The Potential for Electricity-use Reduction in

Grinnell College Residence Halls through Behavioral Manipulation

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Finding ways to reduce electricity use at Grinnell College is imperative, both for deterring climate change and for our role as a socially responsible institution. The effects of climate change can harm human and animal health, impact food and water availability, destroy animal habitats, and displace entire communities (National Oceanic and Atmospheric Administration, 2021; The UN Refugee Agency). While alterations to existing buildings on campus can increase energy efficiency and decrease energy use, most updates have already been made, and the college would benefit from an additional reduction strategy. An alternate route to decrease campus energy use is to promote behavior change. Individual behaviors that negatively impact the environment, such as driving a car, meat consumption, and energy use, cumulate to contribute to climate change (Intergovernmental Panel on Climate Change, 2013). Therefore, it is beneficial to examine the scale of the portion in which individual behaviors influence energy-use levels and how to change individual behaviors to directly reduce the amount of energy used by Grinnell College students.

 For homeowners and renters, there is a direct connection between electricity use and its consequences: the electricity bill. Homeowners who use more energy have greater consequences, which is reflected by a larger bill, so there is prompt, straightforward feedback on their behavior. Additionally, homeowners can easily track data on their electricity usage through their electric bill. Contrastingly, college students who live on campus do not pay an electric bill and usually do not have access to their energy-use data. Because of college students’ indirect relationship with energy-use behavior and its consequences, an intervention must be introduced to change their energy consumption behavior. Historically, Grinnell College’s electricity usage was measured using a single meter for the entire campus, making it difficult to isolate buildings and groups who may have potential for a decrease in usage. In the spring of 2022, submeters were installed in the student dormitories, allowing for more specific tracking of electricity consumption.

Many researchers have studied ways to incentivize people to change their behavior and reduce their electricity use. Kim and Kaemingk (2021) sent out utility bills with electricity usage reports to over 100,000 above-average-energy-using households, where household energy usage was compared to the national user average. Participants who were using more than the average household reduced their electricity usage for up to three months. In a similar study, Allcott and Rogers (2014) sent residents monthly reports on their energy usage, which included personalized comparisons of their usage with their neighbors and with their past selves, along with energy conservation tips. The researchers found that energy use significantly decreased initially, although the reduction in use slowed over time. While the residents still saved money by decreasing their usage, it was the introduction of the social comparison that prompted their behavior change to decrease usage. These studies demonstrate how material incentives are not necessarily required for behavioral change; social comparison and feedback can be effective interventions.

While household electricity use can be manipulated through social comparisons, it is likely that these conditions will have different effects on dorm-living. While households may be composed of about five individuals, most dorms in Grinnell College have over 100 occupants, and as perceived group size increases, communal electricity use increases (Carmi & Mostovoy, 2017). This may be due to the diffusion of responsibility effect, where individuals working with others feel less responsibility as the size of the group increases (Forsyth et al., 2002). Despite this hurdle, those living in group settings still have the ability to decrease their collective electricity use. Many researchers have studied programs for decreasing electricity usage specifically in college dormitories. For instance, McClelland and Cook (1980) implemented a conservation program at a university that included memos emphasizing the need for conservation and information on how to save energy. Experimental buildings had significantly greater reductions in electricity use than control buildings. Additionally, Sintov et al. (2016) created an energy-reduction competition between suites at a residential college, where members of the winning suite received prizes. The researchers also gave energy-use feedback through the form of weekly reports and a kiosk that could be accessed at any time. Dormitory residents decreased their energy use by 6.4%.

Previous research has been conducted with Grinnell College students to understand their environmental attitudes and behaviors. Duncan Ward’s (‘20) MAP in Fall 2019 surveyed students on what would motivate them to reduce electricity consumption. He found that the strongest motivator was learning more about personal electricity consumption and how to reduce it. In combination with broad research, these findings suggest that providing students with more detailed information about their electricity use, comparing their consumption with other groups on campus, and giving recommendations for how to reduce consumption would result in lower electricity use in the residence halls.

Making use of the newly available submeters on campus, I conducted a study on the potential for electricity-use reduction in the residence halls. Students living in the dorms received information on their entire dorm’s electricity use for multiple weeks. Reports included comparisons and tips for reducing electricity use. I predicted that residence halls who were given a negative comparison, where they were shown that their dorm was performing poorly in reference to a different group, would decrease their electricity use for the subsequent week.

**Method**

 While submeters were installed in all residence halls, the data was only accessible for three halls: Haines, Read, and James. These dorms are adjacent to each other in South Campus and are similar shape and size (Table 1), although Haines has a laundry room that is used by nearby dorms and is included in the Haines meter.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Haines | Read | James |
| Net square footage  | 16538 | 17300 | 12579 |
| Occupancy | 110 | 136 | 101 |

*Table 1.* Submeters have been installed and data was accessible for three residence halls on campus: Haines, Read, and James. These dorms are adjacent to each other and similar in shape and size.

Data became available in mid-March 2022. Many students left for spring break on March 19th, allowing for data collection of a lower-occupancy state in each dorm. All data is normalized by total occupancy in each dorm. On April 11th, students in the three dorms received their first report comparing their electricity usage from the previous week to their usage during spring break. Reports were posted on each floor for residents to see. For the next four weeks, an “energy champion” was decided each week based on which dorm had the lowest electricity usage compared to spring break usage. The reports also included tips for reducing electricity usage, such as by opening blinds to warm a room on cold days.

 At the end of the experimental period, students in these dorms had the opportunity to complete a questionnaire assessing their interactions with the weekly reports and whether they prompted individual behavior change to decrease electricity consumption. These were measured on a 5-point Likert scale ranging from 1 (not at all) to 5 (a lot). Students also had the opportunity to share comments about how they reduced their consumption or any general comments.

**Results**

**Electricity Consumption**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Spring Break3/23-3/30 | After Spring Break4/3-4/10 | Week 1After First Report4/10-4/17 | Week 24/17-4/24 | Week 3 4/24-5/1 | Week 4 5/1-5/8 |
| James | 5.03 | 5.15 | 4.86 | 5.07 | 4.95 | 4.66 |
| Haines | 4.54 | 6.80 | 6.09 | 6.15 | 6.22 | 6.14 |
| Read | 2.47 | 3.67 | 3.81 | 3.72 | 3.97 | 3.89 |
| Champion | n/a | n/a | James | James | James | James |

*Table 2.* Weekly electricity usage per occupant (kWh/person) for each dorm.

After spring break, Haines and Read had a 50% and 48% increase in electricity consumption, respectively, while James had a 2% increase. The electricity usage was nearly constant for James through the whole data collection period (Figure 1). Haines had a decrease in consumption after the first report, but their consumption stayed about the same for the remaining weeks. Read stayed mostly consistent in their usage after an initial increase after spring break.

*Figure 1.* Electricity consumption in the dorms over the experiment.



*Figure 2.* Electricity use in kW over a 24-hour period in Haines (May 16-17, 2022).

 Electricity versus time graphs at a higher resolution show some sustained increases and decreases over periods of a few hours. There also are several steep increases, or spikes, in electricity usage over short periods of time.

*Figure 3.* Heating degree days (HDD) and electricity consumption by week by dorm.

 To account for the temperature and its effects on electricity usage, we compared heating degree days to the electricity usage across all the dorms by week (Figure 3). There was no clear relationship between degree days and consumption, as heating degree days decreased over time while electricity consumption stayed mostly constant.

**Questionnaire**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Residents  | “How much did you look at the weekly reports on electricity usage?” (1-5) | “How much did you try to reduce your electricity usage in your dorm after receiving the reports?” (1-5) |
| James | 9 | 3.56 | 2.22 |
| Haines | 9 | 4.44 | 3 |
| Read | 8 | 3.75 | 2.38 |
| Total | 26 | 3.92 | 2.54 |

*Table 3.* Results from the questionnaire.

 Twenty-seven students responded to a survey that was advertised in the sub metered dorms. One person completed the survey who did not live in James, Haines, or Read, and their responses were excluded in the analyses.

 Most students rated that they were moderately to thoroughly engaged with the weekly reports on electricity consumption (Table 3, *M* = 3.92). Students reported changing their behavior some after receiving the reports (*M* = 2.54). From the comments section (see Appendix), students shared that they took action to reduce their electricity usage by increasing the frequency of turning off their lights in their rooms and public spaces, unplugging appliances, and making better use of the light and warmth provided by the sun.

**Discussion**

 The purpose of this study was to examine whether there is potential for a decrease in electricity usage in the dorms through induced behavior change, and how to promote these changes in behavior. We gave students access to electricity data that they did not have access to before. This information was given through weekly reports that compared their previous consumption of the week to a week of lower occupancy over spring break. We predicted that residence halls that we given a negative social comparison would decrease their electricity use in the subsequent week.

 The results show that dorms might have a small potential to decrease their consumption through behavior change. After spring break, Haines increased its weekly consumption by over 2 kWh per person compared to spring break levels. After receiving the first report, Haines residents decreased their weekly consumption by about 1 kWh per person, and their usage stayed at this level for the rest of the experimental period. Haines also showed the largest level of engagement with the reports and efforts to decrease electricity usage. The evidence is not strong enough to conclude that Haines reduced their usage from the reports, but these results show support for our hypothesis. A larger sample size of dorms and longer experimental period would provide stronger evidence. James consumption stayed mostly consistent over spring break and during the experimental period, where we would have expected building occupancy to result in higher electricity usage. These findings suggest that James does not have much potential for decreasing their electricity consumption through behavior change, as the usage did not change when there were fewer people living in the dorm over spring break. Further examination of the James electrical system and appliances is required to understand why this is the case. The small sample size of dorms with accessible sub-metered data and the short experimental period also make it difficult to form a conclusion about the potential for an electricity usage decrease through behavioral change. Future examinations of electricity usage on campus should have access to data on all the dorms to clarify this hypothesis.

 Student survey responses suggest that students are willing and able to engage with the data of their electricity consumption and to decrease that consumption. These are important components of having a successful electricity-reduction program and would signal strong potential for electricity-use-reduction through behavior change. Another required component is having the ability to decrease electricity usage. As people lower their consumption, it becomes harder to continue to decrease consumption with each additional reduction, as the relatively easy and inexpensive conservation efforts were likely the first implemented. Students should not have to lower their standard of living to see an impact in their electricity usage. Additionally, as was discussed before, student behavior change must reflect a sizable decrease in electricity to be effective and meaningful. Submetering data can be used to gain a better idea of how elastic the electricity demand is on campus.

 Some students noted in the questionnaire that they did not buy into the “energy champion” dorm contest. For instance, Haines has a laundry room that would increase their electricity consumption but was not accounted for in the calculations. Students likely needed more information on the methodology of creating the reports and naming the champion. Fair comparisons need to be made across dorms for students to feel that their actions can make a difference. In calculating future comparisons between dorms, laundry room electricity should be excluded, and this should be made clear to residents to promote maximum behavioral change.

 There may be more potential for electricity reduction in other spaces on campus. For instance, the Loose laundry room used 617 kWh in the week of May 1-8, while the entire building of Read used just 529 kWh in the same period. Additionally, residence halls account for a small fraction of the electricity used on all of campus. Using data from the Open Energy Dashboard, electricity use on all of campus was about 142 kWh per person per week[[1]](#footnote-1) in 2020, while resident usage was consistently less than 10 kWh per person per week during the spring of 2022. Resources would be better spent attempting to reduce electricity in places that have the greatest possible reduction, which may be in places with higher electricity usage levels. There may also be better potential for reduction through appliance changes rather than overall behavioral change. Higher resolution electricity versus time graphs for the residence halls (Figure 2) show large spikes over short periods of time, rather than smooth increases and decreases over time. This suggests that residential appliances that are used for short amounts of time, such as a microwave, are pushing electricity usage higher. Finding solutions to these spikes, such as buy installing energy-saving appliances, might result in a greater decrease in electricity use than by targeting individual behavior changes.

 This experiment worked to pave the way for future electricity usage information-sharing on campus. The Open Energy Dashboard (OED), run by Davin Lin (‘22), is the first opportunity to make newly available submeter data accessible for all students on campus. On the OED, weekly reports on electricity usage could be automatically generated and available for all dorms. Results from the present study show that students are interested in reducing their electricity usage, so providing students with this data may result in behavioral change. This platform should make use of the power of social comparisons to try to implement behavioral changes that result in energy reduction. Information on the dashboard should be easy to digest with additional information, such as methodologies, available to support the data.

 Being environmentally friendly is an ongoing and evolving process. This study made use of the newly installed submeters on campus and introduced the concept of decreasing dormitory electricity usage through behavioral manipulation. The results show that students are willing to change their behavior and will accept ecofriendly tips, but it is inconclusive whether student behavioral changes can create a significant electricity-use reduction. Future studies should further explore the potential for a reduction through behavioral changes, whether there are other places at campus that would have better reduction results, and how to best motivate students to reduce their consumption.

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**Appendix**

Questionnaire Responses

1. “If you tried to reduce your electricity consumption at all, what steps did you take to do this?”

|  |
| --- |
| I made a habit of unplugging things i was not actively using |
| Opened windows on good weather days, turned off fairy lights when I’m outside the room  |
| Made sure lights were turned off when i left my room |
| Turning off lights when I left my room |
| Use natural light instead of electricity, turn computer off when not using jt |
| I already am pretty good with electricity consumption so I didn’t really change, just thought about it more |
| Unplugging lights and other electricity sources  |
| Decreasing items plugged in when not using, turned off lights when not in room/needed |
| Turned off my lights a lot |
| Make sure that I turned off the light when I leave my room, shower room |
| I turned off my fan and lights when I wasn’t in the room. |
| Opening window instead of light/air, but that was more because the weather was nice than because of the signs |
| Turning off lights in room, turning off bathroom lights done evenings |
| I usually leave my dimmed smart light on while asleep. I stopped doing so. |
| Stopped leaving the lights on |
| Always turning off lights. Using less water.  |
| Turning off lights  |
| Turning off the kitchen/ hallway lights when not being used. Also opening the window in my dorm room more instead of turning on the light. |
| Unplugged appliances when I wasn’t using them, utilized natural light, etc. |
| Turn off lights in bathroom  |
| I unplugged things I wasn’t using and turned off my power strip  |

1. “Do you have any additional comments?”

|  |
| --- |
| did the energy use statistics include things like the laundry rooms? Because Haines had laundry implemented after spring break, and that would have increased our energy use per occupant. I talked about these posters with many people, and we all had some skepticism around the data. nonetheless the posters were a good reminder to pay attention to outlets and stuff. |
| It seemed pointless/misleading in Haines bc it did not account for how the washing and drying machines were only just now put into use and puts the blame on the individual where the washers/dryers should be accounted for :// |
| The percent change statistic didn’t really mean anything to me, I think a per person or something like x miles on a car/x pounds of coal would’ve been more relevant and understandable for me. Anything that gives more context/perspective to the statistics would be good |
| I’m not convinced there’s a weekly energy champion. I would be much more likely to reduce electricity if there was a competition and prize |
| I use electricity to recharge accommodation technology, and I can’t compromise on that. I do turn off the lights when I leave, and I usually unplug appliances (though I do forget sometimes). And it’s not like this college is struggling to keep the lights on, money-wise, plus we have the solar farm now to offset some of the nonrenewable energy issues, right? |

1. In the year of 2020, total electricity use on campus was about 20 million kWh. When assuming that about 2700 people use the campus, this comes down to about 142 kWh per person per week. [↑](#footnote-ref-1)