The Kukui Cup: Shaping Everyday Energy Use via a Dorm Energy Competition

Robert S. Brewer
Collaborative Software Development Laboratory
Department of Information and Computer Sciences
University of Hawai`i at Mānoa
Honolulu, HI 96822 USA
rbrewer@lava.net

Abstract
Our research seeks to investigate the relationships among energy literacy, sustained energy conservation, and information technology support of behavior change through an advanced dorm energy competition to take place in fall 2011. The competition will attempt to foster changes in participants' everyday energy use by increasing their energy literacy and changing their habits through activities performed during the competition.

Keywords
Sustainability, Energy, Behavior Change

CHI 2011, May 7–12, 2011, Vancouver, BC, Canada.
ACM 978-1-4503-0268-5/11/05.

ACM Classification Keywords
K.4.m [Computers and Society]: Miscellaneous. H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Human Factors, Experimentation, Measurement

Introduction
The state of Hawai`i faces a number of unique challenges in the pursuit of sustainability for its citizens, compared to other states. Hawai`i has fertile agricultural land, and a variety of renewable energy sources (wind, solar, geothermal, wave), but we import 85% of our food, and import over 90% of our energy, in the form of oil and coal. In fact, Hawai`i is the most fossil fuel-dependent state in the United States. Sustainability is a distant goal for most of the approximately 1.3 million people who live in our isolated archipelago.

To make Hawai`i's energy use more sustainable, the state entered into an agreement between the US Department of Energy and the local utility (Hawaiian Electric) called the Hawaii Clean Energy Initiative

(HCEI). HCEI sets the goal of reducing the state's energy consumption by 30% and generating 40% of the state's energy from renewable sources by 2030 [6]. These bold goals are major drivers in energy and sustainability policy in the state. The overall goal of energy sustainability is reminiscent of traditional Native Hawaiian sustainability systems such as the "Ahupua`a", where each island was subdivided in swaths from the top of the local mountain to the shore, allowing each region to be self-sufficient for food, water and other resource needs for the community.

This alignment in ancient cultural concept and economic and environmental policies of today isn't sufficient to meet the goals of this community, whose nature of energy challenges are underrepresented. Active outreach and education of the next generation is needed to change their everyday practice to achieve the HCEI goals.

Energy use can be reduced in two primary ways: making energy consuming devices more efficient, and changing the behavior of the humans that operate the devices. Changing people's behavior with respect to energy offers significant promise in reducing energy use. Darby's survey of energy consumption research finds that identical homes could differ in energy use by a factor of two or more [4]. Our research investigates how best to foster sustained positive energy use in everyday behaviors through information technology. We have devised a research program to investigate the effectiveness of changing the people's everyday behavior with respect to energy, which we call the Kukui Cup.

The Kukui Cup is a three-year series of dorm energy competitions to be held on the University of Hawai`i at Mānoa campus (and later in more general residential settings). The competitions are named after the kukui nut, or candlenut, which was burned as an early source of energy by Native Hawaiians. This is one aspect of our efforts to include a Hawaiian "sense of place" in the competition. A more complete description of the design and motivation of the competition can be found in [3].

Background and Related Work

Energy competitions on college campuses have taken place on many campuses over the last several years. Petersen et al. described their experiences deploying a realtime feedback system in an Oberlin College dorm energy competition in 2005 [10]. They found a 32% reduction in electricity use across all dormitories, with freshmen dorms and those dorms receiving real-time feedback reducing usage the most. However, participants reported making unsustainable changes such as keeping hallway lights off during the competition. Overall, there has been little analysis on energy usage after competitions finish, or how positive behavior changes could be sustained.

StepGreen is a social web application designed to encourage people to undertake environmentally responsible actions. Mankoff et al. have written about the system design and its rationale [7]. Users pick positive environmental actions that they have performed from a list of options. Based on users' self-reports, StepGreen calculates the amount of money saved, and pounds of CO2 saved. Grevet et al. studied social visualizations in StepGreen with a dorm competition at Wellesley College, and found that the list of actions was not well suited to their lifestyle [5].

To reduce their energy use, people must know how much energy they are using. Darby provides a detailed survey of studies on electricity feedback systems from the past 3 decades [4]. The survey of 20 studies found that, on average, the introduction of a direct (real-time) feedback system leads to reductions of energy usage ranging from 5-15%. A variety of products are available for recording and visualizing energy use, ranging from large buildings (Building Dashboard, GreenTouchScreen), to single residences (The Energy Detective, Google PowerMeter).

A variety of methods have been employed in an attempt to get people to change their behavior to be environmentally sustainable; McKenzie-Mohr provides a good summary of the area in his online book [8]. Simply providing information about sustainable behavior tends to not lead to behavior change. Techniques that have been shown to work are obtaining public commitments and setting goals [9, 1].

Another strategy we hypothesize will help change behavior (when combined with the previous two strategies) is increased *energy literacy* (knowledge, attitudes, and behaviors with respect to energy).

Competition Design

The Kukui Cup will take place over a three-week period, structured as two individual rounds and one final overall round. Prizes will be awarded to the winners of each round of the competition, and to overall competition winners. Two parallel competitions will take place: an energy reduction competition and a Kukui Nut points competition.

Energy reduction competition
In this competition, each dorm floor competes to use the least amount of electricity (measured in kWh). For reasons of infrastructure, privacy, and cost, energy can only be monitored at the floor level.

Kukui Nut points competition
In this competition, each participant performs activities described on the competition website. The activities include watching a short educational video on energy, attending an energy-themed event, performing an energy-related action such as switching an incandescent light bulb with a CFL bulb, or making a public commitment to some energy-positive behavior. Each activity is worth a certain number of points based on complexity and the effort required to complete. To receive points, participants must verify their completion of the activity on the website with such actions as answering a question or submitting a digital photo. Points are earned by individuals, but can also be aggregated at the floor or dorm level.

The design of the competition and competition website incorporate the three previously discussed strategies for energy behavior change: energy feedback, behavior change techniques, and energy literacy. The website will provide participants with near real-time energy feedback via a system for energy data retrieval, storage, and analysis we have developed called WattDepot [2]. Behavior change techniques have been incorporated throughout the competition, such as assisting participants in picking an energy conservation goal for each round, encouraging participants to make public, pro-environmental commitments, and incorporating social norm theory by making participants aware of the actions of their fellow participants. The

activities available through the competition website are designed specifically to increase the energy literacy of the participants.

We will collect a wide variety of data during the competition including: fine-grained energy usage (before, during, and after the competition), assessments of energy literacy (before and after the competition), and detailed logs of the competition website.

The inaugural Kukui Cup is scheduled to take place in October 2011, in 3 residence halls with approximately 780 first-year students in total.

Challenges

Most energy conservation campaigns operate in contexts where the participants have some feedback on their energy usage, and they have a financial incentive to reduce their energy usage in the form of a utility bill. University dormitory residents typically have no information about how much energy they consume, and usually pay a fixed rate regardless of how much energy they use. However, exploring this incentive regime is important, as this situation exists in many other contexts as well, such as office workers and apartment rentals where utilities are included.

Our use of a point competition to increase energy literacy also provides motivation for participants in the absence of standard educational motivations, such as grades and class credit.

Since participation in the Kukui Cup is optional, the biggest risk to the success of the research is failure of the residents to participate, and to keep them engaged throughout the competition. For this reason, much of our current work is focused on making the competition and website as exciting as possible.

Conclusion

We have set out to address the need for increased energy conservation, which is particularly keenly felt in Hawai`i, through a combination of smart metering, behavior change techniques, information technology, and engaging interface with which energy literacy information and energy usage data are displayed.

The anticipated contributions of this research are: insight into the effectiveness of psychological techniques for fostering behavior change as embodied in a website, the utility of energy visualizations designed to foster energy conservation, and insights into the impact of various media, delivery modes, and incentives for energy literacy improvement.

References

[1] Becker, L. Joint effect of feedback and goal setting on performance: A field study of residential energy conservation. Journal of Applied Psychology, 63(4), 1978.

[2] Brewer, R.S. and Johnson, P.M. WattDepot: An open source software ecosystem for enterprise-scale energy data collection, storage, analysis, and visualization. In Proc of SmartGridComm 2010.

[3] Brewer, R.S., Lee, G.E. and Johnson, P.M. The Kukui Cup: a dorm energy competition focused on sustainable behavior change and energy literacy. In Proc HICSS 44, 2011.

[4] Darby, S. The effectiveness of feedback on energy consumption. Technical report, Environmental Change Institute, University of Oxford, 2006.

[5] Grevet, C., Mankoff, J., and Anderson, S. Design and evaluation of a social visualization aimed at encouraging sustainable behavior. In Proc HICSS 43, 2010.

[6] Hawai`i Clean Energy Initiative. http://hawaiicleanenergyinitiative.org/

[7] Mankoff, J., Matthews D., Fussell, S.R., and Johnson, M. Leveraging social networks to motivate individuals to reduce their ecological footprints. In Proc HICSS 40, 2007.

[8] McKenzie-Mohr, D. Fostering Sustainable Behavior: Community-Based Social Marketing. McKenzie-Mohr & Associates, Inc., 2009.

[9] Pallak, M.S., Cook, D.A. and Sullivan, J.J. Commitment and Energy Conservation, vol 4 Policy Studies Review Annual, chapter 22, pages 352–370. Sage Publications, 1980.

[10] Petersen, J.E., Shunturov, V., Janda, K., Platt, G. and Weinberger, K. Dormitory residents reduce electricity consumption when exposed to real-time visual feedback and incentives. International Journal of Sustainability in Higher Education, 8(1): 16–33, 2007