Super Sustainable Student Dorm Project

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I. Introduction

In 2007, President Brian Rosenberg signed the American College and University Presidents' Climate Commitment, which committed Macalester College to significant reductions in greenhouse gas emissions, as well educating students and community members about environmental and sustainability issues. One area discussed in the Commitment was energy and electricity use, and the importance of reducing consumption on campus was stressed throughout the document.# Although Macalester College made strides (installing CFL light bulbs across campus comes to mind) in reducing electricity use since 2007, there is a need to continue reducing energy consumption on campus to meet the goal of being carbon neutral by 2025.

One place where energy use remains high is in residence halls. In Macalester's dorms, students are directly responsible for most of the building's energy use including hot water and electricity. Their laundry, appliances, computers, fans, and lights make up a significant part of the college's ecological footprint and energy budget: $93,706 spent on electricity in the residence halls each year. On-campus residency is required for two years and more than half the student body lives in the dorms at any given time. Because these buildings' energy uses are directly dependent on the resident's habits, the dorms would be the ideal target of energy savings campaigns.

Three unique aspects of energy use in the dorms were identified and examined.

Knickelbein examined unnecessary electricity consumption by investigating areas where motion sensor lights would be beneficial. A behavior change campaign by Koda addressed student habits of warm water use for their laundry. Roddy explored a feedback mechanism for easy access to real-time electricity consumption. Together, these themes and projects examine Macalester's residence halls as they exist ecologically: as input/output systems comprised of their residents, subject to change only if brought on by within.

II. Feedback Mechanism

There are currently no incentives for students to recognize, acknowledge, or reduce their contributions to the college's electricity demand. Most Macalester students are aware of the large scale impacts of energy use, but there are no direct information resources for them to see how they, specifically, are contributing. The use of feedback mechanisms has been proven to increase awareness and motivate a reduction in energy.# # # Incorporating an energy use information feedback system into dorm life would make students aware of their day-to-day consumption habits and promote energy reductions.

The infrastructure for this mechanism requires a retrofit of the buildings' electricity meter system, managed by the Macalester Facilities Services Department. They maintain the equipment and data records of electricity use on a monthly basis both per building and campus totals. Most of Macalester's buildings are installed with their own electricity sub-meter calibrated into kilowatt-hours, a standard electricity measuring and billing unit . The meters are located in the basement of each building in limited-access maintenance spaces. To gather the data, a facilities employee manually reads each meter monthly. The difference between the current reading and last month's reading is the kilowatt hours used by the building that month. The data is recorded and published in the Annual Energy Report used by Facilities Services.

RECOMMENDATION: One of the reasons that the current feedback system at Macalester is inadequate is because the publication of data is too seldom, and it inaccessible for students. A successful feedback mechanism requires easily accessible, real-time energy consumption data.# However, the current meters make this impossible. They are outdated analog models tucked deep into the basement of each building, out of sight and out of mind for students. From a sustainability standpoint, this system is insufficient and students do not have good accessibility to view their contribution to Macalester's energy use.

Many steps are required to introduce an adequate feedback system into the dorm buildings. Old electricity meters will need to be replaced with newer models because the current meters are unable to automatically transmit their data. New meters will have a communications port and be wired into Macalester's existing Ethernet network so that the data can be read by a computer. To complete the feedback system, the data must be analyzed and presented directly to students. Macalester personnel will be able to view electricity demand on different time scales, and send that data straight to students.

The first step to incorporate this system into the campus is to upgrade the meters. This requires coordination and cooperation with the Facilities Department. Gathering information on existing infrastructure and potential replacements is logistically a long and tedious process. Campus-scale electricity infrastructure is complex and the utility meter industry is extensive. The semester's worth of research has yielded product recommendations that match the college's needs. The Class 3000 Advanced Meters by E-MON D-MON are the best option for a retrofit at Macalester (see Appendix 1). The data and communication features of these meters allow for incorporation into a feedback system for students.

Careful logistical and financial planning will be required before purchase. Based on a

E-MON customer service estimate, a single Class 3000 meter will cost around $1,300. This price can likely be lowered by sales negotiation and quantity purchasing. Depending on how many meters Macalester decides to purchase, this project will require a budget of no more than $10,000. Table 1 identifies Macalester dormitory meter installation options.

All Residence Halls	Campus Conservation National Residence Halls	Freshman Residence Halls Per Floor (pilot project)
Dupre, Doty, Turk, GDD, Wallace, Kirk, Bigelow, 30 Mac	Dupre, Doty, Turk, Wallace, Bigelow	Dupre (4 floors) Doty (5 floors) Turk (4 floors)
8 meters	5 meters	4 or 5 meters

Table 1: Macalester Residence Hall meter installation options.

Accomplishing these first steps will be crucial to advancing the completion of this feedback system. The final product will be used as an educational tool and to quantify results of sustainability projects aimed at resident electricity use reduction. The incorporation of this mechanism into Macalester's residential life will be a great step in the college's technological sophistication and sustainability progress.

III. Behavior Change

Laundry, the dreaded task of a college weekend, second only to homework is a task normally taken care of by parents at home. Many students know very little when it comes to "doing the laundry," simply shoving two-week's worth of accumulated clothes into the machine, dousing them with detergent, picking the setting they believe will work best (labeled "normal"

aka “warm”), and going about the rest of their day. Little do they know that there are a surprising amount of “green” ways and incentives to change their washing habits, and they won’t break the bank or the already stressed-out mind.

One of the easiest ways to instantly reduce one’s “washing footprint” dramatically is to wash in cold. On average, 90% of the energy consumed in washing machines goes towards heating the water.# A habit change can be as simple as pushing a button. It creates no extra work for the individual, for they are already pushing a button to begin with, just the appearance of the button changes. There is no added wait-time for the washer to do its job and it’s in one’s best interest once their on their own paying for their own utilities to do so; it saves money! One can save close to an average of $60 per year in energy costs.[6] That may not sound like much, but for as simple a lifestyle change as pushing a different button, a small step can go a long way.

A student might ask themselves, “So why do people even ever wash in hot?” Many are simply uninformed and go for the safe bet which is usually the “warm” or “normal” setting as stated earlier. Many grew up with their mothers washing everything in warm or hot water and simply had habits passed down onto them. Many also believe that in order to get clothes clean, hot water must be used. All of these feed into washing habits, which as trivial as they may seem, add up in the long run. Given that the average household does the wash a little over once a week, totaling roughly 392 loads per year.# Little habitual changes can make a real difference.

Now for the shocking numbers: with the simple habit of washing in cold in mind, if an individual washed in cold, they would save the equivalent of 182 gallons of gasoline a year.[7] Depending on what car they drive, that can be as much as 7,280 miles of driving (in a Toyota Corolla avg. 40 MPG)! That’s the equivalent of driving almost one third of the way around the earth. For those who own an electric hot water heater and wash in hot, they have the chance at

reducing their carbon footprint by 2,245 lbs of CO2 per year.[7] Washing in cold only produces about 162 lbs of CO2 per year or about the same as 8 gallons of gasoline. Multiply these numbers by the number of people across the globe that have access to washing machines and the world-potential CO2 savings go through the roof.

After looking the numbers over, it's easy to see the positive environmental impact of washing in cold water. But what are the other, potentially, unintended benefits? For one, washing in cold increases the longevity of clothing. Hot water can hurt one's clothes as much as it can hurt one's hand. Fibers and dyes break down much more quickly when continually washed in hot water than they do when washed in cold. Hot water can cause dyes to bleed (this is how pink socks are made) and fibers to become worn. If one truly wants their clothes to last, they will re-wear them until they need to be washed, i.e. dirty and stinky. Washing clothes less significantly increases their lifespan, as well as using less energy. Another factor to think about that can also net some savings is what the machine's optimal capacity is. Most machines run best when full.[6] Therefore, less loads need to be run when the machine is fully loaded. Making less work for the individual and meaning less frequent trips to the laundry room for students.

For those especially concerned with getting clean clothes and think that that can only be achieved in warm water, think again. Cold-water laundry detergents have been making a splash in the market lately. They have been shown to work equally as well as their warm-water counterparts under similar circumstances# and allow one to rest at ease helping out Mother Nature without having to grimace at dirty clothes. Tide Coldwater™, introduced in 2005, has since wracked up over $900 million in sales in the US alone[8], showing that the trend is catching on.

For those that want to do the most that they can for Mother Nature without

compromising the cleanliness of their clothing, there is hope. Such big name brands like Tide™ use petroleum-based chemicals in detergents and soaps. Although they work well, they also contribute to problems of the day, such as dependence on fossil fuels. Luckily, plant-based detergents are available. Plant-based detergents require less oil than petroleum-based counterparts, although some oil is used in the growing and transportation of plant ingredients. They contain no harmful chemicals, such as formaldehyde and phosphate, which can remain in fibers after the wash. They are also biodegradable and don't pollute groundwater or other waterways.

Two of the most popular brands of biodegradable, petro-chemical free, plant-based detergents include Seventh Generation™ and SmartKlean™. Seventh Generation's doubly concentrated detergent is formulated to work best in cold and since it's 2x concentrated, less means more; more uses per bottle and more savings on transportation and packaging. The back of their 50 oz. bottle reads, "If every household in the U.S. replaced just one bottle of 50 oz. 2X petroleum based liquid laundry detergent with our 50 oz. 2X plant-derived product, we could save 233,000 barrels of oil, enough to heat and cool 13,400 U.S. homes for a year." All that can come from just a simple change in consumer habits. Surprisingly though, Seventh Generation's™ savings are dwarfed by the savings that the SmartKlean's™ ball can bring to the table, or rather the washing machine. SmartKlean™ has created a revolutionary device, a reusable laundry ball that acts a detergent and fabric softener. Where one Seventh Generation™ 50 oz bottle of detergent handles up to 66 loads, one SmartKlean™ ball can handle up to 365 loads!# That's 5 times that of a bottle of Seventh Generation™ and nearly a year's worth of laundry for an average family. In terms of barrels of oil saved, SmartKlean™ takes the cake with 1,165,000 barrels vs. 233,000.[9] Cost savings are also evident. One SmartKlean™ ball

costs about $45. The cost of the 5 bottles of Seventh Generation™ necessary to match the one ball is between $60-75, depending on where one's buys them. That's anywhere from $15-30 of savings a year on plant-based detergent alone.

An effort from Macalester College to inform incoming students could prove extremely effective in reducing energy used for the laundry. Something as simple as a poster designed to inform students as to how much energy is saved by washing in cold would sway some (hopefully all) students to change their washing habits. If resources were to be made available, such as a web page on the Sustainability Website giving a rundown on green-washing tips and recommended detergents, students would be more apt to utilize them. If the initiative did not include this aspect, students would largely be too lazy to go about researching the topic on their own. Making the change as *easy* as possible is probably the only way to convince busy students. Just as the water bottle ban that most every student is aware of, a similar level of awareness would be the goal of a green-washing campaign.

The switch can be as easy or intensive as one wants to make it. If it's simply taking time to think about which setting to use or going the whole nine yards to wash sustainably. Cost savings provide immediate incentive, while CO2 emission reductions provide a sense of fulfillment by doing what's right for the planet. There are going to be many more pressing issues in years to come regarding how humans can live more sustainably. If green washing habits are learned early on in a student's life, the probability that they will carry them on into their lives outside of Macalester is promising, thereby having a profounder effect on the world. If students were to be informed at the start of their Macalester career through informational posters and web resources their habits are likely to be heavily influenced. This is one lifestyle change that requires hardly any effort to succeed, just a simple behavioral change.

IV. Wasted Energy and Motion Sensors

Too often, lights are unnecessarily left on in residence hall bathrooms. Whether because of habit or by accident, both electricity and money are wasted when students forget to shut off the lights. An easy solution to that problem is to install motion sensors in the bathroom. Motion sensors are connected to the lights in the bathroom and set to a timer (often 30 minutes), when they will shut off if they do not detect any movement. While installing sensors does not affect the behavior of students nor does they implement a long-term environmental mindset, they are quite practical for achieving a reduction in electricity use in bathrooms.

Currently, Macalester has sensors installed in some bathrooms, but that number can certainly be expanded upon. The simple act of putting motion sensors in bathrooms of buildings that already have some sensors installed would be a very important and logical step in reducing electricity use here on campus. We surveyed the current status of sensor placement in bathrooms in on-campus residence halls (Doty, Turck, Dupre, Wallace, Bigelow, 30 Mac, and Kirk). Out of 50 possible bathrooms, only 22 had motion sensors already installed. That leaves 28 bathrooms where sensors could be installed.

While the potential energy savings of installing motion sensors is high, so too is the cost of installing sensors. Installing just one sensor unit in a residence hall bathroom at Macalester will cost approximately $50.# So with high up-front costs, can sensors actually save money in the long run? According to several studies, yes they can.# # Although sensors present large up-front costs, the electricity saved over many years can, and often does, present a payback in the long run.# Furthermore we calculated that installing sensors in 20 of the 28 recommended locations would save Macalester $108 per month (see Chart 1).

One standard bathroom light bulb unit=370 kilowatt hours (kWh) per month
Installing one sensor reduces electricity use by 60 kilowatt hours per month
370 kWh-60 kWh=310 kWh used per sensor each month
370 kWh20 standard light bulbs=7,400 kWh/month
310 kWh20 sensors=6,200 kWh/month
7,400-6,200=1,200 kWh saved per month
$.09=average cost of one kilowatt hour of electricity in 2010 in Minnesota
1,200 kWh$.09=**$108**,projected monthly savings

Chart 1: Motion sensor lighting budget calculations.

Electricity is cheap now, although electricity prices per kilowatt hour have been rising, and are expected to rise for at least the next 20 years. In his article “Do Motion Activated Light Switches Save Money,” Trent Hamm discussed different types of people and whether it was practical for them to install sensors#. The first type of person this study mentioned was meticulous, well-planned, and already quite environmentally conscious. The report said that installing sensors in areas frequently inhabited by this type of person would be no help in reducing energy use and lowering costs, because chances are these people already remember to turn the lights off. However, a second type of person, the spontaneous, free-spirited, and sometimes forgetful person, will significantly benefit from installing motion sensors. Macalester contains all types of students, and installing sensors will be beneficial for the overall student

population, and will certainly be cost effective over the long run.

The Facilities Department has agreed to install light sensors in many of our proposed bathroom sites. In a recent meeting with Mark Dickinson, he suggested he was looking at installing sensors in approximately 20 of the 28 suggested locations. He did not, however, reveal which locations he deemed suitable for sensor placement. The good news is that he is very enthusiastic about the project, and the timeline for installation of the sensors is rather quick. At our most recent meeting, Mark stated that he expects the installation of the sensors to take place over J-term, and that students will return to the dorms with brand new sensors installed in many new bathrooms.

V. CONCLUSION

Through efforts to increase awareness, decrease electricity waste, and change behavioral habits, sustainable actions and choices become part of a student's day to day life. When entering a bathroom, the click of a sensor turning on the light reminds them of the effort being made to reduce energy. Seeing real-time energy use statistics helps illustrate the student's cumulative impact on energy. Direct feedback from daily actions has a higher likelihood of inciting change than from maintaining the facade that a student's actions are without consequence. Going about encouraging habitual changes also has a more profound effect when the change is voluntary. Students are more likely to feel a sense of accomplishment in knowing that their actions made a difference when they directly choose to take part rather than being forced by a new policy to comply. The implementation of these proposed changes will have lasting effects on the student body and bring about considerable progress towards Macalester's sustainability goals.

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