The Energy Contest Cover Page
Rutgers New Brunswick Undergraduate Students

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Cover pages should be submitted along with the proposals **on or before April 1, 2013** to via email to bea@marine.rutgers.edu.

Proposal Title: Reducing Utility Consumption via Incentives (RUCVI)

Total number of pages (not counting cover pages):

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200 word (maximum) summary of the proposal or video:

In the following paper, we propose for the implementation of a novel incentivisation program which, in close collaboration with the Residence Hall Association, we believe can serve to reduce this discrepancy to the greatest extent possible. It goes roughly as follows:

> *Step 1:* Measure average electricity, heating, and water usage per residence hall; set a realistic target for reduction of energy expenditure (i.e.: reduce 10% of this measured consumption) for subsequent years

Step 2: Implement a monetary reward system, coupled with real-time visual feedback of energy savings, to maximally incentivize students to reach and surpass this target figure

Step 3: Carefully monitor term-by-term statistics to revise the program implementation strategy and further optimize revenue

The remainder of this proposal essay elaborates and provides numerical justification for the viability of such a procedure, and outlines a course of action so that it can be actualized as readily as next year

Background

From our very first days living in Barr and Mattia Halls, Matt, Joe, and I have observed that energy expenditure in residential buildings is unnecessarily high. As on-campus students are billed a flat semesterly fee for electricity usage rather than on a per unit-consumption basis, a seemingly ubiquitous practice is to leave lamps, fans, televisions, monitors, gaming consoles, and other electrical devices turned on in the dorms and lounges, even when not in use. Additionally, without any incentive — financial or otherwise — heating and water utility costs will remain well above the sufficient rates of consumption; in fact, one could even argue that, with the current system of billing, students are motivated to waste more (their parents voices echoing, "make the most of what we are paying for!").

While we can appreciate the need for the university to issue general utility bill deadlines prior the commencement of each semester, the reality is that students are being grossly ill-prepared for the energy rationing requirements of the real world. Environmental impact aside, university graduates on typical entry-level salaries inevitably cannot afford to consistently indulge in 78-degree heating conditions, 40-minute hot showers, and televisions that remain turned on throughout the remainder of each night. More consequentially, however, it remains a fact of matter that the mere conveniences afforded to students by such cost-inducing habits do not even begin to justify the hefty financial burden that the university has to bear as a result.

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Environmental Impact

In the United States, the average resident spends more than ninety percent of their lives inside residential and commercial buildings, accounting for approximately two-thirds of total electricity usage and one-third of greenhouse gases in the nation. In fact, the ultimate of the energy expenditure in these environments is a substantial and highly negative impact on climate, disease, water depletion, pollution, and habitat destruction, and thus defines a problem that rightfully needs to be addressed. In particular, due to the widely prevalent wasteful energy consumption habits in residence halls, college dormitories naturally present themselves as impactful preliminary targets for go-green campaigns, as it encourages our nation's youth to develop energy-conscious habits that will serve the environment well as we progress into the future. However, from anecdotal experience, the authors of this proposal feel that, to date, no long-term changes in behavior have been observed in the general on-campus public, and that

excessive electricity, water, and heating consumption in such buildings are just as omnipresent as they have ever been(Petersen et al.).

Incentives

It is with this issue in mind that we call for the RUCVI program, a novel strategy that incentivizes students to become more environment-conscious via a monetary reward system which, coupled with real-time visual feedback of their energy savings, we believe can create beneficial habits that they hold on to long after graduation. As described in the introduction, a target reduction goal is defined at the beginning of the school year; for the purposes of simplification, let us say that campus officials desire at least a 10% reduction in energy consumption by student residents, which, from evidence we will cite later, seems to be a realistic and attainable figure. Next, through extensive collaboration with the residence hall association and other partners, students are motivated to surpass this goal to the greatest extent possible. This is done by incentivizing them financially: every dollar in energy savings produced by a student's dormitory or hall residence beyond the reduction target will be reimbursed to the students as a prize for their change in behavior. Thus, students will be benefit directly from their actions towards cutting out their wasteful practices, while Rutgers will receive the 10% savings back as revenue.

It is worth elaborating on specific strategies that we believe should accompany the project implementation. Firstly, collaboration with the RHA is crucial to the success of this proposal; we are of the opinion that with properly trained residence and apartment assistants, students can be motivated to keep consistent with their energy saving habits. This ties closely into the reasoning for our choice of the target scope and implementation frequency for the project (i.e.: individual residence halls should participate on a semesterly basis). When students

are part of a close-knit community, such as a single dormitory residence, rather than an entire campus, they feel more accountable for the individual contributions they make to the success or failure of the community as a whole. We believe that with enthusiastic RA's and AA's in particular, who themselves are perhaps incentivized by an additional reward (such as a gift card) on top of the monetary reimbursement, students will feel obliged to put more effort into reducing energy consumption for the sake of their peers. The choice of a per-semester frequency was made due to reasons of convenience and ideal length.

In addition, extensive research has been done on the effect of real-time visual feedback on the reduction of electricity consumption. Hence, we call for the integration of a web-based system that allows student to monitor the immediate effect of their change in behavior on energy savings and the environment, which in itself is a strong motivator for appropriate action. Further, such a system allows for projections to be made with regards to how much students can realistically expect to be reimbursed, and can even state the top-saving dorms week-by-week to spark a bit of competitive camaraderie. It should be noted, also, that the development of a program for such a system will be cheap, as we briefly describe later a means to market off the idea as a project in a capstone design course in the computer science or ECE curriculum.

Important clarifications should be described with regards to the type of information that will be monitored. In the research article by Peterson, et al., two types of resolutions for feedback were examined in their effects on energy savings: low resolution and high resolution. In the low resolution feedback, average data was only given for individual dormitories on a monthly basis. In contrast, high resolution data could provide with instantaneous feedback on individual rooms and even individual appliances. Although results demonstrated a 21% addition in reduction when high resolution monitoring systems were implemented, we believe that the expense — nearly

$10,000 per installation — does not justify the initial investment. However, we believe that a high resolution feedback system can be utilized in subsequent years if our program is implemented as follows: 1.) use low-resolution monitoring systems to target freshman-based dormitories first, which, statistically performed 43% better when confronted with energy savings incentives, then 2.) implement high resolution monitoring systems for upperclassmen in subsequent years with the revenue earned (Petersen et al.).

Viability

In the study done at Oberlin College, there was an impressive performance showcased by the small test group. During the two-week period, the 1688 students were able to save $5,368, which equates to $3.18 per student ($5,107 in electricity savings, $261 dollars in water savings). Scaling up to Rutgers's size, a semester long test of fifteen weeks for roughly 6,400 freshman, on-campus students would yield an estimated minimum of $152,640 savings. At Oberlin college, the overall reduction in electricity use (the primary mode of savings) was thirty-two percent, but in the two primarily freshman dormitories they averaged a staggering forty-six percent reduction. Thus, initiating our program with only freshman would maximize the rate of reduction of consumption and thus yield a higher than predicted value. Moreover, the $150,000 savings is farther inflated through heat savings that were not calculated in Oberlin's study and also the additional incentives included in our proposal such as the rewards system and key card device. In the long-term usage of this proposal, expanding to Rutgers's 10,380 on-campus students and calculating with Oberlin's thirty-two percent reduction that resulted in an average $3.18 savings, Rutgers can potentially save an estimated $247,563 through our proposal. Compared to the low costs of initiating and maintaining our program, this yields an a large percentage of profits for Rutgers, and much that is returned to the student body. With nearly half-a-million dollars in

savings per-year from an elementary proposal, the savings will only increase as our process is refined and stabilized to find the correct equilibrium point for maximum profits. (Petersen, Shunturov, Janda, Platt, Weinberger 23-3

Implementation Plan (2 Year Plan)

Step 1: Capstone Design Project for Electrical and Computer Engineers (September 2013-May 2014)

Senior Electrical and Computer Engineering students are given the option of creating and designing website and phone applications to monitor consumption of various utilities through a Low and High-Resolution Monitoring system for their Capstone Design Proejcts.

Step 2: Installation of the Low-Resolution Monitoring System in Freshman dormitories (July 2014)

Initial monitoring system is up and running to obtain real-time data from target audience when school semester begins.

Step 3: Implementation of Training Program to RHA (August 2014)

RA's and AA's are informed on how the proposal is structured and ways to reduce energy consumption. RA's and AA's interact with students to provide motivation and guidance for participating in this proposal.

Step 4: Environmental Awareness Week & Announcement of Contest (First week of September 2014)

Freshman students are introduced to the program and the rewards system and also given tips on how to save energy.

Step 5: Diagnostics & Analysis of Figures of First Semester (December 2014)

Data is analyzed to indicate which areas of the proposal need improvement and how energy and profits can be maximized for the next semester.

Step 6: Installation of High-Resolution Monitoring System and Key Card device (January 2015)

Upgraded monitoring system is installed to further incentivize students to save. Devices are installed in dormitories that require students to insert their key card in order to turn on the electricity in their room. This prevents wasting electricity while student rooms are vacant.

Step 7: Diagnostics & Analysis of Figures (May 2015)

Data is analyzed and compared to previous semesters to indicate which areas of the proposal need improvement and how energy and profits can be maximized for the next semester. The proposal is now in full effect and this step is repeated until the process achieves maximum efficiency.

Works Cited

John E. Petersen, Vladislav Shunturov, Kathryn Janda, Gavin Platt, Kate Weinberger, (2007). "Dormitory residents reduce electricity consumption when exposed to real-time visual feedback and incentives", International Journal of Sustainability in Higher Education, Vol. 8 Iss: 1, pp.16 – 33.

Shabecoff, Philip. "Earth Rising." *The New York Times - Breaking News, World News & Multimedia*. N.p., n.d. Web. 2 Apr. 2013. <http://www.nytimes.com/books/first/s/shabecoff-earth.html>.