Poster Abstract: The Impact of User Engagement in the Effectiveness of Energy Saving Programs

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***Abstract*—Significant energy wasted in private homes each year. Most of the times, the residents do not know the cause of energy waste in their homes. We designed several activities to encourage the homeowners to learn about how energy is used at their homes and start thinking about eliminating those waste. The program consists of twelve weekly activities in which the homeowners participate. We analyzed monthly electricity bills for all the program's participants and found that energy savings achieved by the participants has close relationship to level of their engagement in the program. People who were highly involved in program saved much more energy (5%) compared to participants who were involved in less than 25% of activities.**

I. Introduction

A large variety of of hardware and software tools have been used to make people aware of sources of energy waste in their homes and encourage them to eliminate those waste. Use of such systems reportedly result in 3% to 15% reduction in energy bill [1]. Effectiveness of this such approaches is closely related to how engaged the participants are.

We designed an energy saving program that tried to achieve high level of engagement and significant energy savings for the participants. We combined hardware tools along with simple activities and guidelines to increase participants' interaction with our program and reduce their energy waste.

We ran the energy savings program in Oahu in Hawaii. The project provided participants with the ability to access their energy data through a smartphone app; smart plug devices for their homes; and a twelve-week "Energy Engagement Program" consisting of weekly challenges to save energy and earn points/rewards.

This program establishes a easy to use platform with a fun and highly-engaging behavioral modification approach to deliver energy savings higher than that of historical energy efficiency programs. In this work, we calculated energy savings through the program, participant's engagement in our designed program and we also quantified relationship between participants' engagement in the program and the energy savings achieved by the participants.

We make these contributions:

- We designed a simple but effective energy saving activities with the goal of high user participation rate
- We designed and developed a user-friendly mobile application which enables users to report the outcome of the weekly activity
- We ran the program with 740 households and evaluated the effectiveness of the energy saving program.

II. Related Work

A large number of efforts worldwide are geared towards making homes energy efficient, typically starting by educating the users about their energy use [2], [3]. One of the common approaches is to provide energy monitoring tools to provide (real time or delayed) feedback to the users about their energy use. Eco-feedback devices have been widely used in energy waste reduction and resident's behavior modification [4], [5]. The major challenge about eco-feedback tools are strategies and tactics to keep the user engaged in the program.

The common point among all the related work is that user engagement has a critical role in the effectiveness of the energy saving programs. In *Schich et al.2011*[4], four strategies have been proposed to increase user engagement which are: marketing and communication, Tips & Assistance, Goal setting and reward & recognition.

III. Energy Savings Program Design

The energy savings program consisted of a smartplug device, a set of weekly activities, and a smartphone app to respond regarding the completion of the weekly activities. Here is a list of weekly activities:

Activity 1: Count all Lights, Appliances, and Electronics in the Home. Activity 2: Find the Plugged in Appliance that Consumes the most. Activity 3: Find the Plugged in Appliance that has the most Vampire Power. Activity 4: Thermostat, Refrigerator, and Water Heater Set It and Forget It. Activity 5: Create a Rule for your Monster Smart Plug and SAVE. Activity 6: Plant a Seed and Spread Roots in the Community. Activity 7: Energy Efficient Appliance and Electronics Wish List. Activity 8: Get To Know Your Energy Meter. Activity 9: Study Your Electric Usage Profile. Activity 10: Detecting Air Leaks. Activity 11: Lights Out. Activity 12: Final Survey.

Of the 740 households enrolled in the program, 106 households opted in for historical data sharing; did not have solar panels; had energy use profiles resembling residential use; had spent sufficient time after the end of the program to measure the change in energy use, and hence were selected as participants for analysis. We call these households participants.

We identify 2054 homes in the neighborhood of the participants and selected 106 households that had similar monthly

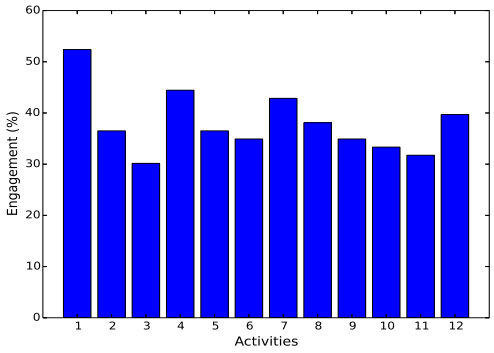

Fig. 1. Participant's Response Rate per Activity

bills distribution as the population of the participants. This second set of 106 households are is the control group in our study. To compute the effective energy savings achieved by the participants, we subtract the savings achieved by the control group from the savings achieved by the participants. The subtraction is to control for the baseline trends in energy usage due to weather or other factors in the neighborhood.

We are interested in the amount of change in energy consumption after participating in program. To calculate that change, we used difference of averages method. In this approach, we calculate average for the participant's energy consumption before and after the program. In all of our analysis, we considered four months before start day of program as pre-period interval and four months right after end day of program as post-period interval. Then, we can subtract the pre-period average from the post-period average.

IV. Results

We want to measure participant's engagement in our program and calculate direct impact of this interaction on their final savings.

The program participants have an application on their phones to send feedback regarding each activity. We assume that highly engaged users perform many tasks and send the reports for the task. We counted number of feedbacks received per activity and found out in average 32% of participants performed each activity. We plotted participation per activity in Figure 1.

Figure 1 shows that the most popular activity is activity number 1 which is counting number of lights and appliances. The first reason for popularity of this activity is its order. In other words, at the very beginning of the participants are excited and try to participate in program. Another reason is the simplicity of this activity. The response rate does not drop off in the middle of the program.

A. Relationship between Engagement and Energy Savings

We divided the participants into two groups: highly engaged participants and slightly engaged participants. We counted number of feedbacks each user posted during the program period and labeled participants with more than 3 feedback as highly engaged participants and those with less than or equal 3 feedbacks as slightly engaged participants. Table I shows the energy savings for the two groups.

TABLE I
Participant's Energy Saving

All Participants	#	Energy Consumption Change
Slightly Engaged	81	-12.55%
Highly Engaged	25	-17.04%

Highly engaged users saved more energy compared to slightly engaged users. Given that the average energy saving among control group is -15.84%, energy consumption increased for slightly engaged users but for highly engaged users, the direct saving from the program is 1.2% which is significant considering the simplicity and length of the program.

V. Conclusion

We designed a task based energy saving program and deployed it in Hawaii. The highly engaged participants achieved high energy savings. These savings have a potential to create a positive feedback cycle - the participants that are highly engaged see savings in their electric bill and may be even more motivated to seek additional savings. These results emphasize the importance of the impact of engaging users in fun and interactive activities to achieve behavioral modification related to their energy consumption, versus simply showing users their consumption data.

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