

Realizing Rental Energy Efficiency

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Abstract: Hawaii is one of the few states in the United States that utilizes crude oil to produce electricity. This practice has shown harmful emissions that damage the environment and contribute significantly to climate change. The first step toward reducing our demand for imported oil is to be conscious of it and to reduce our oil consumption by increasing our energy efficiency. Previous research has shown that low-income, multi-family, rental households utilized significantly more electricity per square foot than other types of households. Furthermore, energy efficient upgrades are most likely to be done when individuals recognize the financial benefits and environmental impacts of these upgrades. This project developed an asynchronous web-based instructional module to best inform the rental household target population about their options for greater energy efficiency and their benefits. The pre- and post-survey results revealed greater potential for behavioral change when financial incentives are realized and energy users are directly accountable for their electric bill.

Introduction

As of September 1, 2013, Hawaii's electric rates are about 3-4 times higher than the national average; additionally, in 2013, Hawaii utilities used 11.3 million barrels of petroleum for electricity production (Hawaii Energy, 2014). Hawaii is one of the few states in the United States that utilizes crude oil to produce electricity. This practice has been known to produce carbon dioxide as well as other harmful emissions that are released into our environment and contribute significantly to climate change. These harmful chemicals pose a hazard to the Hawaiian islands as well as the global condition as a whole. Additionally, the dependency on a finite resources like oil is unsustainable. Oil has become increasingly hard to extract, progressively expensive to import, and can only serve as a temporary solution for energy needs. The solution to this problem is multi-faceted, consisting of demand reduction, sustainable energy generation, and infrastructure management. The first step toward reducing the demand for imported oil is to be educated through online resources of current consumption levels and use those learned concepts to make critical steps to reduce oil consumption and improve energy efficiency.

Background

The purpose of this instructional design project was to develop and evaluate an online resource that will educate property renters in Hawaii, aged 18 and older, to select solutions which increase

home energy efficiency in lighting, water heating, large appliances, identifying phantom loads. There is substantial research to support this goal. Through an analysis of US Residential Energy Consumption surveys, Pivo (2012) discovered low-income, multi-family, rental households utilized significantly more electricity per square foot than other types of households. La Jeunesse (2013) argued that renters have minimal responsibility for their electricity usage when it is included in their rent. According to Pivo and La Jeunesse, a majority of heavy electricity usage is due to these rental households.

This project sought to best inform the target rental household population about benefits and options for greater energy efficiency. In a study of Swiss homeowners, Alberini, Banfi, and Ramseier (2013) found that energy efficient upgrades were most likely to be completed when the financial benefits and environmental impacts are recognized by the individuals. The path to energy efficiency can be as easy as a behavioral change, such as turning off a power strip (Singh Solanki, Sarma Mallela, & Chengke, 2013). Other behaviors are based in consumer habits, replacing incandescent light bulbs with energy efficient ones can offer energy savings, as much as 75% over traditional bulbs and even increase satisfaction with the quality of the light. (Kuhn, Hohansson, Laike, & Goven, 2013).

Methods

Subjects

The target demographic of this instructional design project were housing renters in Hawaii ages 18 and older. As previous research has shown, renters have a tendency to utilize more energy per square foot than other types of housing occupants. Renters, specifically, are also more limited in their options for increasing energy efficiency in the home. Additionally, living in Hawaii presents unique energy consumption compared to other regions. The age group 18 and older was selected to help ensure common familiarity with the internet and digital content. Content will be designed to engage this age group.

Data Collection

Mixed-measure attitudinal surveys were utilized to collect demographic data on the target population, and analyze the online resource's effectiveness. Data was collected through Google Surveys. Participants were first directed to a consent form which informed them about the study, what information is collected, and their rights. Following review of the consent form, a pre-survey was provided to participants for demographic information and to gauge attitude toward the concepts in question. Participants needed to accept the consent form provided, by means of a required question embedded, in order to complete the pre-survey. Additionally, subjects were prompted for an "Alias" of their own choosing. This was defined as a word, letters, numbers, or combination of those, that the participant was to remember. Upon review of the online instructional module, the subjects were then provided with a post-survey to determine any change in attitude and knowledge of the content. Participants were re-prompted for their alias in the post-survey to link the two surveys together and still allow anonymity.

Overview of Online Resources

In response to prior research revealing that renters are the largest domestic users of electricity, an online resource was developed on the methods and benefits of energy efficiency in the home.

This online resource provided information on consumers of high electricity usage in the home, and their feasible alternatives. Additionally, the financial incentives and environmental benefit of these efficient conversions were outlined.

The module was designed to be completed asynchronously, to allow participants the greatest flexibility as to when and where they interacted with the content. This strategy was also utilized to afford learners the ability to leave the module and resume their work at a later time.

The design of the site focused on ease of navigation, simplicity of material, and learner engagement strategies. Content was chunked into four categories to ease content digestion: lighting, water heating, other appliances, and phantom loads. After review of the consent form and completion of the pre-survey, participants were free to work their way through the content. Each section contained relevant images and videos in addition to practice activities to enhance learner engagement. Lastly, additional resources were provided at the end of the module so that participants could further their learning.

Implementation

Recruitment for participants started January 31, 2014 and the module went live on February 2, 2014 with the Google Forms beginning acceptance of responses. Ongoing recruitment continued through February 14, 2014 and responses to surveys were no longer accepted after February 16, 2014. Following this implementation of the online resource, the resulting data was analyzed through Microsoft Excel spreadsheets. Data analysis of the two surveys provided an accurate depiction of any knowledge, attitude, or potential behavioral changes, that have occurred as a result of the online resource. A summary of the data collected is presented in subsequent sections of this paper in graphical and narrative form.

Results

Demographic information

Of the 30 respondents who completed the pre-survey of the study, 18 completed the full module and post-survey. Only 17 completed responses could be used for this study because one of the post-survey responses could not be linked to the pre-survey due to inconsistency in the alias used.

Demographic information was categorized by gender, age group, highest education received, and whether they pay their own electric bill or it is included in rent. Age, education level, and gender were deemed as inconclusive to the results due to the limited size and diversity of the sample group. This is discussed further in the *Discussions* section.

When reviewing data on electric bill accountability, 11 participants pay their own electric (65%) and six have it included in their rent (35%). Figure 1 provides graphical depiction of the electric bill payment demographic data.

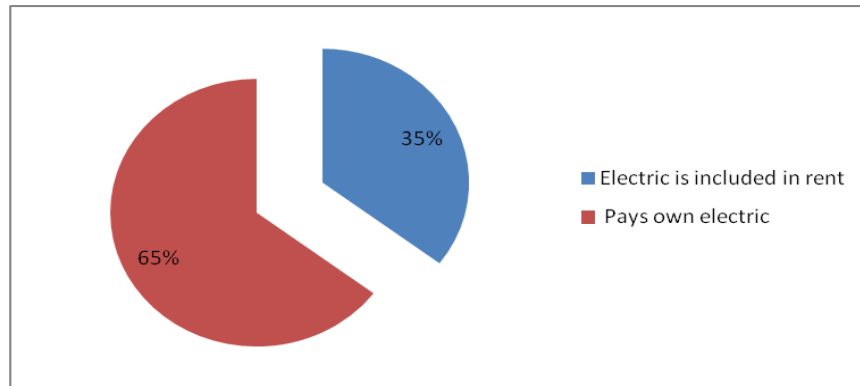


Figure 1: Accountnability Demographic

Attitude

The pre-survey contained three questions to determine participants attitude about module content. These were ratings on a Likert-scale of 1-5 (5 = strongly agree to 1 = strongly disagree) to determine participants' perception about the importance of energy efficiency, concern about the environment, and their desire to save money on their electric bill.

When asked if they felt energy efficiency is important, 14 (82%) strongly agreed, one agreed (6%), and two felt neutral (12%) (see Figure 2).

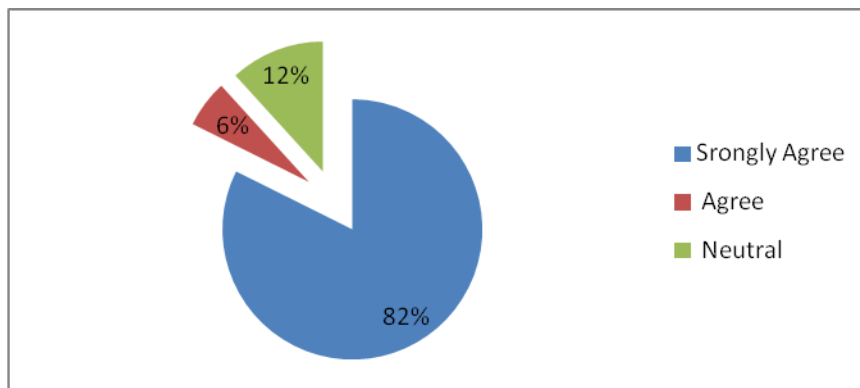


Figure 2. Energy efficiency importance attitude

When asked if they were concerned about the environment, 12 (70%) strongly agreed, two agreed (12%), and three were neutral (18%) (see Figure 3).

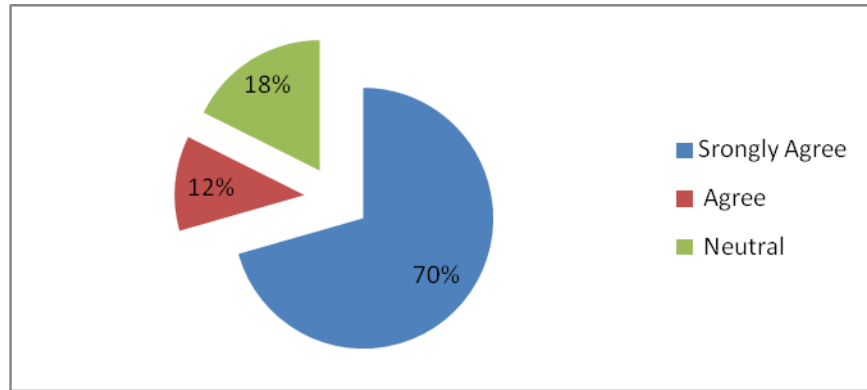


Figure 3. Environmental importance attitude

Lastly, when questioned if they would like to save money on their electric bill, 14 (82%) strongly agreed, two agreed (12%), and one felt neutrally (6%) (see Figure 4).

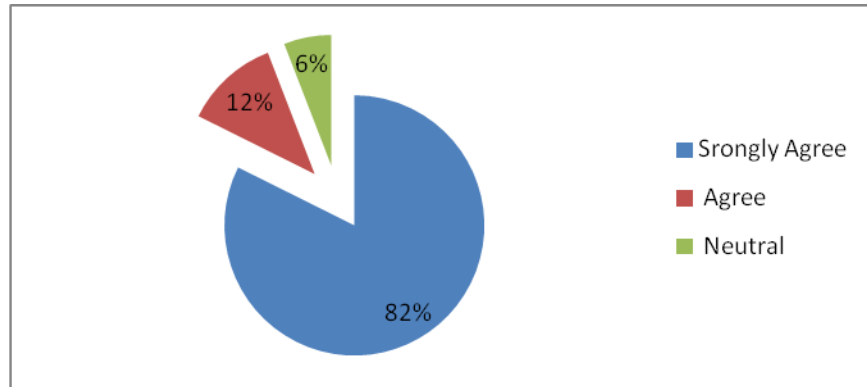


Figure 4. Financial importance attitude

Module Effectiveness

In the required pre-survey, participants were asked four self-assessment questions to measure their ability to select solutions in each of the four areas: lighting, water heating, large appliances, and phantom loads. During the post survey, participants were asked parallel questions to determine how well they could select the same solutions after completion of the online instructional module. Responses were gauged on a five point Likert-scale. Average to the pre- and post-survey responses were compared.

Participants rated their ability to select energy efficient solutions in lighting at 4.2 averaged. Following the module, the same assessment was increased their rating to 4.9 averaged. Before review of the module, participants rated their ability to select energy efficient solutions in water heating at 3.9 averaged. Following the module, the same assessment was rated 4.6 averaged. Before review of the module, participants rated their ability to select energy efficient solutions in large appliances at 3.9 averaged. Following the module, the same assessment was rated 4.6 averaged. Before review of the module, participants rated their ability to select energy efficient solutions in phantom loads at 3.5 averaged. Following the module, the same assessment was rated 4.6 averaged. There was an over-all increase in self assessed ability to select energy efficient solutions in each of the four areas of content (see Table 1).

Module Question	Pre-Module	Post-Module
ability to select energy efficient solutions in lighting	4.2	4.9
their ability to select energy efficient solutions in water heating	3.9	4.6
ability to select energy efficient solutions in large appliances	3.9	4.6
ability to select energy efficient solutions in phantom loads	3.5	4.6

Table 1. Module Effectiveness

Comparisons

To understand whether or not any differences were exhibited in attitude and potential for behavioral change, participants how paid for their own electric were compared to those who had it included in rent. Questions were based on a 5-point Likert-scale and averaged for the results. When asked if participants felt energy efficiency is important, those who paid their own electric averaged 4.6. When presented the same question, those that had it included in rent averaged 4.8. When asked if participants were concerned about the environment, those who paid their own electric averaged 4.5. When presented the same question, those that had it included in rent averaged 4.7. When asked if participants would like to save money on their electric bill, those who paid their own electric averaged 4.8. When presented the same question, those that had it included in rent averaged 4.7. When asked if participants were likely to perform some kind of energy efficient retrofit after the module, those who paid their own electric averaged 4.8. When presented the same question, those that had it included in rent averaged 4.3. When asked if participants were likely to perform some kind of energy efficient retrofit for environmental reasons, those who paid their own electric averaged 4.7. When presented the same question, those that had it included in rent averaged 3.8. When asked if participants were likely to perform some kind of energy efficient retrofit for financial reasons, those who paid their own electric averaged 4.9. When presented the same question, those that had it included in rent averaged 4.0. Figure 5 provides graphical depiction of this comparative data.

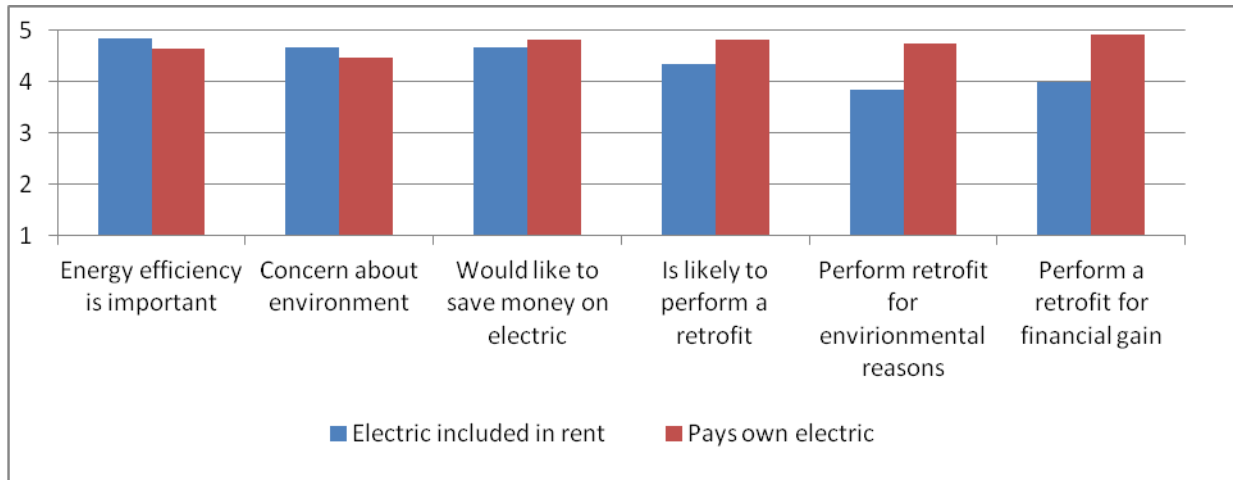


Figure 5. Bill Payment Differences

Implications / Discussion

Implications

Results from this study supported previous research and also highlighted areas for further investigation. Participants who paid for their own electric bill reported that they had a greater desire to save money on electricity, as well as were more likely to perform energy efficient upgrades in general, for environmental reasons, or environmental reasons. In contrast, participants who had their electricity included in rent rated energy efficiency as more important and were more concerned about the environment. This is supported by previous research where La Jeunesse (2013) and Pivo (2012) argued that a limited accountability of energy use remains an obstacle to incorporation of energy efficiency measures. Those who have electric included in their rent have less incentive to reduce their consumption as they do not directly experience the monetary benefits of efficiency measures. This is reflected in those that have electric included in rent, rating themselves as less likely to perform energy efficient upgrades. It is proposed that this population either requires a more fully developed educational module that covers intrinsic motivations for change or extrinsic incentives.

Additionally, previous research by Alberini, Banfi, and Ramseier (2013) is also partially supported with this study's findings. Upgrades were more likely to be accomplished when environmental and economic incentives were recognized by the individual. Results from this study support both areas; however, financial benefits were rated as a greater incentive than those of an environmental nature. This is potentially a result of the responding population's demographics and further research needs to be done to uncover more detailed information.

Discussion

This project worked to address the most effective incentives previous research has found to affect behavioral change. The module resulted in an increase in participants self-assessed ability to select solutions in each of the four content areas. Although the module was well received, more thorough research remains to be done on the assurance of behavioral change in the target audience. The greatest limitations of this project are perceived in the area of the small respondent pool, brief timeline of the study.

When considering the participants to the study, there were several areas in which a larger respondent pool may have given a greater understanding on the impact of demographic information. Although the study was open to participants ages 18 and above, there were no participants under the age of 24, and only one over the age of 40. This is potentially a result of the nature of the project, targeted at renters. The limited population sample in age groups below 24 and above 40 makes it difficult to determine if there is an age-based trend for the willingness to learn about energy efficiency measures. Additionally, the educational levels of the sample population was also limited. Similarly to the age pool, the sample group did not adequately represent the target audience as a whole. The population was skewed toward undergraduate educated individuals, leaving those with other educational backgrounds under-represented. The limited educational diversity of the population prohibits implications on attitude and potential behavioral change based on this demographic information. This is a potential result of recruitment measures taken by the facilitator and leaves room for research as to the impact of education level on attitude and potential for behavioral change.

Based on comparative results of those who pay their own electric bill and those that have it included in rent, those who pay their own electric seemed to have greater meaningful outcomes

from the module by being more likely to change their behavior and incorporate energy efficiency strategies (see Figure 5). To improve upon this study, motivating factors for individuals that do not pay their own electric bill need to be examined further. Additionally, a study with a longer timeline would provide information as to whether or not actual behavioral change occurred as a result of completion of the modules.

Conclusion

The purpose of this instructional design project was to develop and evaluate an online resource that would teach renters how to select solutions to increase energy efficiency in their home. Comparison of the pre- and post-surveys found that the module was successful in increasing participant's self assessed ability to select energy efficient solutions in each of the four content areas. Additionally, the study revealed that those that pay their own electric bill are more likely motivated to complete energy efficiency upgrades after learning about energy efficiency in opposition to renters who have included electricity in their rental agreement. This is in support of prior research which found individuals who have electricity included in rent are less financially responsible for their electric use. When looking at motivation in completing these upgrades, financial reasons outweighed those of an environmental nature. Due to the fact that those that have electricity included in their rent do not receive as much, if any, financial incentive to complete retrofits, one can see why the module content seemed to be better received by those that do pay their own bill.

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