Second, hotels consider the customer's satisfaction as a top priority, and may engage in unnecessary energy use to please the customer (e.g., keeping pools or gyms open and lit even when no one is present) [7]. Third, evidence suggests hotel customers are not likely to cut their energy use even when they claim to be energy conservative [7, 12].

In addition, energy consumption in hospitality settings is different in nature from energy consumption in the home or office. On one hand, hotel customers have more limited control over energy use in hotels and motels than they do at home. For example, they cannot install energy efficient light bulbs in their hotel rooms even though they might do so at home. On the other hand, hotel customers have more control over their energy use than does the typical officer worker. For example, lighting in a shared workspace is often centrally controlled and workers cannot switch on/off the lights. Achieving a balance of different controls over energy is important for energy conservation, which affects people's experience of consuming energy.

The novelty of energy consumption in hospitality settings inspires us to rethink the user experience, particularly users' satisfaction with their energy consumption. In this study, we aim to answer the following two research questions: 1) How do hotel customers feel about consuming energy in their rooms? and 2) What are the mobile design opportunities for maintaining users' satisfaction while motivating them to save energy?

Literature review

With the discussion of *sustainable interaction design* introduced by Blevis [1], much research looks at motivations, awareness, and behaviors of energy conservation. Investigators and designers have purposed multiple methods to motivate energy-conserving behaviors or to increase awareness of energy conservation, e.g., providing energy-related information and feedback [5, 11], rewarding certain behaviors [4], showing visualizations [9], or presenting social comparisons and social supports [10]. In particular, Cialdini pointed out that hotel customers' energy-consuming behaviors are influenced by social norms such as what others consider is reasonable for energy use [3].

However, most of the research focuses on energy consumption at the personal level, looking at how awareness of energy use, change of behaviors, and motivations for energy conservation affect personal decisions, controls, daily practices, and energy saving behaviors. There is much less discussion of what degree of control an individual vs. the system (automation) should have over energy usage. For example, is it better to motivate people to turn off lights when they leave a room, or to install sensor based lights that turn off automatically when no one is present? Under what circumstances is it better to have personal control of energy use, under what circumstances it is better to have intelligent system

Interviewee #11: *"But I think I even might have left the bathroom lights on when I was sleeping, just because when you were in a new environment, I was like 'if I am going to the bathroom, I am going to get confused, or run into any furniture', so I just left the bathroom lights on there at least I could find my way to the bathroom... Ya, you are like 'just a little bit of lights'. Because I mean at home, I feel really comfortable when sitting in the dark. I don't know. It's just that something with the unfamiliar space."* (Female, hotel)

Interviewee #5: *"If I am more familiar with my room, I don't need to keep more lights on because I could see every single concern of my room. But in the hotel room, I would typically keep the hallway light on when I am awake. So it just makes me feel safe."* (Female, hotel)

control of energy use, and under what circumstances is a combination of personal and system control optimal?

Another theme tightly associated with energy conservation is persuasive technology, where researchers and designers attempt to persuade people to adapt to energy-conserving behaviors or practices [2]. However, many persuasive designs tend to highlight the experience and effectiveness of persuading users to behave sustainably according to researchers' or designers' intentions, without much discussion of the user's satisfaction with using such technology to save energy.

Our study focuses on both aspects that have been neglected from the field. First, we want to understand user experience, particularly feelings of satisfaction around energy consumption. Second, we discuss design opportunities suitable for personal control, system control, or both.

Methodology
We used a two-step research procedure. First, we conducted a diary study with 13 participants to understand people's experience around energy consumption in hospitality settings, their use of technology (e.g., personal electronics, hotel room devices) when staying at a hotel, and their opinions about several design ideas for tools to reduce energy consumption. In particular, we asked them to document how long they used each hotel room device, once per day of hotel stay ranging from one day to a week. All diaries were filled out while the participants were staying in the hotel. Second, we conducted 20 semi-structured interviews to further understand people's attitudes, feelings, behaviors, and overall

experience of energy use in hotels and motels. Each interview lasted 30 to 45 minutes. All interviews were transcribed, and the diary studies and interviews were coded iteratively using the constant comparative analysis introduced by Glaser and Strauss [6].

All respondents were graduate students or working people who could pay for their own hotel stay. Of the 13 participants in the diary study, 8 were doctoral students and 5 were working in big companies. Of the semi-structured interview participants, 16 were doctoral students, and 4 were working in big companies. 8 of the 20 participants in the semi-structured interviews had also participated in the diary study.

User experience around energy consumption
We are interested in understanding user experience around energy consumption in hospitality. In particular, we attempt to find out how hotel customers use energy in a hotel room and the reason why they consume energy in such ways. We identified two major themes regarding user experience: *preparation for the unknown*, and *luxury*.

Preparation for the Unknown
Participants mentioned that they would keep one or two lights on before going to bed or during sunset time before going out, for two major reasons: unfamiliarity with the environment and safety concerns.

Unfamiliarity with the environment led to perceived risks of stumbling, falling over, or failing to find one's way in a hotel room at night. Participants mentioned that they kept lights on all night to prevent potential danger. Most (16 out of 20) interviewees mentioned that they were concerned that they would stumble into

Interviewee #6: *"My mom is very old fashion, she'd like to have fresh towel every day. So … each person has two towels in the hotel room, so it's like 10 towels. If it I hang them up, she would throw it to the floor to signal new towels. So when I travel, I reuse my towels, but she doesn't like it, and she doesn't reuse them either...I don't think she sees the reason the hotel room has this, but for me, I do see the values of reusing the towels, to save electricity, the wash like that. And my mother is wonderful, but it's always been a tough sell for her. It's not that she doesn't believe it is a good idea, but it's just like while she's travelling, I'm expecting this, and I'm paying for this so I will have fresh towels every day."* (Male, hotel)

something at night and hurt themselves. Some were concerned that they would not be able to find their way in the dark if they woke up at night (as described by interviewee #11).

Half of the participants (10 interviewees) mentioned that they had safety concerns of staying in a hotel room but most of them did not specify a particular reason for these concerns. However, they reported that, keeping one or two lights on in the evening increased their sense of security (as described by interviewee #5).

Luxury
Luxury is often associated with personal comfort when staying in hotel rooms and people's desire to be catered to in a hotel.

Personal comfort in the hotel room—for example, pleasant room temperature, sufficient brightness, fresh air in the room, and an overall relaxing environment—were all important issues for our participants. All of the participants from the interviews and nearly half of diary studies (6 participants) discussed what they did to achieve personal comfort in a hotel room. However, achieving higher comfort levels usually came at the cost of greater energy use, e.g., keeping the air conditioning or heating on once it reached a comfortable temperature, turning on extra and unnecessary lights, opening the hotel room door to bring in fresh air while blasting the air conditioner, and turning on the TV to create a relaxing environment.

In addition, participants viewed hotels as a special place that is different from their home or office. As is mentioned by interviewee #6, hotel customers are being catered to or taken care of by the hotel staff or

service. For example, hotel services change the bed sheets and towels, and clean the room for customers. Several participants in the interviews mentioned that they have the right and freedom to consume as much energy as they want, because electricity and water is already included in the price of staying in a hotel.

Mobile design ideas
In this section, we discuss two smartphone design ideas inspired from our findings about energy consumption in hospitality settings: *location-based energy conservation* and *blending lights*. Our intention is to provide the user with *ways to consume less energy while maintaining their satisfaction, and in such a way that it does not have a negative influence on the user's experience of consuming energy*. We argue that more personal control over energy use via smartphones is better under some situations, more automated controls are better in other contexts, and some situations are suitable for both types of controls.

Idea 1: Location-based Energy Conservation
This idea is inspired by the theme of *luxury*, but it can be applied in other circumstances such as *unfamiliarity*. Our design idea, location-based energy conservation smartphone application, aims to satisfy people's desires for a luxury experience while conserving energy at the same time. A key feature of this idea is GPS detection, an automatic device switch to control the electronic devices in the hotel room, and the ability to remember temperature and lighting settings. For example (see **Figure 1**), if the customer leaves the air conditioning at 70 degrees, the application triggers the automatic switch to turn on the air conditioning and set it to 70 degrees when the customer is close to the hotel. The lights are also automatically turned on. Similarly, if a

Figure 1: Location-based energy conservation app (hotel lamps and temperature are activated when a user comes back to the hotel)

Figure 2: Blending lights

customer is leaving the hotel, the application will trigger the automatic switch to turn off the room devices. Even if the customer forgets to turn off the devices, e.g., lights, TV, or air conditioning, this application prevents them from staying on all day.

We suggest giving more controls to a smartphone system rather than a person when energy consumption is motivated by a desire for *luxury*, that is, when people's satisfaction is associated with greater energy use. People are unlikely to decrease their satisfaction and enjoyment because they feel they have already paid for or are accustomed to luxury. In such circumstances, system control over energy conservation can be effective because intelligent systems can adjust to an energy-saving environment when no one is in the room and return control to the users when they return, thereby maximizing both user satisfaction and energy conservation.

Idea 2: Blending Lights
The idea of blending light is inspired by people's comments about *unfamiliarity* and *laziness*. For example, participants were worried about stumbling in the dark and safety, especially in the evening. Lighting up the room when it is needed becomes important in these circumstances. However, after lighting the room, participants mentioned that they sometimes just left the lights on because the switches were out of reach. Thus, it is important that the light switch be easy to reach from anywhere in the room.

Blending light is the idea that a person can control the lights in a hotel room via his or her smartphone. The hotel environment and the smartphone are blending together, as in **Figure 2**. When a user puts his or her

smartphone over the room environment, its camera captures the room environment and blends the environment with the smartphone. A user can simply touch the bedside reading lamp, floor lamp, and other devices figures on their smartphone, in order to turn the devices on or off. Blending light is convenient for people to use their smartphones to light up the hotel room in the evening or turn off electronic devices.

This idea provides more personal control than smartphone system control over energy use. When a user is unfamiliar with the environment and wants to create a sense of safety, consuming energy is a strategy to bring and enhance familiarity and safety. It respects their choices of energy consumption and provides an alternative way for them to use less energy. This design also takes into account participants' reports that laziness sometimes resulted in more energy consumption, e.g., leaving lights on for the whole night. Thus, providing a convenient and easy means of controlling these devices can lead to lower energy use. This design solution is not unique to the hotel setting, and it can also be applied to household contexts.

Conclusion
The goal of our study is to use smartphones to support users' satisfaction and expectation around energy consumption in hotel settings, and explore mobile design opportunities for energy conservation.

We identified two major reasons why people consume more energy than expected in hotels: (1) *preparation for the unknown*. *Unfamiliarity* and *safety concerns* are two important reasons for energy use under this theme; (2) *luxury*. People's desires for *comfort* and *being catered to in a hotel* are the major reasons for energy

consumption. Inspired by these findings, we proposed two mobile design ideas, *location-based energy conservation* and *blending lights* to motivate energy conservation in U.S. hospitality settings while maintaining customers' satisfactions. We also discussed possibilities of maintaining user's satisfaction around energy conservation based on two levels of control – personal control and system control (automation). Creating more system controls over energy conservation seems to better maintain people's desires to enjoy a *luxury* environment, while giving more personal control can help to reduce *unfamiliarity*.

In future work, we plan to further evaluate these mobile designs to examine which features are effective for motivating energy conservation and supporting users' satisfaction, and to generalize our design strategies for motivating energy conservation using mobile technology to other types of settings.

Acknowledgements

References

[1]   Blevis, E. (2007). Sustainable interaction design: invention & disposal, renewal & reuse. In *Proc. CHI*, 503-512.

[2]   Brynjarsdottir, H., Håkansson, M., Pierce, J., Baumer, E., DiSalvo, C., & Sengers, P. (2012). Sustainably unpersuaded: how persuasion narrows our vision of sustainability. In *Proc. CHI*, 947-956.

[3]   Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A Focus theory of normative conduct: recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology*, 58(6), 1015-1026.

[4]   Froehlich, J., Dillahunt, T., Klasnja, P., Mankoff, J., Consolvo, S., Harrison, B., & Landay, J. A. (2009). UbiGreen: investigating a mobile tool for tracking and supporting green transportation habits. In *Proc. CHI*, 1043-1052.

[5]   Froehlich, J., Findlater, L., & Landay, J. A. (2010). The design of eco-feedback technology. In *Proc. CHI*, 1999-2008.

[6]   Glaser, B., & Strauss, A. (1999). *The discovery of grounded theory: strategies for qualitative research*. Aldine Transaction.

[7]   Goldstein, N. J., Cialdini, R. B., & Griskevicius, V. (2008). A room with a viewpoint: using social norms to motivate environmental conservation in hotels. *Journal of Consumer Research*, 35, 472-482.

[8]   International Energy Agency. (2008): 'Worldwide trends in energy use and efficiency: key insights from IEA indicator analysis', *International Energy Agency*.

[9]   Mankoff, J., Fussell, S. R, Glaves, R., Grevet, C., Johnson, M., Mattews, D., Mattews, H. S., McGuire, R, Thompson, R., Shick, A., & Setlock, L. (2010). StepGreen.org: increasing energy saving behaviors via social networks. *AAAI*.

[10] Petkov, P., Goswami, S., Köbler, F., & Krcmar, H. (2012). Personalised eco-feedback as a design technique for motivating energy saving behaviour at home. In *Proc. NordiCHI*, 587-596.

[11] Pierce, J., & Paulos, E. (2012). Beyond energy monitors: interaction, energy, and emerging energy systems. In *Proc. CHI*, 665-674.

[12] Ricaurte, E., Verma, R., & Witham, G. (2012). Hospitality sustainability report: slow, steady progress. *Cornell Hospitality Proceedings*.