Recommendations of Potential Interventions that Could Motivate Reductions in Residential Energy Use at the Husky Village Housing Complex, UW Bothell

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Abstract

Husky Village current has the highest energy consumption per person on the UWB campus, which has made finding means to reduce energy use in this facility a high priority. This study was designed to contribute to efforts to lower the energy footprint of Husky Village. Primarily, the study sought to test discrete interventions to motivate a decrease in energy use among residents of Husky Village following promising methods used in the literature. I sought to explore how two potential intervention processes, providing feedback on energy consumption and encouraging goal setting, could impact subsequent energy use, and developed a factorial experiment to test the efficacy of these methods alone and in combination. Unfortunately, only one unit of students opted to participate in the intervention and survey. Although it is possible that students reduced their energy use in response to the notice regarding the study alone, no significant differences in energy use over the course of the study were seen among the treatment groups. Secondarily, this study contributes a fine scale analysis of the electricity metering data from the apartments that could be used for future administrative interventions. I found that three apartments had unusual energy consumption, which should be investigated further by campus staff. Recommendations are made for more successfully engaging students in assessments and interventions to encourage participation in energy conservation efforts at Husky Village. In addition, suggestions are made for policies that could reduce energy consumption over the short term.

Introduction

Energy conservation in student housing has become a renewed area of academic focus. During the 1970s, scholars tried to develop different interventions to motivate reduction in household energy consumption due to the energy crisis caused by the Arab oil embargo. Today, studies of energy consumption continue to focus on methods to reduce household electricity use, as the urgency for energy conservation has increased due to the threats from global climate change.

At the University of Washington Bothell (UWB), sustainability is one of the seven priority areas for the campus, having become a focus for campus operations, as well as curricular development. UWB developed a reputation for working at the forefront of sustainability initiatives, yet campus energy use greatly increased when the campus added a block of apartments for student housing in 2011.

Husky Village, as the largest apartment site in UWB, reached its full capacity (220 students) in Autumn 2011. Despite its utility in providing housing, Husky Village poses a problem to the campus due to its high energy demand. In March, 2013, Husky Village used 18 % of total energy consumption in UWB, which was the second largest share of all UWB buildings. As a result, UWB is actively seeking means to reduce the energy use within the student housing complex.

As the first energy conservation study of UWB student housing, the primary goal of this study was to test potential interventions that could be used to promote energy conservation in student housing. The second component of the study sought to undertake a survey to understand how interventions change resident's energy consumption behavior through enhancement of cognitive abilities, specifically recognition of behaviors that influence energy use. The third goal of the study was to explore relationships between energy consumption and geographic factors, such as floor levels and hall locations.

This capstone report summarizes key findings in the literature regarding motivating energy use reductions, describes steps taken in a pilot study to employ such methods, and makes suggestions to the campus for future studies that could better assist in motivating students to reduce their energy consumption.

Background

Although studies of energy conservation from the 1970s to the present mostly relate to households rather than student housing, interventions tested by these researchers are being adopted in new applications to motivate reductions in energy consumption in student housing. One of the most helpful reviews on the topic was completed by Abrahamse et al. (2005), who categorized 38 household interventions into antecedent strategies and consequence strategies, and reviewed evidence for their effectiveness. Among these, a number were seen to be effective in at least some settings, and so are discussed further here. The antecedent strategies include commitment, goal setting, providing information, and modeling. The consequence strategies include providing feedback on energy usage and rewards or penalties for changes in energy use.

A commitment is an oral or written pledge or promise to change behavior (e.g. to conserve) in public, and is effective because residents will receive social pressure to conserve after they agree to make a specific commitment. Goal setting entails giving households a reference point to conserve. Becker (1978) found that a fairly ambitious goal is one of the most effective interventions to reduce electricity usage. In her experiment, she assigned a 20% energy reduction goal or 2% energy reduction goal to households and monitored their electricity use. She found that households with a 20% goal successfully reduced energy consumption, while those with a 2% goal did not reduce their energy consumption very much (Abrahamse et al. 2005, p. 276).

Provision of information or consumer education is a commonly used strategy to promote energy conservation behaviors. For example, the information can relate to energy-related problems or specific information about possible solutions. However, Hayes (1977) found that providing information alone does not have strong impacts on energy reduction unless this strategy is combined with other strategies, such as feedback and economic incentives (e.g., cash payments). Furthermore, Abrahamse et al. (2005) noted that consumers tend to have higher motivation to reduce energy consumption if they are willing to study the information provided. Thus, this study suggests the importance of consumer's educational backgrounds in influencing the success of intervention strategies.

Feedback strategies consist of giving households information about their energy consumption or energy savings, which can be given as feedback that is continuous, daily, weekly, monthly, and/or comparative (e.g., by an electronic system such as a smart meter system). Feedback can be electronic (as above), via an external intervener (experimenter), or by self- monitoring. Van Houwelingen et al. (1989) found that families receiving daily feedback from self-monitored electronic systems reduced their natural gas consumption by more than their original conservation goal (12.3% vs. 10%). In contrast, Siero et al. (1996) found that residents achieved the highest energy savings when provided comparative feedback regarding their own reductions and that of neighbors. Although these two studies presented results from externally-provided comparative feedback and self-monitored electronic systems, Abrahamse et al. (2005) concluded that the effectiveness of feedback systems is unclear because prior researchers used a combination of interventions in their studies.

Providing financial incentives for energy conservation can also promote energy savings in households. Gamtessa (2013) analyzed the EnerGuide for Houses (EGH) program (a Canadian government energy conservation program) data from 1998 to 2005, and concluded that energy cost savings, financial incentives, and costs of retrofits are major factors in consumer decisions to reduce energy consumption in households. For example, he found out residents have higher incentive to save energy if they also have higher expectations of financial rebates. Hayes et al.,

(1977) examined how the pay-off structure influenced energy consumption reductions in student housing, and then applied feedback and information as extrinsic motivators in later stages of their study. Specifically, they randomly assigned multiple-baseline pay-off structures where the payoff increased for those who reduced their energy use by higher amounts (e.g. 10% to 19% reduction earned $3, and 20% to 29% earned $9) and external motivations (e.g. feedback and prompts) to four apartment units in student housing. Residents in these apartments units originally did not need to pay for electricity because their rental payment had already included all utilities, which is parallel to the study case of Husky Village. After their experiment, Hayes and Cone (1977) found that the most important factor influencing student consumption patterns was the pay-off structure, and that neither feedback nor information influenced student energy use behaviors significantly. In contrast, Winett et al. (1978) noticed that feedback was one of the most important factors influencing reduction in energy consumption in their test of high vs. low monetary rebates given to households that cut their energy use. Again, it is difficult to discern what is most influential because all the researchers used a combination of interventions in their studies (Abrahamse et al. 2005).

Another intervention that has been shown to be effective is modeling, based on Bandura's (1977) learning theory, which entails providing examples of recommend behaviors for energy conservation and showing the consumer the savings that would result from adopting those behaviors (Abrahamse et al., 2005, p. 277). For example, Winett et al. (1985) used a national cable TV channel to deliver a program, entitled "Summer Breeze", to provide communication and social learning aspects of energy conservation. This program was meant to be engaging and memorable, and was characterized by rapid pacing, a theme song related to conservation practices. The program emphasized key points of effective energy conservation practices, and repeated the key points throughout the program. Winnet et al, (1985) found that after the residents were exposed to the programming for 20 minutes, they saved around 10% of energy in the cooling and heating seasons. In addition, Winnet et al., (1985) further suggested that a small media effort from local programs could be more economical than large-scale media efforts (national cable TV channel) because this lowers cost to broadcast the programs. In the 21st century, social media provides another choice to promote the modeling.

Emeakaroha et al. (2012) discussed the challenge of improving energy efficiency with today's technology in student housing. They reviewed and analyzed six studies on energy conservation in student housing units from the U.S.A, Australia, and New Zealand. All the studies showed that feedback on energy consumption patterns was the intervention that most effectively reduced energy consumption in student housing. Furthermore, they also showed that comparative feedback, modeling, and electronic systems of feedback could be combined effectively to motivate energy conservation in student housing environment. For example, Indiana University, Bloomington (IUB) collects real-time energy consumption data at the individual unit level via its smart meter system, and then publishes the data via social media to create an energy conservation competition. The social media also highlights how the top six energy savers adopted different energy saving behaviors (e.g. unplugging their chargers or shutting off computers at night) to promote modeling to other residents.

Corradi et al. (2012) further explained how energy conservation interventions can result in energy saving behaviors through modification of cognitive effort. They theorized that cognitive abilities, such as sustained attention, processing speed, and working memory, were positively related to energy conservation behavior. They inferred that interventions can reduce failure of cognitive abilities that can occur as people multi-task, and forget to attend to tasks that require consistent effort, such as energy conservation. They hypothesized that residents would be more likely to engage in energy saving behaviors that do not require as much sustained attention or memory. They also discuss that some residents might resist energy saving behaviors if they have larger concerns that are met by using more energy, e.g., if residents turn on lights to prevent robbery when they leave home.

Study Site Characteristics

University of Washington Bothell (UWB) seeks to be a leader in sustainability for the state, citing environmental sustainability as one of the seven priorities in 21st Century Campus Initiative (UWB, 2013). Accordingly, UWB has adopted comprehensive interventions to reduce energy consumption on its campus over the past decade (A. Guerrero, pers. comm., 2012). For example, most of the buildings in UWB/ Cascadia Community College (CCC) joints campus have already installed Johnson Controls Metasys building automation and control systems in 2001 to adjust heating, ventilation, and air conditioning (HVAC) in order to reduce energy consumption during different climate conditions. The joint campus also installed solar power systems and electrical car chargers in parking garages to reduce emission from power generators and transportations. In 2010, all water system and electrical systems in the campus were connected to the energy dash board via smart meters. The UWB and broader public can check water and electrical consumption in real-time through the dash-board on the internet (http://buildingdashboard.net/uwb-ccc/).

Beside hardware, the campus also has several organizations that cultivate environmental awareness through academic courses, administrative departments, and student organizations. At the administrative level, the Chancellor's Advisory Committee on Environmental Sustainability (CACES) has responsibility for setting up a sustainability guide, as well as fostering sustainability efforts on campus. CACES reports to the Vice Chancellor annually (UWB, 2013). Members on the committee have diverse backgrounds, including students, faculty and administrative staff. At the student level, the UWB Sustainability Organization and its Cascadia Community College counterpart hold joint campus activities to promote sustainable living to all students in UWB and CCC (Sustainability Organization UWB/CCC, 2012).

In 2011, UWB acquired its first student housing by purchasing an apartment complex adjacent to the UWB/CCC joint campus, which was renamed Husky Village. Constructed in the mid-1970s, most of its public facilities (e.g. water and electrical meters) were installed during 1980s (Stroup, 2013). All of the apartment units in the site have an individual electrical meter, but the water meters are shared by one hall, which has 6-12 units. Each apartment unit has a private restroom, laundry, and kitchen. Through Spring 2013, UWB has kept the original structure of all the units and halls, with 90 apartment units spread across five halls (Aspen, Cottonwood, Dogwood, Oak, and Hawthorne). The total area and descriptions of Aspen, Cottonwood, Dogwood, Oak, and Hawthorne Halls are listed in Appendix 1: Tables A1-A3. A site map to Husky Village that indicates the location of the halls, and the interior designs of the 640 sq. ft. units are shown in Appendix 2: Figures A1-2, respectively. Husky Village reached its full capacity of 220 occupants in Autumn 2011, however, the facility lacks an energy conservation plan.

A recent report of energy usage across the campus (UWB, 2013) showed the UWB campus has reduced its energy consumption steadily, despite increased growth in the staff and student populations, with one exception – Husky Village. The overall energy consumption at Husky Village is quite high, especially when considered per capita, and thus, the campus could benefit from efforts to reduce energy consumption in this facility. Although energy savings can be met through modifications of the facility itself, at least some of the energy demand may be caused by high energy use by student occupants. This study was developed to try to help reduce the energy demand by UWB students living in Husky Village.

Study Design

To test potential interventions that could be used to promote energy conservation in student housing, I developed a simple factorial experiment to contrast the efficacy of two potential interventions – goal setting and feedback. The use of a factorial design was meant to avoid the problems of prior studies that confounded several interventions. As one of the antecedent strategies, set A would tell residents their previous energy consumption amount, and then ask them to set a % goal to cut energy consumption, which may help them increase attention paid to their energy use. Set A also would receive a report of their energy consumption data weekly as feedback to enhance working memory. Set B would assign the same % goal to residents, but would not report energy consumption amounts to them. Set C does not assign a goal to residents, but would report energy consumption amounts to the residents weekly as in Set A. Lastly, residents in set D wouldn't receive any intervention, but would serve as a control, and energy consumption data would continue to be collected to compare with other sets.

To establish a baseline record of energy consumption, I measured each apartment's energy consumption weekly from Jan 29, 2012 to Mar. 12, 2012 as background data. I selected 24 double occupancy units in Husky Village of identical size, electrical application, occupants, and interior installations to be the focus of my intervention experiment. According to Linenberger

(2013), these apartments have standard electrical configurations, the same number of occupants, and equivalent style of interior installations (e.g. thick of window glass and window shades). The housing department has regularly inspected the units to ensure these standards are maintained. However, residents may install extra electrical appliances or change interior installation (e.g. add extra window shade) for personal uses, which may change their energy consumption. Thus, as part of this study, I intended to survey residents to investigate any such changes for further analysis. Despite having similar layout, etc., the units did vary in terms of several environmental parameters, such as floor levels, orientation to the sun, or shade by trees, any of which might also influence energy consumption in these apartment units, and thus these variables were also explored in this analysis.

I randomly assigned these units to one of four treatment groups: goal setting with feedback (set A), goal setting only (set B), feedback only (set C), and control (no intervention, set D) (see Table 1). Six units were assigned to each treatment group.

Set	Goal Setting	Feedback
A	✓	✓
B	✓	✗
C	✗	✓
Control	✗	✗

Table 1. Energy Conservation Intervention Design with Set A, Set B, Set C, and control (or Set D).

In a letter inviting students to participate in the study, I also included a survey of their energy use habits. Students were to be surveyed both before and after their participation in this intervention to understand their behavioral changes. The survey did not include demographic questions at this stage because I assumed that as students, all would have a similar educational background (as all are enrolled as undergraduates at University of Washington Bothell), and relatively low variance in economic status. The invitation letters are provided in Appendix 3, while the complete survey is in Appendix 4.

Before I distributed the invitation letters and surveys to the residents, the resident director had posted my brief resume and an introduction of the study to the Husky Village newsletter. I selected all 640sq. ft double-occupancy units from Aspen, Cottonwood Dogwood, Oak, and Hawthorne as the target population for the study to keep apartment unit size and number of residents (2/unit) consistent across treatments. Secondly, I randomly assigned the units to one of 4 treatments, 3 sets of interventions and 1 control, placing 6 units in each treatment type. After making these assignments, I delivered a paper letter to the mail boxes of the residents in the experimental groups, but not in the control, asking them to enroll in the study. All the letters were written to encourage a sense of community, telling residents that their contributions will bring positive impacts by helping make UWB the greenest college in WA (See Appendix 3). At the same time, residents were asked to complete a short survey about their energy use behaviors, which was to be repeated at the end of the intervention. The letters and surveys were sent to resident mail boxes by the resident director, so the residents would have less chance to know the details of each other's interventions. If the unit residents wanted to join the study, they needed to finish the survey form and then put it on their doorstep within 5 days. I went to collect the letters once a day over those 5 days during the evening. The whole experimental process above is shown in fig. 1 below.

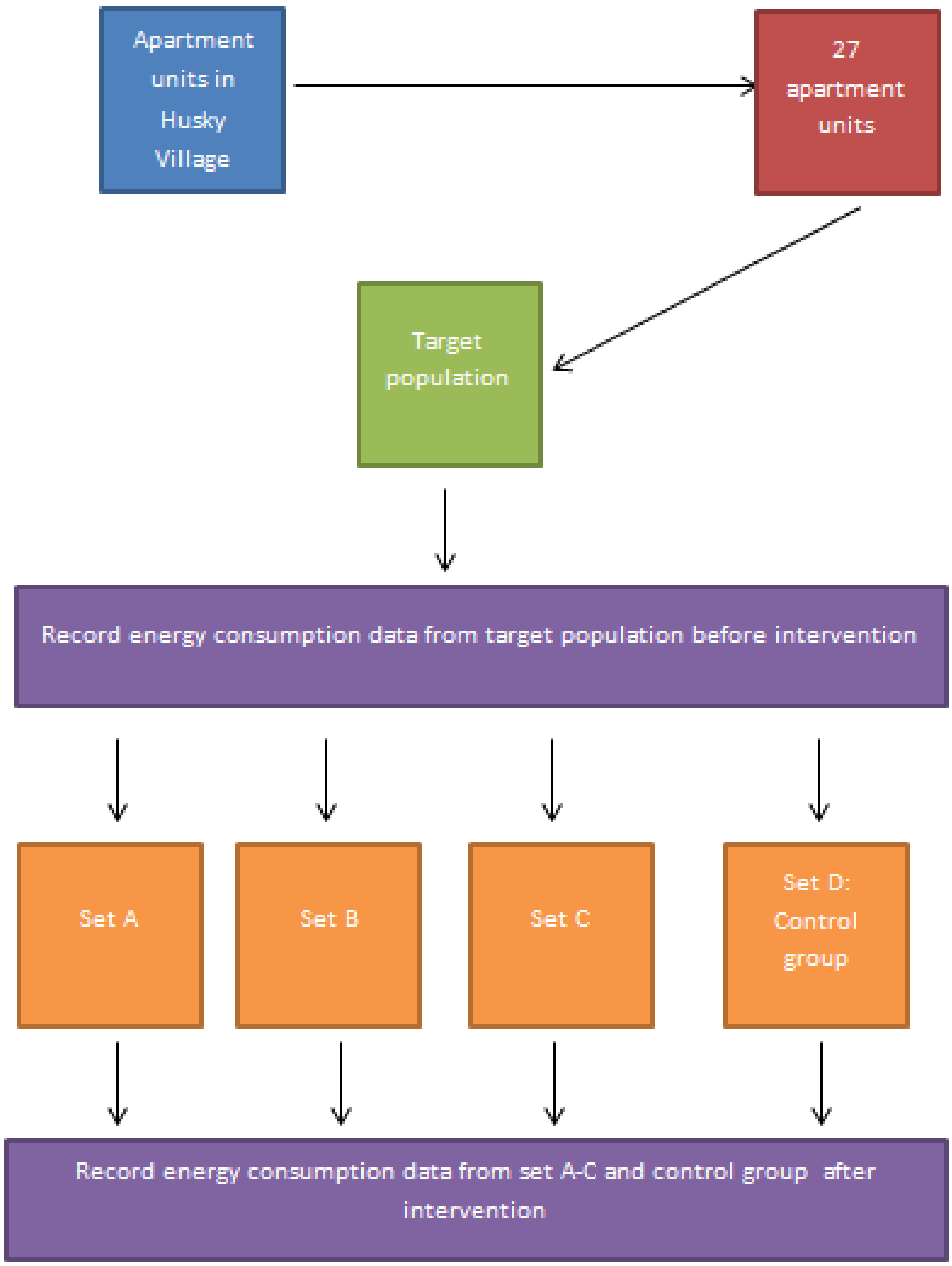


Fig. 1. Experimental Design of Intervention Study in Husky Village. Twenty-four of the 27 double occupancy units were randomly selected for inclusion in the study.

Based on my literature review, I predicted that those units that both set goals and received feedback on their energy use (set A) would show the greatest reduction in energy use, followed by those units that either were encouraged to set goals alone (set B) or received feedback on their energy use (set C), and that units in the control treatment (set D) would show the least less reduction. I expected all of the units to use less electricity over the study duration, as both daylight and temperatures were increasing over the study period.

Energy use data were collected weekly for all the units, including the control (Set D) from 4/9 to 4/23. The data were calculated as the difference between weekly meter readings. I sent the letters inviting students to participate in the research study and requesting them to respond to my survey on 4/27. Their energy consumption was measured again on 4/30, which I considered to be a transitional week between the pre-treatment (before the letters had been sent) and the post-treatment period (after the letters had been sent). I continued to measure energy consumption data weekly from 4/30- 5/14.

Hypotheses

There are were three null hypotheses to be tested in this study.

H_{01}: All the units have equal electricity consumption on average.

H_{02}: After the letters were delivered (the interventions), residents will consume equal amount of electricity as before.

H_{03}: The two factors are independent and an interaction effect is not present.

Statistical analysis

After all data were recorded, I used MANOVA to explore relationships between intervention treatment and energy use. Treatment and date were used as main effects in the model. Both average weekly temperatures and day length were added as co-variates to control for changes in environmental conditions that would affect energy use. Because as the study progressed, we transitioned from Winter to Spring, bringing slightly warming temperatures and longer day lengths. Both of these environmental changes are expected to decrease energy use, regardless of treatment, and thus these variables were included as co-variates.

The data of average weekly temperatures were retrieved from Weather.com (Weather, 2013), and the data of average weekly day length were retrieved from Timeanddata.com (Timeandate, 2013). Because Timeanddate (2013) does not provide the day length data for Bothell, this study used the data from Seattle, which is the closet city to Bothell. The day length data were converted from standard time to decimal time.

Post-hoc tests were used to determine if the units in the control set were different from the units in A-C sets. In addition, post-hoc tests were used to explore whether there were any differences in energy use between floors or hall locations.

Finally, graphs of energy use over time were used to visualize differences in energy consumption among the units and to explore changes of energy used over the study period.

Results

Analysis of the preliminary electricity usage data collected from February 5-March 21 2013 showed that the apartment units together consumed 20% of the total campus' electricity use. Fig. 2 compares the consumption of the apartment units with other buildings on the campus, showing that the single largest fraction of energy use was made by the Husky Village apartments – more than the consumption of the largest academic building on campus, UW1. The significance of the difference in energy consumption is heightened when we consider that UW1 has 1527 students, faculty and staff using the building from 8:00am to 10:00pm each weekday, while only ~200 residents live in Husky Village (Building Dashboard, 2013).

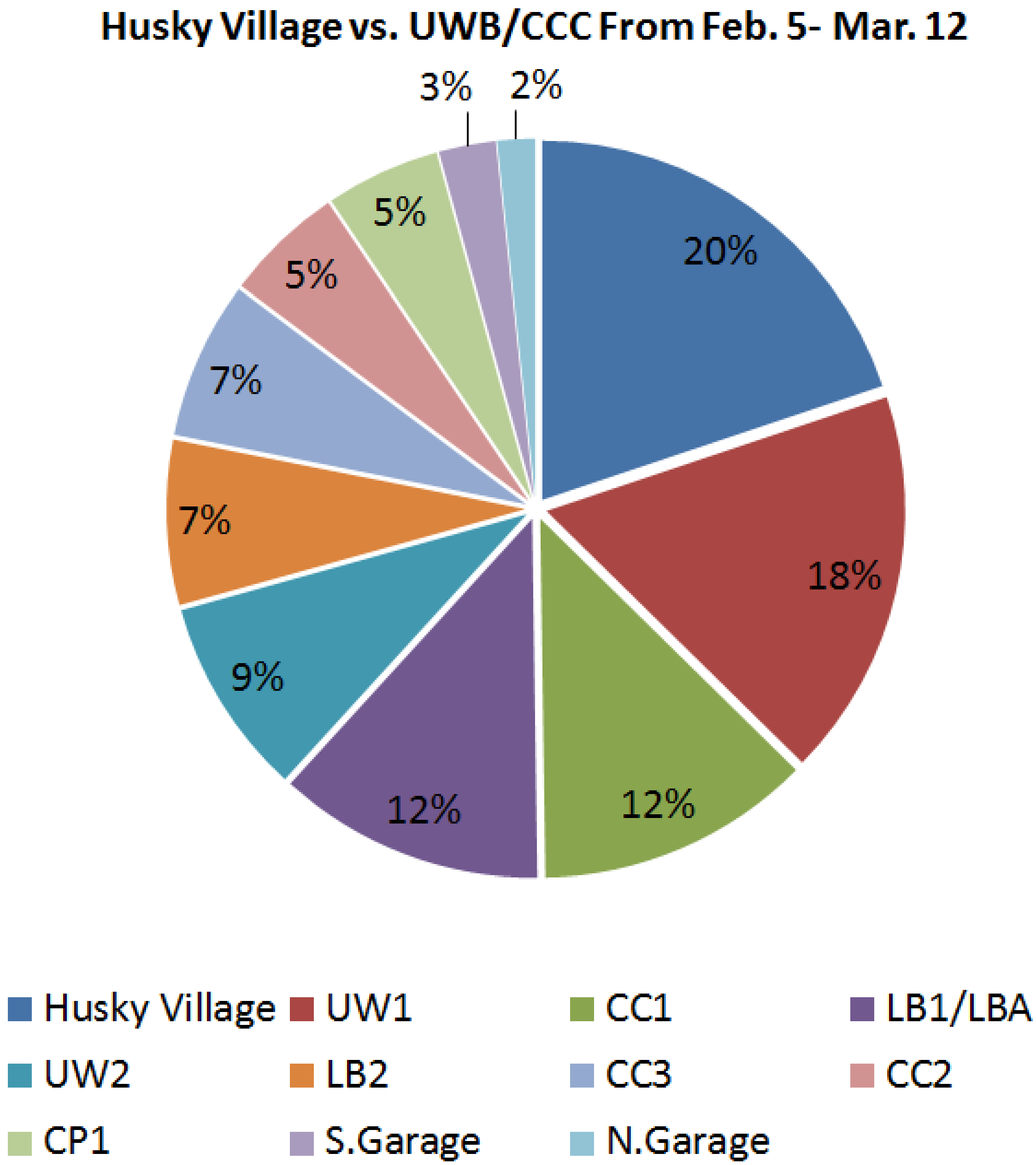


Fig.2, Energy consumption,of the Husky Village apartment units and other buildings on UWB/CCC campus, expressed as percent of total energy use. Data were provided by the UWB Building Dashboard (Building Dashboard, 2013). Note: The "apartment units" does not include the community center in Husky Village or the apartment units in Campus View.

Electricity consumption in each of the designated intervention sets, average temperatures, and day lengths per week are shown in Table 2. In these data, average temperature increased from 45.13 F to 58 F from week 1 to week 6, while average day length increased from 13.52 to 14.96 decimal hours from week 1 to week 6. As predicted, the energy use of the units decreased over the same time period (see also Figure 3a-d).

Time Periods (week to week)	Set A (Ave. kwh)	Set B (Ave. kwh)	Set C (Ave. kwh)	Control (Ave. kwh)	Ave Temp (F)	Average day length (hr)
4/9/2013-4/16/2013 (W2-W1)	199.57	226.14	185.71	245.83	45.13	13.52
4/16/2013-4/23/2013 (W3-W2)	164.43	221.29	172.14	234.17	47.13	13.91
4/23/2013-4/30/2013* (W3-W4)	168.57	181.14	138.43	206.67	50.88	14.28
4/30/2013-5/7/2013(W4-W5)	131	148.57	125.57	173.17	56.38	14.63
5/7/2013-5/14/2013 (W5-W6)	99.29	119.14	102.71	125.83	58	14.96

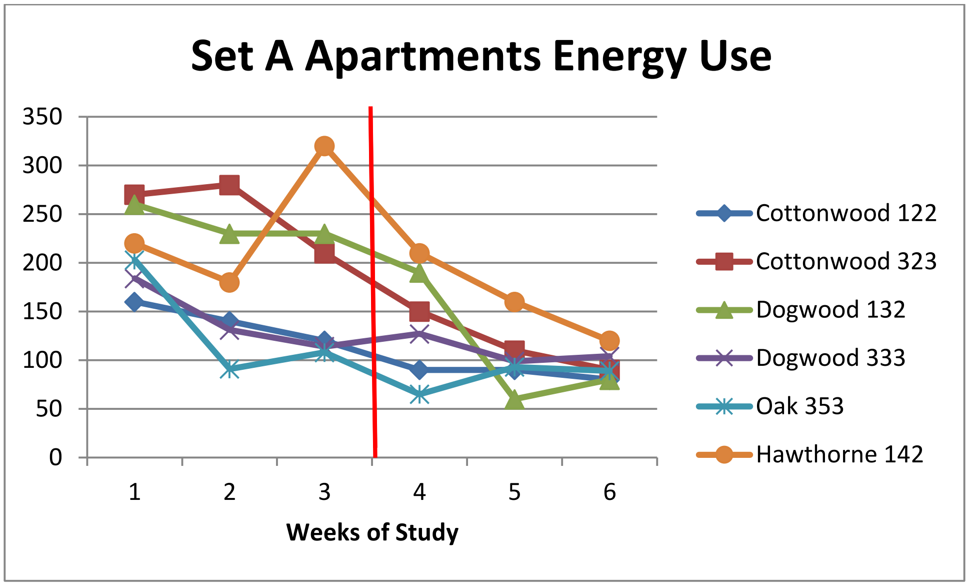
Table 2. Average electricity use by treatment group, temperature and day length from 4/9/2013 to 5/14/2013. The yellow bars highlight the week preceding and immediately after the delivery of the letters inviting students to participate in the study, while the shaded bar indicates the week the letters were received.

Day length explained the greatest amount of variation in electricity consumption, while temperature did not seem to impact consumption over the interval of the study (Table 3). Treatment assignment also had a significant effect on electricity consumption (Table 3), because Set C apartments used less and Set D units used more energy, on the whole, than the other units. However, there was no indication that there was any systematic change in usage over time among the units as shown in the post-hoc analysis (Table 4).

Effect	Wilks' Lambda	F	df	Error df	p-value	Observed Power[b]
Intercept	.109	69.423[a]	2	17	.000	1.000
Temperature	.845	1.313[a]	2	17	.263	.227
Day Length	.329	16.542[a]	2	17	.000	.978
Treatment	.265	4.925[a]	6	34	.001	.958

Table 3. MANOVA of electricity consumption in the Husky Village study units, with Temperature and Day Length as continuous covariates.

Perusal of the energy use of individual units (Figures 3a-d) allow us to see some outliers in energy use, as well as overall patterns among the units. Nearly all the units showed decreases in energy consumption over the length of the study, with a few units staying approximately flat in their energy consumption (e.g., unit Cottonwood 223, Dogwood 233 (both in Set C), Aspen 212 and Dogwood 232 (both in Set B). A few units showed very high spikes in energy use (e.g., Hawthorne 142 and 342) at different points during the study. Interestingly, many units increased their energy usage in the final week of the study. It is unknown whether this coincides with a period of midterms or similar periods where students might be expected to use computers and lights more than usual.


Set A Apartments Energy Use
350
300
250
200
150
100
50
0
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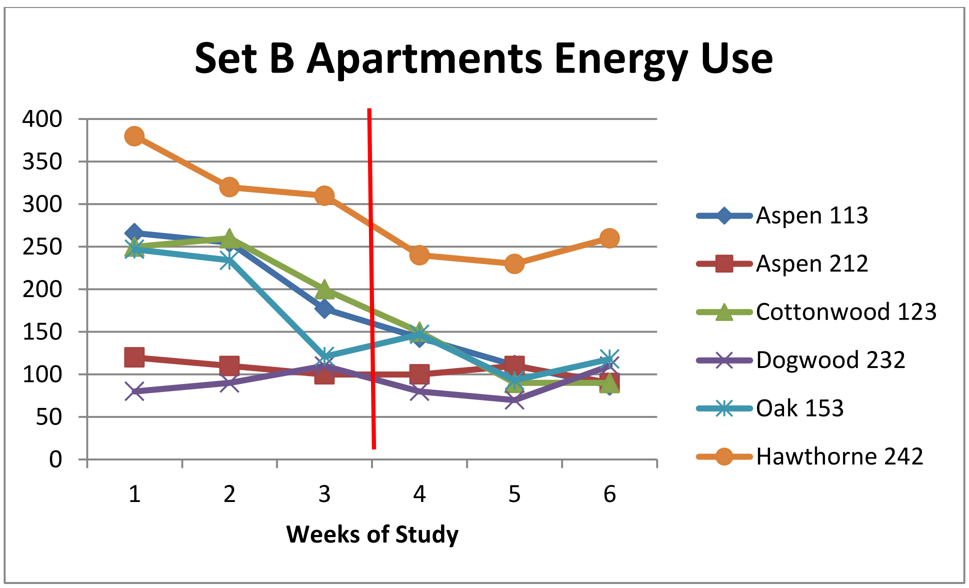
Weeks of Study
Cottonwood 122
Cottonwood 323
Dogwood 132
Dogwood 333
Oak 353
Hawthorne 142


Set B Apartments Energy Use
400
350
300
250
200
150
100
50
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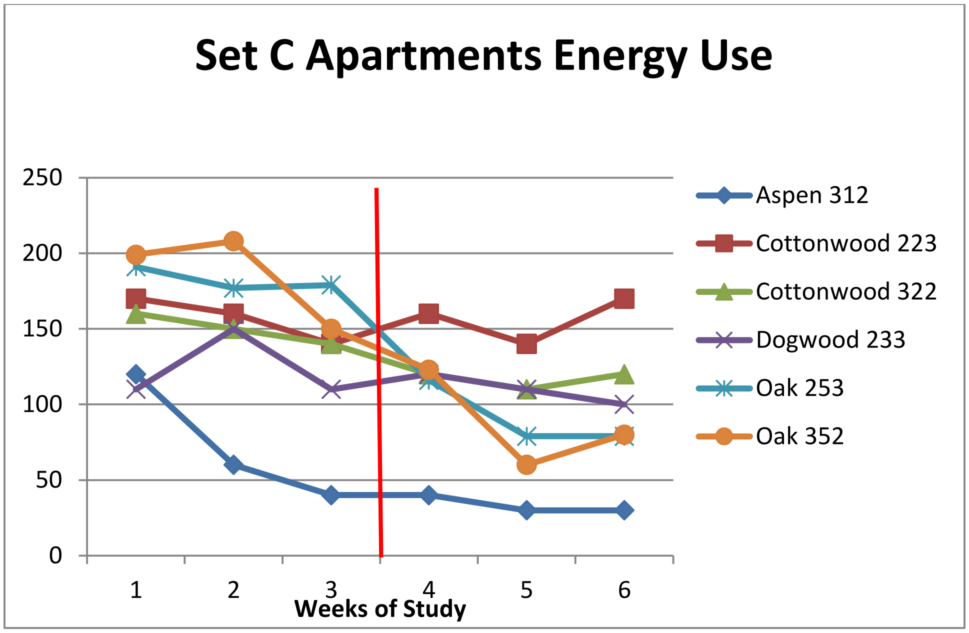
Weeks of Study
Aspen 113
Aspen 212
Cottonwood 123
Dogwood 232
Oak 153
Hawthorne 242



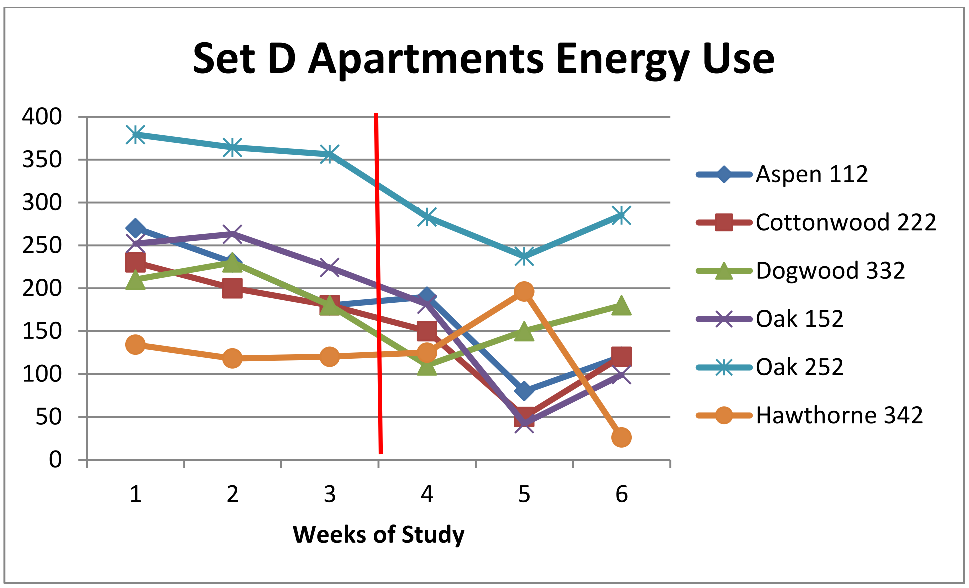


Fig.3a-d, Energy use by treatment groups (sets A –C) and control group (set D) from 4/9/2013 to 5/14/2013 (Week 1-6). The red line separates the weeks preceding the delivery of the letters inviting students to participate in the study, and the weeks following receiving the letters.

The first post-hoc analysis of the MANOVA did not reveal any systematic difference between the treatments (Appendix 7: Table A1). In particular, there was no difference in weekly energy consumption between control set and other sets (set A, set B, and set C: Appendix 7: Table A1). Nor were there any significant differences in energy use among the sets of units I had designated for particular treatments (A vs B; B vs C; A vs C: p=.957; p=.478; p=.774).

The second post-hoc analysis of the MANOVA also did not reveal any systematic difference between the floors (Appendix 7: Table A2). In particular, there was no difference in weekly energy consumption between each floor (floor 1, floor 2, and floor 3: Appendix 7: Table A2). Only in the final week was there a weak, non-significant difference seen between floors 2 and 3, with values from 3 being higher than those from 2.

Similarly, the third post-hoc analysis of the MANOVA did not reveal any systematic difference between the halls, with the exception that Hawthorne showed higher energy use than Aspen in Week 5 and a tendency to have higher energy use than the other units during that same week (Appendix 7: Table A3). In particular, there was no difference in weekly energy consumption between each hall (Cottonwood (Cotton), Dogwood (Dog), Oak, Aspen, and Hawthrone: Appendix 7: Table A3).

. Individual apartment unit energy consumption data from week 1 to week 6 (before the intervention, during the week that the intervention letters were delivered, and after the intervention) are attached in appendix 6. From these data, and as seen in Figures 3a-d, we do see some units have very high energy consumption patterns compared with other units. For examples, Hawthorne 242 and Oak 252 consistently consumed high amount of energy within range 280kwh to 237kwh. Others had low energy consumption, such as Aspen 312, which consistently consumed low amounts of energy within the range of 30kwh to 60kwh. Still others showed large changes, such as Oak 152, which suddenly dropped energy consumption from 181kwh (w5-w4) to 42kwh (w6-w5).

Unfortunately, this study only received one energy consumption behavior survey form. Cottonwood 123 (see appendix 5), which had been assigned to Set A with Goal Setting and Feedback. There were multiple attempts to have the Resident Advisors (RAs) in the units remind the students about the study notice, but these attempts were not successful. Thus, the full experimental design of the study was not possible to complete, and no feedback was given to any of the units.

Discussion

Energy use in the Husky Village apartments is quite high on a per capita basis (see Figure 1). Thus, interventions that could motivate energy conservation could have a large impact on the campus carbon footprint. This study sought to examine the efficacy of two low-cost interventions in motivating reductions in student energy use, and to understand the details of student energy use behaviors to help the campus develop a strategy to lower energy consumption in the Husky Village. However, because of a lack of student participation, my intervention experiment and survey effort failed. Participation rate is a key factor determining success and failure of an intervention, particularly one that involves commitment to goal setting or to information exchanges, such as through energy use surveys. Groves et al. (1992, p. 1) noted that "the lack of full participation in sample surveys threatens the inferential value of the survey method". They further suggested that providing survey respondents with an ethical imperative to participate is successful in increasing participation rates. For example, an experimenter can tell potential study participants in an introduction letter that their participation and emission reductions could help protect the Earth for everyone. Bennett et al. (2010) noted that personalized letters could increase participation rates in campus initiatives.

The mode of a survey also affects the participation rate. Sax et al. (2005) showed that web options (with incentive and without) yield the lowest response rates compared with paper options. On the other hand, the response rates for web options can be boosted by lottery incentives (Laguilles et al., 2010). Laguilles et al. (2010) further noticed that "lottery incentives not only positively impacted response rates but also exerted differential effects by gender (p. 537)". Their result showed that lottery impacted participation rate for women only (63% for women in the incentive group vs. 58.33% for women in the control group). Other researchers have found that social engagement has positive effects on participation rates, and further, that women are more likely to participate in social surveys than men (Poster et al., 2005).

I attempted to boost participation rates by applying some of these techniques from the literature. For example, I applied ethical implications from Groves et al. (1992), and personalized letter from Bennett et al. (2010), but I did not apply the lottery technique from Laguilles et al. (2010) because I did not have enough funding to do so. Unfortunately, the result shows that only one resident was willing to join the study. It is possible that with different recruitment techniques, a greater level of participation could be developed in future interventions with students living in Husky Village. Although I asked the resident advisors to help collect more letters for me, this was not effective. Engagement and commitment of resident advisors to participate in the study might have increased participation, through their moral presence (following Ciadni et al., 1992).

Although the electricity monitoring data showed treatment differences, these did not occur in a systematic way to allow us to gain any inference of differences between the assigned treatment groups (compare Tables 3 and 4). This is not surprising given the low level of participation in the study, although it is possible that the receipt of the letters alone might stimulate some students to engage in more energy saving behaviors. However, if that had been the case, then energy use in sets A-C should have been lower than those in set D after the letters were delivered. The average energy use of units in set D was higher after the letters were delivered than in the other sets, but then it was also higher before the intervention. Thus, there was little change attributable to intervention that can be seen from these data. Instead, the main predictor of electricity use in this experiment is the increase in day length, which is hardly a surprising result.

The individual unit data (appendix 6) might be useful to help the UWB facilities department to target particular units to encourage energy consumption, or to determine if there are any unusual energy drains in those units. Examination of the data on energy use in individual units showed that Hawthorne 242 and Oak 252 consumed extremely high amount of energy, much more than other apartment units. Staff from Husky Village should check these units to understand what may cause these high rates. It is possible that the aspect of the units increases energy demand (e.g., a Western exposure with no shade trees), or that the behavior of the individuals in the unit was very wasteful. Equally, it would be useful to understand what activities are typical of students in units that have very low energy consumption. For example, Aspen 312 had extremely low energy consumption, which might be due to a favorable location, but might also be due to very frugal energy habits. The large differences between individual units in their energy consumption suggests that it could be useful to have a competition between units to try to achieve greater savings overall, and that modeling between units could also be effective. However, to be successful, such strategies would need to take place with modest funding from UWB.

Recommendations

In this section, I make two kinds of recommendation. This first type of recommendation is to provide administrative methods to take immediate action to enhance energy conservation in the student housing. Another type of recommendation is to provide academic knowledge for the next energy intervention and survey in Husky Village.

I suggest that facilities should pay attention to the use of electronic appliances in Hawthorne 242 and Oak 252. The resident advisors might pay attention to any unusual factors, such as extra student guests staying in the units or extra electronic appliances, to find out the cause of unusually high energy consumption patterns. For example, Hawthorne 342 had increased its energy consumption rapidly from week 4 to week 5, and then decreased the consumption rapidly after week 5. The initial assumption is that the resident(s) in Hawthorne 342 used extra energy for cleanup and pack up before she/he/they moved out from the units on week 6. The advisors may pull out individual residential records for further analysis and brainstorming about potential interventions. Resident advisors might also launch an energy conservation competition between different halls, which could encourage units to reduce the amount of energy consumption.

At a minimum, UWB should increase feedback on energy use to occupants of Husky Hall to help them begin to self-monitor their electricity consumption. Meters in Husky Village could be connected to Building Dashboard (smart meter system) and the results could be distributed via social networking. This could increase efficiency of future interventions and studies of student energy use behaviors.

Another potential intervention could be made through the Living-Learning Communities (LLC) program (http://www.bothell.washington.edu/housing/llc). These programs could relate sustainability to current themes (e.g. Global Learning, Science and Technology) creating a new social hub for both the intervention and survey. To enhance participation, it might be useful to create some social events to increase interest in and completion of their survey, according to methods described in Porter et al. (2005). Interviewers may also adopt a web-survey to speed up the survey process, although this method typically has lower participation rates than paper surveys (Sax et al., 2005). Participation might be increased if the online survey was coupled with social media. Generally, residents have higher social incentive to complete an activity, including a survey, if they can track each other's participation on the media (Fogg, 2003). In addition, the campus might consider cash incentives, e.g., increasing participation rates by lottery incentives (Laguilles et al., 2010).

I also suggest that UWB should generate different types fundings, such as instant funding, or long-term scholarship program to support sustainability research at the student level. For the short term, this funding could support a researcher to include monetary incentives and energy efficiency equipment (e.g. LED light bolts or automatic water sensors) in their experiments. Over the long term, scholarship programs could be used to attract more students to participate in research to enhance campus sustainability. To be effective, such work might require experimental equipment (e.g. daylight sensor, humidity sensor, and temperature sensor) to measure environmental data in distinct environments (e.g. floor levels, hall locations, near trees and pond). For example, apartment units beside the pond may have higher humidity than other units near street. Or, some apartments may have less impact from day length because their windows are blocked by leaves (See Appendix 2).

For the next intervention and survey, I suggest that interviewers should collect and analyze demographic information of residents to explore potential relationships between differences in student socioeconomic and cultural background, academic major, and energy consumption behaviors. Thus, the survey could include indirect questions (e.g. "Do you think leave lighting on at home will scare away thieves?" or "Do you think hot water cleans clothes better than cold water?" to understand more about beliefs that govern energy consumption behaviors. It would be helpful to ask students about their history of environmentally-oriented action and their ideology.

However, an effective survey might include fewer direct questions about energy use to reduce intimidation. Finally, experimenters should not advertise their projects before the intervention begins to ensure control group is not compromised through learning about the project.

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Appendix 1

Room Descriptions and Total Area (sq. ft.) of units in Aspen,

Cottonwood, Dogwood, Oak, and Hawthorne Halls

Table A1. Room Descriptions and Total Area (sq. ft.) of Aspen and Cottonwood Halls.

Units	Room Description	Total Area (s.Feet)
Aspen 111/Cottonwood 121	Two Bedroom, One Bath (Bottom Floor)	852
Aspen 112/Cottonwood 122	One Bedroom, One Bath (Bottom Floor)	640
Aspen 113/Cottonwood 123	One Bedroom, One Bath (Bottom Floor)	640
Aspen 114/Cottonwood 124	Two Bedroom, One Bath (Bottom Floor)	852
Aspen 211/Cottonwood 221	Two Bedroom, One Bath (Second Floor)	868.5
Aspen 212/Cottonwood 222	One Bedroom, One Bath (Second Floor)	640
Aspen 213/Cottonwood 223	One Bedroom, One Bath (Second Floor)	640
Aspen 214/Cottonwood 224	Two Bedroom, One Bath (Second Floor)	868.5
Aspen 311/Cottonwood 321	Two Bedroom, One Bath (Third Floor)	868.5
Aspen 312/Cottonwood 322	One Bedroom, One Bath (Third Floor)	640
Aspen 313/Cottonwood 323	One Bedroom, One Bath (Third Floor)	640
Aspen 314/Cottonwood 324	Two Bedroom, One Bath (Third Floor)	868.5
	Total Square Footage	9018

Table A2. Room Descriptions and Total Area (sq. ft.) of Hawthorne Hall

Units	Room Description	Total Area (sq. feet)
Hawthorne 141	Two Bedroom, One Bath (Bottom Floor)	852
Hawthorne 142	One Bedroom, One Bath (Bottom Floor)	640
Hawthorne 241	Two Bedroom, One Bath (Second Floor)	868.5
Hawthorne 242	One Bedroom, One Bath (Second Floor)	640
Hawthorne 243	Two Bedroom, One Bath (Third Floor)	868.5
Hawthorne 244	One Bedroom, One Bath (Third Floor)	640
	Total Square footage	4509

Table A3, Room Descriptions and Total Area (sq. ft.) of Dogwood and Oak Halls.

Units	Room Description	Total Area (sq. feet)
Dogwood 131/Oak 151	Two Bedroom, Two Bath (Bottom Floor)	918
Dogwood 132/Oak 152	One Bedroom, One Bath (Bottom Floor)	640
Dogwood 133/Oak 153	One Bedroom, One Bath (Bottom Floor)	640
Dogwood 134/Oak 154	Two Bedroom, Two Bath (Bottom Floor)	918
Dogwood 231/Oak251	Two Bedroom, Two Bath (Second Floor)	937
Dogwood 232/Oak 252	One Bedroom, One Bath (Second Floor)	640
Dogwood 233/Oak 253	One Bedroom, One Bath (Second Floor)	640
Dogwood 234/Oak 254	Two Bedroom, Two Bath (Second Floor)	937
Dogwood 331/Oak 351	Two Bedroom, Two Bath (Third Floor)	937
Dogwood 332/Oak 352	One Bedroom, One Bath (Third Floor)	640
Dogwood 333/Oak 353	One Bedroom, One Bath (Third Floor)	640
Dogwood 334/Oak 354	Two Bedroom, Two Bath (Third Floor)	937
	Total Square footage	9424

Appendix 2

Husky Village Site Map and Unit Floor plans

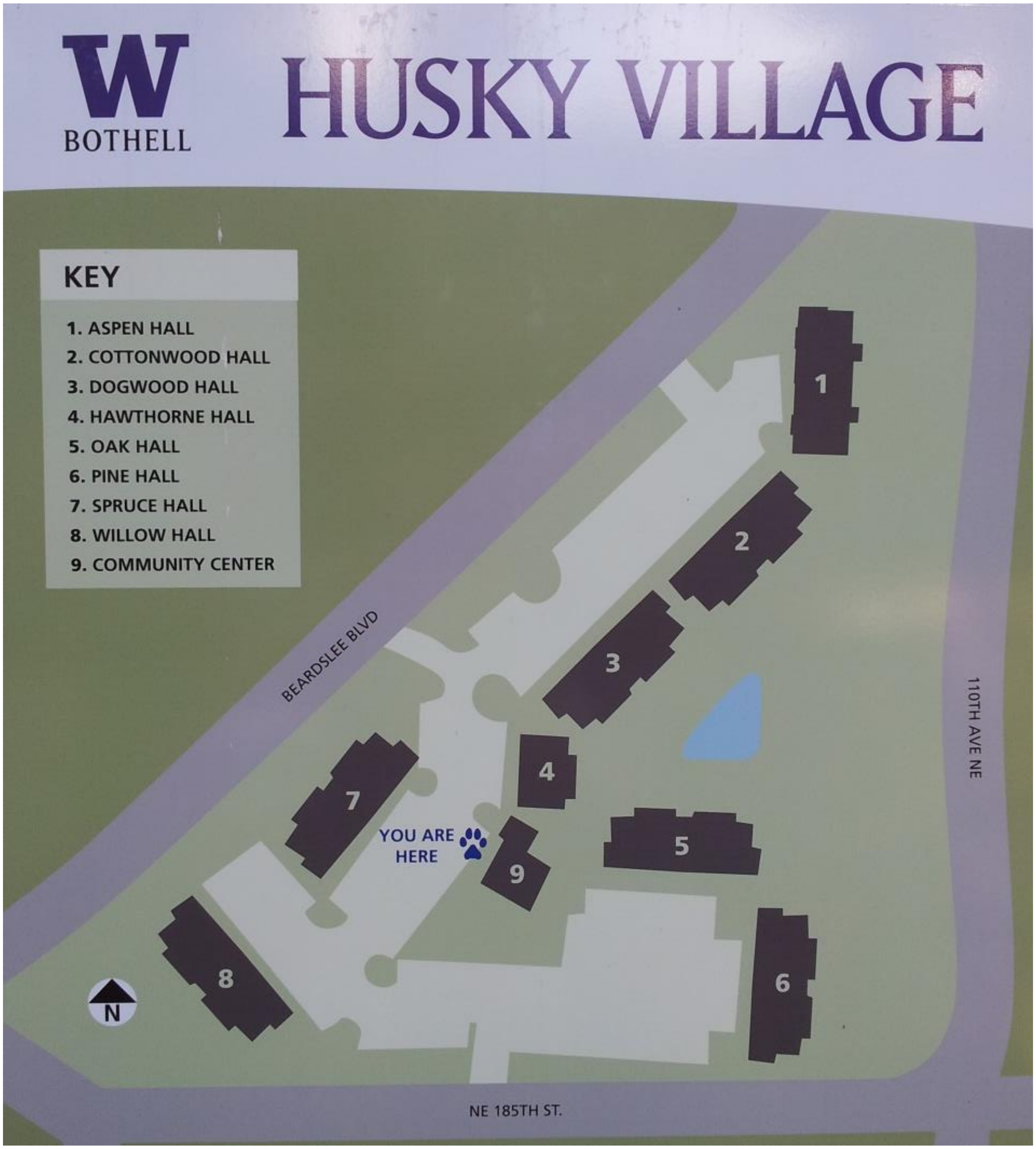


Fig.A1. Husky Village site map. Double Units (640 sq ft) included in the study were located in halls 1, 2, 3, 4 and 5.

Fig. A2. Husky Village Satellite map. It shows geographic variety in the study site.

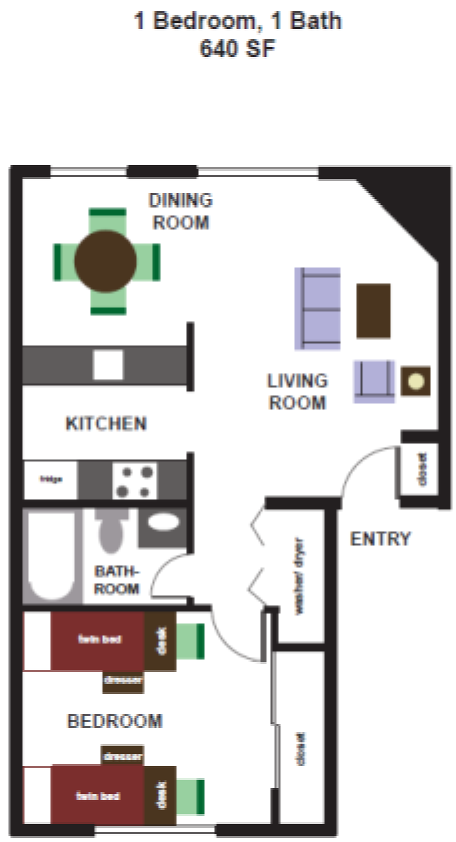


Fig. A3. Floor plan for a 1 Bedroom, 1 Bath, 640 sq ft. apartment unit. These units are designed for double occupancy.

Appendix 3

Set A, Set B, and Set C paper notices

Set A

W
UNIVERSITY of
WASHINGTON
BOTHELL

Dear residents in Husky Village,

Congratulations! Your apartment has been selected into energy conservation project in 2013!

Just follow the few simple steps below, and you may help UW Bothell to become “greenest college” in Washington State.

1. Relax! And, live as usual.☺
2. Fill out a survey form (attach behind this paper).
3. Set an energy saving goal:____% cut
4. Put the whole document on your front doorstep before ____________________

Thanks for your help!

Michael Ng

UWB energy conservation project

Set B

W
UNIVERSITY of
WASHINGTON
BOTHELL

Dear residents in Husky Village,

Congratulations! Your apartment has been selected into energy conservation project in 2013!

Just follow the few simple steps below, and you may help UW Bothell to become "greenest college" in Washington State.

1. Relax! And, live as usual.☺
2. Fill out a survey form (attach behind this paper).
3. Your will receive energy saving report on each ____________until_____
4. Put the whole document on your front doorstep before ___________________

Thanks for your help!

Michael Ng

UWB energy conservation project

Set C

W
UNIVERSITY of
WASHINGTON
BOTHELL

Dear residents in Husky Village,

Congratulations! Your apartment has been selected into energy conservation project in 2013!

Just follow the few simple steps below, and you may help UW Bothell to become "greenest college" in Washington State.

1. Relax! And, live as usual.☺
2. Fill out a survey form (attach behind this paper).
3. Set an energy saving goal:____% cut
4. Your will receive energy saving report on each ____________until_____
5. Put the whole document on your front doorstep before ___________________

Thanks for your help!

Michael Ng

UWB energy conservation project

Appendix 4

Survey form

Survey 1.

What is the typical setting of your thermostat during the day? ______F

What is the typical setting of your thermostat at night? ______ F

What temperature do you find most comfortable? _______F

If you have a programmable thermostat, please provide information on the temperature settings and times that trigger changes in temperature:

Work and Leisure

In a typical ***day***…………………

1. How long do you spend your time doing homework with computer? ___hours
2. How long do you spend your time with computer for leisure? ___hours
3. Do you use any other electronic devices for homework, and if so what? ________________
4. How long do you spend using your other electronic devices for homework? ___hours
5. Do you use any other electronic devices for leisure, and if so what? ________
6. If so, how long do you spend using your electronic devices for leisure? ___hours

Laundry

1. In a typical ***week***, how many loads of washing are done in this unit? ___loads
2. How many of those loads use cold water? ___loads
3. How many of those loads use warm water? ___loads
4. How many of those loads use hot water? ___loads

Cooking

In a typical ***week***………

1. How many times do you use oven? __times
2. How long do you use the oven for each time? __minutes
3. How many times do you use stove (cooktop)? __times
4. How long do you use the stove for each time (cooktop)? __minutes
5. How many times do you use microwave? __times

6. How long do you use the microwave for each time?__ minutes

Lighting

1. What kind of light bulbs do you use? (For example, CFL Bulbs, LED Bulbs, or Standard Household)[1]
   Type A: ______
   Type B: ______
   Type C: ______
2. For type A,
   a. How many light bulbs do you have in your unit? ___bulbs
   b. What is the strength of the light bulbs in watts? ___watts
   c. How long do you use the light bulbs for each ***day***? ___hours
3. For type B,
   a. How many light bulbs do you have in your unit? ___bulbs
   b. What is the strength of the light bulbs in watts? ___watts
   c. How long do you use the light bulbs for each ***day***? ___hours
4. For type C,
   a. How many light bulbs do you have in your unit? ___bulbs
   b. What is the strength of the light bulbs in watts? ___watts
   c. How long do you use the light bulbs for each ***day***? ___hours

Extra electrical applications

1. Please list extra electrical applications (not provide by Husky Village) in your unit.
   ____

Did you receive any information and tips about energy conversation from Husky Village or UWB?

__Yes or __No

Comments

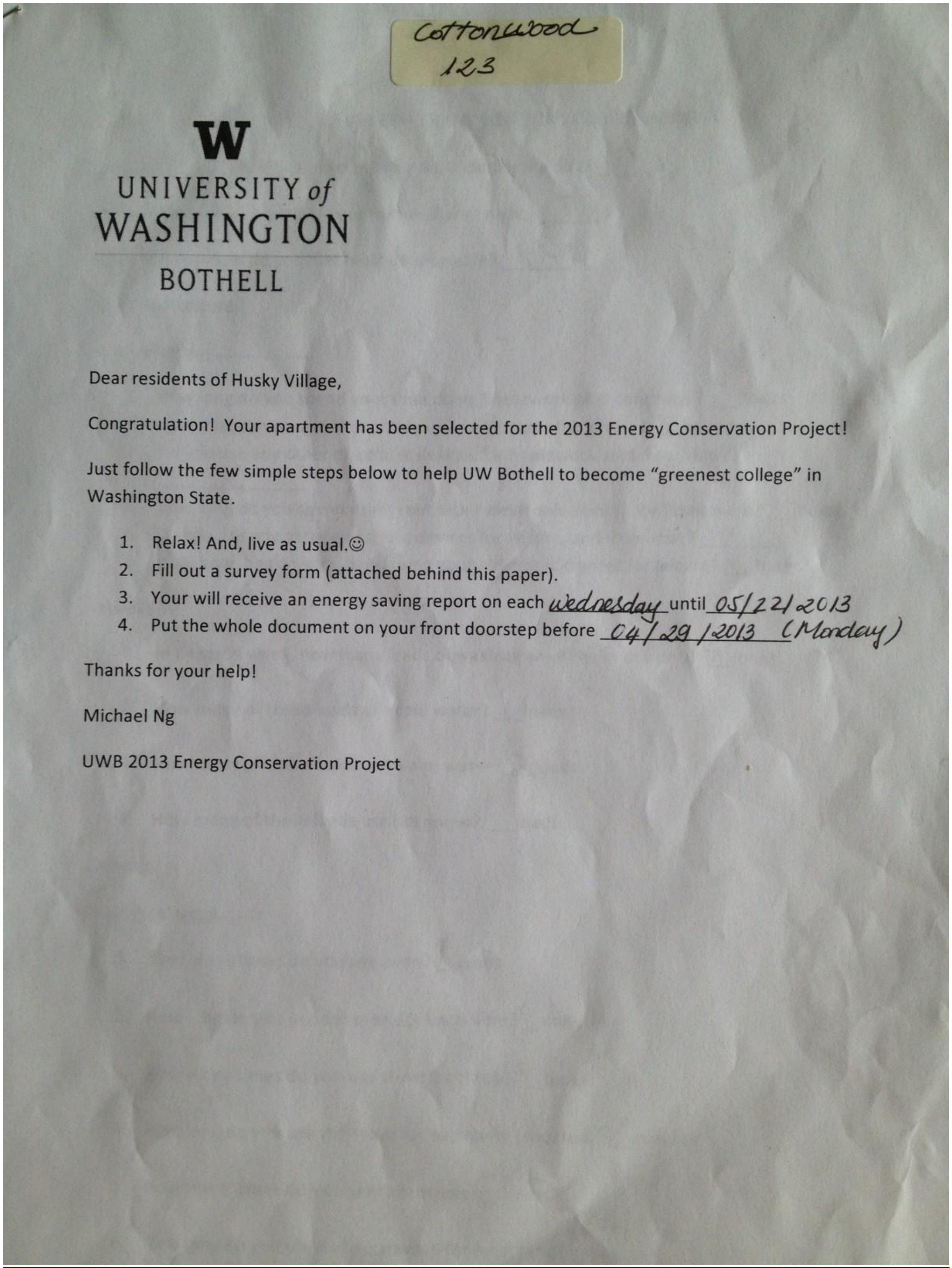
1. Do you have any comments you wish to add about energy use?

[1] See example picture on next page

Retrieved from: http://www.lampsplus.com/light-bulbs/

Appendix 5

Survey form returned from Cottonwood 123



Cottonwood
123

W
UNIVERSITY of
WASHINGTON
BOTHELL

Dear residents of Husky Village,

Congratulation! Your apartment has been selected for the 2013 Energy Conservation Project!

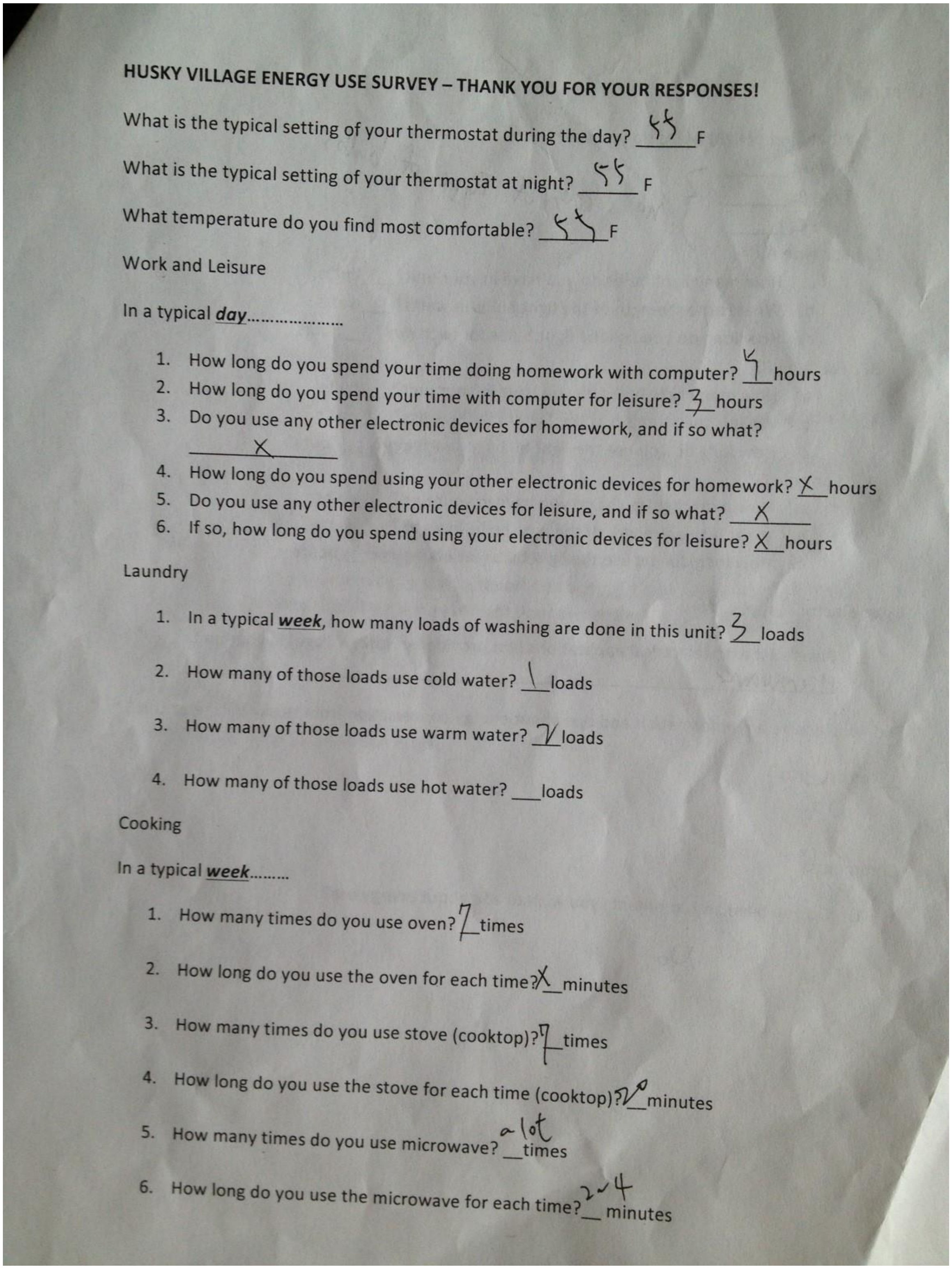
Just follow the few simple steps below to help UW Bothell to become "greenest college" in Washington State.

1. Relax! And, live as usual.☺
2. Fill out a survey form (attached behind this paper).
3. Your will receive an energy saving report on each Wednesday until 05/22/2013
4. Put the whole document on your front doorstep before 04/29/2013 (Monday)

Thanks for your help!

Michael Ng

UWB 2013 Energy Conservation Project



HUSKY VILLAGE ENERGY USE SURVEY – THANK YOU FOR YOUR RESPONSES!

What is the typical setting of your thermostat during the day? 55 F

What is the typical setting of your thermostat at night? 55 F

What temperature do you find most comfortable? 55 F

Work and Leisure

In a typical ***day***…………………

1. How long do you spend your time doing homework with computer? 4 hours
2. How long do you spend your time with computer for leisure? 3 hours
3. Do you use any other electronic devices for homework, and if so what? X
4. How long do you spend using your other electronic devices for homework? X hours
5. Do you use any other electronic devices for leisure, and if so what? X
6. If so, how long do you spend using your electronic devices for leisure? X hours

Laundry

1. In a typical ***week***, how many loads of washing are done in this unit? 3 loads
2. How many of those loads use cold water? 1 loads
3. How many of those loads use warm water? 2 loads
4. How many of those loads use hot water? ___loads

Cooking

In a typical ***week***………

1. How many times do you use oven? 7 times
2. How long do you use the oven for each time? X minutes
3. How many times do you use stove (cooktop)? 7 times
4. How long do you use the stove for each time (cooktop)? 20 minutes
5. How many times do you use microwave? a lot times
6. How long do you use the microwave for each time? 2~4 minutes

Lighting

1. What kind of light bulbs do you use?
   Type A: ______
   Type B: ______ } no ideas of Type of bulbs
   Type C: ______
2. For type A,
   a. How many light bulbs do you have in your unit? ___bulbs
   b. What is the strength of the light bulbs in watts? ___watts
   c. How long do you use the light bulbs for each ***day***? ___hours
3. For type B,
   a. How many light bulbs do you have in your unit? ___bulbs
   b. What is the strength of the light bulbs in watts? ___watts
   c. How long do you use the light bulbs for each ***day***? ___hours
4. For type C,
   a. How many light bulbs do you have in your unit? ___bulbs
   b. What is the strength of the light bulbs in watts? ___watts
   c. How long do you use the light bulbs for each ***day***? ___hours

Extra electrical applications

1. Please list extra electrical applications (not provide by Husky Village) in your unit.
   Microwave

Did you receive any information and tips about energy conversation from Husky Village or UWB?

__Yes or ✓ No

Comments

1. Do you have any comments you wish to add about energy use?

   No

Appendix 6

Raw Data of Individual Unit Electricity Use over the Course of the Study

	Before Intervention (kwh)		Letter (kwh)	After Intervention (kwh)	
Set A	**W2-W1**	**W3-W2**	**W4-W3**	**W5-W4**	**W6-W5**
Cottonwood 122	160	140	120	90	90
Cottonwood 323	270	280	210	150	110
Dogwood 132	260	230	230	190	60
Dogwood 333	184	131	114	127	99
Oak 353	203	91	108	65	93
Hawthorne 142	220	180	320	210	160
Set B					
Aspen 113	266	255	177	143	111
Aspen 212	120	110	100	100	110
Cottonwood 123	250	260	200	150	90
Dogwood 232	80	90	110	80	70
Oak 153	247	234	121	147	93
Hawthorne 242	380	320	310	240	230
Set C					
Aspen 312	120	60	40	40	30
Cottonwood 223	170	160	140	160	140
Cottonwood 322	160	150	140	120	110
Dogwood 233	110	150	110	120	110
Oak 253	191	177	179	116	79
Oak 352	199	208	150	123	60
Control					
Aspen 112	270	230	180	190	80
Cottonwood 222	230	200	180	150	50
Dogwood 332	210	230	180	110	150
Oak 152	252	263	224	181	42
Oak 252	379	364	356	283	237
Hawthorne 342	134	118	120	125	196

Appendix 7

Tukey HSD Post-Hoc test of variation by intervention sets, weeks, and halls.

Table A1. Tukey HSD Post-Hoc test of variation between intervention units (sets A-C) and the control units (set D).

(I) Intervention	(J) Intervention	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Set A	Set B	-15.9583	31.73704	.957	-104.7883	72.8716
	Set C	30.4167	31.73704	.774	-58.4133	119.2466
	Control	-36.7083	31.73704	.660	-125.5383	52.1216
Set B	Set A	15.9583	31.73704	.957	-72.8716	104.7883
	Set C	46.3750	31.73704	.478	-42.4550	135.2050
	Control	-20.7500	31.73704	.913	-109.5800	68.0800
Set C	Set A	-30.4167	31.73704	.774	-119.2466	58.4133
	Set B	-46.3750	31.73704	.478	-135.2050	42.4550
	Control	-67.1250	31.73704	.182	-155.9550	21.7050
Control	Set A	36.7083	31.73704	.660	-52.1216	125.5383
	Set B	20.7500	31.73704	.913	-68.0800	109.5800
	Set C	67.1250	31.73704	.182	-21.7050	155.9550

Based on observed means.

The error term is Mean Square(Error) = 3021.720.

Table A2. Tukey HSD Post-Hoc test of variation between floors 1-3 from Week 1-6 energy consumption (Eng1-6)

Weekly Energy Con.	(I) Floor	(J) Floor	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Week1	1	2	33.1250	37.74284	.660	-62.0085	128.2585
		3	55.6250	37.74284	.323	-39.5085	150.7585
	2	1	-33.1250	37.74284	.660	-128.2585	62.0085
		3	22.5000	37.74284	.824	-72.6335	117.6335
	3	1	-55.6250	37.74284	.323	-150.7585	39.5085
		2	-22.5000	37.74284	.824	-117.6335	72.6335
Week2	1	2	27.6250	37.48236	.745	-66.8519	122.1019
		3	65.5000	37.48236	.212	-28.9769	159.9769
	2	1	-27.6250	37.48236	.745	-122.1019	66.8519
		3	37.8750	37.48236	.579	-56.6019	132.3519
	3	1	-65.5000	37.48236	.212	-159.9769	28.9769
		2	-37.8750	37.48236	.579	-132.3519	56.6019
Week3	1	2	10.8750	37.29729	.954	-83.1354	104.8854
		3	51.2500	37.29729	.372	-42.7604	145.2604
	2	1	-10.8750	37.29729	.954	-104.8854	83.1354
		3	40.3750	37.29729	.535	-53.6354	134.3854
	3	1	-51.2500	37.29729	.372	-145.2604	42.7604
		2	-40.3750	37.29729	.535	-134.3854	53.6354
Week4	1	2	6.5000	25.45929	.965	-57.6719	70.6719
		3	55.1250	25.45929	.101	-9.0469	119.2969
	2	1	-6.5000	25.45929	.965	-70.6719	57.6719
		3	48.6250	25.45929	.161	-15.5469	112.7969
	3	1	-55.1250	25.45929	.101	-119.2969	9.0469
		2	-48.6250	25.45929	.161	-112.7969	15.5469
Week5	1	2	-37.5000	27.11374	.367	-105.8421	30.8421
		3	-15.2500	27.11374	.841	-83.5921	53.0921
	2	1	37.5000	27.11374	.367	-30.8421	105.8421
		3	22.2500	27.11374	.695	-46.0921	90.5921
	3	1	15.2500	27.11374	.841	-53.0921	83.5921
		2	-22.2500	27.11374	.695	-90.5921	46.0921

Week6	1	2	-52.5000	27.49976	.161	-121.8151	16.8151
		3	9.3750	27.49976	.938	-59.9401	78.6901
	2	1	52.5000	27.49976	.161	-16.8151	121.8151
		3	61.8750	27.49976	.086	-7.4401	131.1901
	3	1	-9.3750	27.49976	.938	-78.6901	59.9401
		2	-61.8750	27.49976	.086	-131.1901	7.4401

Based on observed means. The error term is Mean Square(Error) = 3024.946.

Table A3. Tukey HSD Post-Hoc test of variation between Cotton hall, Dog hall, Oak hall, Aspen hall, Hawthrone hall energy consumption.

Weekly Energy Con.	(I) Hall	(J) Hall	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Week1	Cotton	Dog	37.8667	46.40981	.922	-101.6972	177.4305
		Oak	-38.5000	44.25001	.904	-171.5689	94.5689
		Aspen	12.6667	49.47302	.999	-136.1089	161.4422
		Hawthrone	-38.0000	54.19498	.954	-200.9754	124.9754
	Dog	Cotton	-37.8667	46.40981	.922	-177.4305	101.6972
		Oak	-76.3667	46.40981	.488	-215.9305	63.1972
		Aspen	-25.2000	51.41387	.987	-179.8121	129.4121
		Hawthrone	-75.8667	55.97233	.662	-244.1870	92.4536
	Oak	Cotton	38.5000	44.25001	.904	-94.5689	171.5689
		Dog	76.3667	46.40981	.488	-63.1972	215.9305
		Aspen	51.1667	49.47302	.836	-97.6089	199.9422
		Hawthrone	.5000	54.19498	1.000	-162.4754	163.4754
	Aspen	Cotton	-12.6667	49.47302	.999	-161.4422	136.1089
		Dog	25.2000	51.41387	.987	-129.4121	179.8121
		Oak	-51.1667	49.47302	.836	-199.9422	97.6089
		Hawthrone	-50.6667	58.53727	.906	-226.7003	125.3669
	Hawthrone	Cotton	38.0000	54.19498	.954	-124.9754	200.9754
		Dog	75.8667	55.97233	.662	-92.4536	244.1870
		Oak	-.5000	54.19498	1.000	-163.4754	162.4754
		Aspen	50.6667	58.53727	.906	-125.3669	226.7003
Week2	Cotton	Dog	32.1333	48.57840	.962	-113.9519	178.2186
		Oak	-24.5000	46.31769	.983	-163.7868	114.7868
		Aspen	34.5833	51.78475	.961	-121.1441	190.3107
		Hawthrone	-7.6667	56.72735	1.000	-178.2575	162.9241
	Dog	Cotton	-32.1333	48.57840	.962	-178.2186	113.9519
		Oak	-56.6333	48.57840	.770	-202.7186	89.4519
		Aspen	2.4500	53.81629	1.000	-159.3867	164.2867
		Hawthrone	-39.8000	58.58776	.959	-215.9854	136.3854
	Oak	Cotton	24.5000	46.31769	.983	-114.7868	163.7868
		Dog	56.6333	48.57840	.770	-89.4519	202.7186
		Aspen	59.0833	51.78475	.783	-96.6441	214.8107
		Hawthrone	16.8333	56.72735	.998	-153.7575	187.4241

	Aspen	Cotton	-34.5833	51.78475	.961	-190.3107	121.1441
		Dog	-2.4500	53.81629	1.000	-164.2867	159.3867
		Oak	-59.0833	51.78475	.783	-214.8107	96.6441
		Hawthrone	-42.2500	61.27254	.956	-226.5091	142.0091
	Hawthrone	Cotton	7.6667	56.72735	1.000	-162.9241	178.2575
		Dog	39.8000	58.58776	.959	-136.3854	215.9854
		Oak	-16.8333	56.72735	.998	-187.4241	153.7575
		Aspen	42.2500	61.27254	.956	-142.0091	226.5091
Week3	Cotton	Dog	16.2000	42.00588	.995	-110.1203	142.5203
		Oak	-41.3333	40.05104	.837	-161.7750	79.1084
		Aspen	40.7500	44.77842	.890	-93.9079	175.4079
		Hawthrone	-85.0000	49.05230	.439	-232.5104	62.5104
	Dog	Cotton	-16.2000	42.00588	.995	-142.5203	110.1203
		Oak	-57.5333	42.00588	.653	-183.8537	68.7870
		Aspen	24.5500	46.53510	.983	-115.3906	164.4906
		Hawthrone	-101.2000	50.66100	.304	-253.5480	51.1480
	Oak	Cotton	41.3333	40.05104	.837	-79.1084	161.7750
		Dog	57.5333	42.00588	.653	-68.7870	183.8537
		Aspen	82.0833	44.77842	.385	-52.5746	216.7413
		Hawthrone	-43.6667	49.05230	.897	-191.1770	103.8437
	Aspen	Cotton	-40.7500	44.77842	.890	-175.4079	93.9079
		Dog	-24.5500	46.53510	.983	-164.4906	115.3906
		Oak	-82.0833	44.77842	.385	-216.7413	52.5746
		Hawthrone	-125.7500	52.98254	.166	-285.0794	33.5794
	Hawthrone	Cotton	85.0000	49.05230	.439	-62.5104	232.5104
		Dog	101.2000	50.66100	.304	-51.1480	253.5480
		Oak	43.6667	49.05230	.897	-103.8437	191.1770
		Aspen	125.7500	52.98254	.166	-33.5794	285.0794
Week4	Cotton	Dog	11.2667	33.19575	.997	-88.5598	111.0931
		Oak	-15.8333	31.65091	.986	-111.0141	79.3474
		Aspen	18.4167	35.38679	.984	-87.9987	124.8320
		Hawthrone	-55.0000	38.76428	.624	-171.5722	61.5722
	Dog	Cotton	-11.2667	33.19575	.997	-111.0931	88.5598
		Oak	-27.1000	33.19575	.922	-126.9264	72.7264
		Aspen	7.1500	36.77503	1.000	-103.4401	117.7401
		Hawthrone	-66.2667	40.03558	.483	-186.6619	54.1286
	Oak	Cotton	15.8333	31.65091	.986	-79.3474	111.0141
		Dog	27.1000	33.19575	.922	-72.7264	126.9264

		Aspen	34.2500	35.38679	.866	-72.1653	140.6653
		Hawthrone	-39.1667	38.76428	.847	-155.7388	77.4055
	Aspen	Cotton	-18.4167	35.38679	.984	-124.8320	87.9987
		Dog	-7.1500	36.77503	1.000	-117.7401	103.4401
		Oak	-34.2500	35.38679	.866	-140.6653	72.1653
		Hawthrone	-73.4167	41.87021	.427	-199.3290	52.4957
	Hawthrone	Cotton	55.0000	38.76428	.624	-61.5722	171.5722
		Dog	66.2667	40.03558	.483	-54.1286	186.6619
		Oak	39.1667	38.76428	.847	-77.4055	155.7388
		Aspen	73.4167	41.87021	.427	-52.4957	199.3290
Week5	Cotton	Dog	.5333	27.99498	1.000	-83.6533	84.7200
		Oak	-2.3333	26.69216	1.000	-82.6022	77.9355
		Aspen	15.5833	29.84275	.984	-74.1599	105.3266
		Hawthrone	-97.0000	32.69109	.054	-195.3088	1.3088
	Dog	Cotton	-.5333	27.99498	1.000	-84.7200	83.6533
		Oak	-2.8667	27.99498	1.000	-87.0533	81.3200
		Aspen	15.0500	31.01349	.988	-78.2139	108.3139
		Hawthrone	-97.5333	33.76321	.063	-199.0663	3.9996
	Oak	Cotton	2.3333	26.69216	1.000	-77.9355	82.6022
		Dog	2.8667	27.99498	1.000	-81.3200	87.0533
		Aspen	17.9167	29.84275	.973	-71.8266	107.6599
		Hawthrone	-94.6667	32.69109	.062	-192.9755	3.6422
	Aspen	Cotton	-15.5833	29.84275	.984	-105.3266	74.1599
		Dog	-15.0500	31.01349	.988	-108.3139	78.2139
		Oak	-17.9167	29.84275	.973	-107.6599	71.8266
		Hawthrone	-112.5833*	35.31041	.035	-218.7690	-6.3977
	Hawthrone	Cotton	97.0000	32.69109	.054	-1.3088	195.3088
		Dog	97.5333	33.76321	.063	-3.9996	199.0663
		Oak	94.6667	32.69109	.062	-3.6422	192.9755
		Aspen	112.5833*	35.31041	.035	6.3977	218.7690
Week6	Cotton	Dog	-3.1333	38.05280	1.000	-117.5659	111.2993
		Oak	-13.3333	36.28192	.996	-122.4405	95.7739
		Aspen	29.9167	40.56443	.945	-92.0689	151.9022
		Hawthrone	-23.6667	44.43610	.983	-157.2952	109.9618
	Dog	Cotton	3.1333	38.05280	1.000	-111.2993	117.5659
		Oak	-10.2000	38.05280	.999	-124.6326	104.2326
		Aspen	33.0500	42.15579	.932	-93.7211	159.8211

		Hawthrone	-20.5333	45.89341	.991	-158.5442	117.4776
	Oak	Cotton	13.3333	36.28192	.996	-95.7739	122.4405
		Dog	10.2000	38.05280	.999	-104.2326	124.6326
		Aspen	43.2500	40.56443	.821	-78.7356	165.2356
		Hawthrone	-10.3333	44.43610	.999	-143.9618	123.2952
	Aspen	Cotton	-29.9167	40.56443	.945	-151.9022	92.0689
		Dog	-33.0500	42.15579	.932	-159.8211	93.7211
		Oak	-43.2500	40.56443	.821	-165.2356	78.7356
		Hawthrone	-53.5833	47.99648	.796	-197.9186	90.7519
	Hawthrone	Cotton	23.6667	44.43610	.983	-109.9618	157.2952
		Dog	20.5333	45.89341	.991	-117.4776	158.5442
		Oak	10.3333	44.43610	.999	-123.2952	143.9618
		Aspen	53.5833	47.99648	.796	-90.7519	197.9186

Based on observed means.

The error term is Mean Square(Error) = 3949.134.

*. The mean difference is significant at the .05 level.