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Abstract	The purpose of this project was to design an energy reduction program for residence hall laundry facilities. The project group worked to set the framework for such a program, including planning methods for collecting baseline data and monitoring program progress. The project group also proposes a behavior change campaign that involves encouraging student residents to use the cold setting on their washing machines.
Problem Statement	A University-sponsored program that encourages student residents to launder with cold water is a yet unexploited avenue for energy conservation.
Keywords	Laundry, cold water, natural gas, residence halls
Data	Existing

Laundry Energy Reduction

Environmental Science Capstone, Fall 2013

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Considering the continuing problems stemming from our energy demand nationwide, the need for better solutions to the increasingly problematic issue of fossil fuel will only become more important with time. While policy and national government-level decisions are crucial to reducing our dependence on fossil fuels, a more bottom-up approach through a combination of efficiency and reduction in demand is necessary for a feasible progression into a more environmentally co-adaptive and sustainable future. Humboldt State University, as an institution dedicated to the education of new generations of future scientists, leaders, and artists, has an imperative to be part of this bottom-up approach. With a relatively captive population of on-campus residents and students, conscious and educated changes in behavior can be combined with greater efficiency to minimize energy use and reduce the burden on the environment that the university represents currently.

Humboldt State University is committed to sustainability, and its mission, vision and values are representative of this commitment. The University Mission is, in part, to “promote understanding of social, economic and environmental issues.” The University’s Vision includes being “renowned for social and environmental responsibility and action.” Additionally, the University Values state, “Individuals must be environmentally, economically and socially responsible in the quest for viable and sustainable communities.” Some of HSU’s recent efforts toward developing a sustainable community include the establishment of the Office of

Sustainability in 2011 and the achievement of a silver rating in the year-long Sustainability Tracking and Ranking System (STARS) in 2013.

One of the foci of HSU's sustainable development is improved energy efficiency. According to its STARS report data, the University reduced its energy consumption by 32% between 2005 and 2013. This reduction is primarily attributable to various lighting efficiency installations, such as occupancy sensors and LEDs. These improvements conform to the California State University's sustainability policies of Executive Order 987, in which the Office of the Chancellor mandates that "each campus will continue to reduce energy consumption". However, in order to continue reducing energy consumption, HSU needs to diversify its energy conservation efforts by employing innovative efficiency improvements to multiple areas of consumption.

Residence hall laundry facilities are an area of significant energy consumption. Laundry facilities consume energy by requiring hot water for washing and hot air for drying. According to EnergyStar.gov, water heating consumes about 90% of the energy it takes to operate a clothes washer. According to the U.S. Department of Energy (DOE), water heating accounts for about 14% of utility bills in American homes. According to the Energy Information Agency, clothes dryers account for over 4% of total residential energy use in the U.S., and the Environmental Protection Agency (EPA) estimates that all residential clothes dryers in the U.S. consume 43 billion kilowatt hours of electricity and 445 million therms of natural gas every year. While the exact energy load of residence hall laundry facilities at HSU is not provided here, one might figure that the 2,100 student residents at HSU create a substantial energy

demand in the laundry room and that it is in the University's best interest to reduce that demand.

The DOE claims that "there are two ways to reduce the amount of energy used for washing clothes -- use less water and use cooler water." Since heating water requires energy, laundering with less water or cold water conserves energy. High efficiency, front load washing machines significantly reduce the amount of water required to do laundry and therefore are more energy efficient than their toploader counterparts. The residence hall laundry facilities at HSU are equipped with high efficiency front-loaders, and so the University has addressed the first said method of reducing the energy demand in the laundry room. However, the second said method, washing with cooler water, is currently subject to the laundry habits of on-campus residents.

In order to maximize the energy conservation potential within residence hall laundry facilities, the University should consider ways that it can encourage residents to wash their clothes with cold water. The project group proposes that a University-sponsored cold water laundering program that encourages residents to use the washing machines' cold setting would effectively reduce the energy demand from residents hall laundry facilities. The basis of this project is that such a program is a yet unexploited avenue for energy conservation.

The idea of launching a cold water laundering initiative in HSU residence halls originally stemmed from an objective of the Alliance to Save Energy's PowerSave Campus Program, a student-driven organization that seeks to achieve measurable energy savings at HSU and other college campuses in California. PowerSave Campus divides its energy-saving goal into parts, including saving electricity, saving natural gas, and identifying areas of potential savings. It then

assigns specific objectives to each of these parts of the goal. To save 600 therms of natural gas at HSU this year is the PowerSave Campus Program objective that stimulated the cold water laundering idea.

In light of the said PowerSave Campus objective, the project group took to designing a semester-long project that would assume the role of the development of a cold water laundering program for HSU student residents. The initial project plan was to launch a campaign in the residence halls aimed at reducing natural gas consumption by encouraging the use of cold water laundry cycles through education. The basis of this campaign idea was that education about the heavy energy load of hot water laundry cycles would instigate the behavior change among residents of switching from running hot or warm water laundry cycles to laundering with cold water, which would reduce the amount of natural gas used on campus by reducing the amount of gas burned to heat water. The project's dual-aim education campaign design would encourage residents to use cold water laundry cycles more often or exclusively, as well as provide general information on how to reduce one's energy consumption in the laundry room. In this way, the program would be informative and reduce energy consumption on campus, which is consistent with University's commitment to sustainability.

The flagship component of the education campaign would be interpretive signage. Signs would be designed for installation in laundry facilities and would provide useful and relevant information about 'greening' the laundry experience. PowerSave Campus had previously worked with a student group from the Environmental Education and Interpretation Graphics class to design such a sign, which serves as the campaign's prototype. The project group intended to improve upon the prototype design. Other ideas for campaign materials included

placards that could be placed directly on the washing machines' controls. Such placards would rename the machine's default settings as "High Energy Use" and "Low Energy Use", for hot and cold water, respectively. The said placards would effectively associated one's decisions in the laundry room with one's level of energy consumption. The design process of the program's campaign materials would involve inspection by University Marketing and Communication and conform to Facilities Management standards for signage wall installation.

The cold water laundering program would also involve an outreach component. The project group brainstormed potential, effective promotion strategies. Informational pamphlets could be distributed to residents and to places on campus likely to be trafficked by residents. The said pamphlets would communicate the main benefits of washing with cold water. Press releases could be sent to on campus media outlets, briefing the general campus community about the cold water laundering program. T-shirts displaying a campaign slogan could be awarded to program participants. The outreach component of the program would require sourcing funds, which could come from organizations like ResLife, PowerSave Campus or the Humboldt Energy Independence Fund. Effective outreach would ultimately result in greater awareness of the program and the establishment of a cold water laundering social norm among student residents.

In order to measure the effectiveness of the cold water laundering program, the project group planned on measuring changes in laundry behavior among residents and natural gas consumption in residence hall laundry facilities. The said measured changes would need to be compared to reference or baseline data established prior to the start of the program. In order to establish a baseline for the laundry habits of residents, the project group intended to

conduct surveys of residents' laundry habits and make direct observations of residents' laundry habits. Of particular interest would be the frequency of cold, warm and hot water cycles. Additionally, in order to establish a baseline for the gas consumption of resident hall laundry facilities, the project group would need to extract a refined gas-use value for particular laundry facilities by, in part, analyzing past gas records of residence halls.

After laying down some of the initial groundwork like designing a campaign framework and meeting with stakeholders from Facilities Management and Housing, the project group identified several constraints. University policy concerning residents' privacy and human subjects research prevented the project group from lawfully obtaining information about residents' laundry habits by direct observation. Housing Administration authorized the project group to survey residents about their laundry habits; however, before surveying residents, the project group must have received approval from the Institutional Review Board (IRB), which governs human subjects research. While the project group completed some of the initial steps of the IRB research submission process, such as an online course in research ethics, it decided to focus its time and efforts to more productive tasks. The IRB approval process became a time-related constraint. In this way, the project group was unable to determine a baseline for resident laundry habits, specifically water temperature preferences.

The project group also faced a constraint to determining an energy load baseline for residence hall laundry facilities. The campus infrastructure for gas distribution and metering did not provide data refined enough for assessing the energy load of laundry facilities without bearing consequential assumptions. In other words, residence halls are usually metered individually, but laundry facilities therein are not. Surmounting this constraint would involve

the installation of improved gas monitoring technologies. The project group deemed the installation of such devices beyond the scope of its attainable objectives. However, it does propose that, with access to accurate information regarding residents' energy-consumption habits *outside* of the laundry room, such as shower duration, that fair assumptions could be included in gas records analyses, and a good gas baseline for laundry facilities could be extracted. Of course, obtaining such additional information would require prior IRB approval.

The project group found the constraints to determining the two necessary baselines to be insurmountable during the remaining time frame of the project. Inevitably, the said constraints would later inhibit monitoring program progress and evaluating program success. Without the ability to collect information about residents' laundry habits, the project group could not measure any behavior change in result of the program. Without the ability to monitor the gas consumption of individual laundry facilities, it could not measure any reduction in natural gas consumption. Since level of behavior change and natural gas reduction are the two primary metrics of interest of the project, the project group proposes that surmounting the said constraints is a prerequisite of launching a successful cold water laundering program.

The project group submitted its cold water laundering program design to the Humboldt Energy Independence Fund (HEIF) in the form of an Idea Paper, as per the official HEIF Idea Paper protocol. The HEIF Committee unanimously voted to accept the project idea for further development. During the Spring '14 semester, a student Project Developer will research possible improvements to the project design and redesign the project as necessary, addressing the identified constraints. At the end of next semester, the Project Developer will propose the improved project design to the HEIF Committee, who will assess its feasibility and vote to or not

to fund and oversee the project planning, implementation, monitoring and evaluation. The Cold Water Laundering Program Pilot Idea Paper is included in the appendix of this report.

The revised project goal became centered around an initiative to replace existing older, inefficient water heaters in the various campus residence halls and buildings with newer, more efficient models that would create a net saving of both money and natural gas over a payback period and beyond. New facilities such as the College Creek residence halls are fitted with brand new, highly efficient water heaters that are significantly better than older models used in older resident halls, giving the project an easy basis of comparison. To achieve this, a monitoring plan was set up to provide a baseline use rate for natural gas in one or more residence halls so that a reliable value for energy and cost savings can be determined, providing a basis for comparison between the current water heaters and proposed replacements.

" Manufacturers of water heaters have sought to increase the efficiency of the exchange of this heat energy from burned fuel to the water contained in the water heater" (Ritsema). Conventional water heaters are less efficient than the condensing alternative. Conventional water heaters exhaust their hot gasses and their combustion side products all at once through a vent. The hot gases usually around 300 degrees C will eventually cool outside of the heater but often cool significantly to the point of condensation before the gases are fully expelled from the vent. This corrodes the vent which would need to be built with Polyvinyl chloride piping; also known as PVC piping. This is because PVC piping is resistant to corrosion. Conventional water heaters are less efficient because of the heat that is expelled to the atmosphere, and not heating the water in the water heater. The most efficient conventional water heaters are generally less than 80 percent.

Condensing water heaters are much more efficient because this type of water heater retains the exhaust gas until its temperature is around 100 degrees C. This increases the efficiency of the water heater up to 95, and for really efficient ones 98 percent. “The ability to capture the energy created from the vapor to liquid phase change is why condensing water heaters are so efficient; the water heater is using the energy of the latent heat from the phase change to heat the water in the water heater”(Pvi). The main problem is that since the combustion side products never leave the water heater the interior of the water heater needs to built of material that is both resistant to heat and resistant to corrosion. “As heat exchange efficiency increases, however, such increased efficiency gives rise to the problems associated with the condensation of water vapor from the products of combustion”(Ritsema) “The water heater utilizes stainless steel components, electroless nickel plating and acid-resistant polymers in areas where it is exposed to the corrosive condensate” (Pvi).

While the project group did not accomplish its initial objectives, it identified some valuable information and posed some critical questions. The project group identified the two most suitable laundry facilities for analyzing gas consumption. Those are the laundry facilities at College Creek and at Creekside Lounge. College Creek is suitable because its gas consumption for HVAC is metered separately from that for domestic water heating. So, at the current state of gas metering technologies, one can at least narrow the sources of gas consumption to showers, sinks, dishwashers, clothes washers and dryers.

The gas consumption data for Creekside Lounge, where the Housing’s largest laundry facility is located, is equally refined, but in a different way. Creekside lounge is the common area for the 250 residents of Creekview and is metered individually. Two residents live there

and have a wall heater. A couple staff work there and operate the heating system. The clothes dryers are electric. In this way, the gas demand from water heating for the washing machines may be extracted with a few small assumptions.

The HSU ResNet office presented the project group with monthly usage data for all the washers and dryers in residence hall laundry facilities. Drew Meyer, Housing Info Tech Consultant for ResNet, described the payment logistics of washer and dryer use to the project group. The University leases all of its washers and dryers from a third party laundry appliance provider. It was disclosed that a certain percentage of the money received from the laundry rooms goes to the company who owns the washers and dryers. The other part of the percentage Humboldt State keeps. Mr. Meyer did not disclose how the laundry funds are distributed between the two parties. Nonetheless, he was able to back calculate a rough estimate of the number of loads of laundry being done per month on campus, which accounted for all of the residential laundry facilities. This number was useful on estimating the amount of loads of laundry done per resident per week.

Residents do about 0.8 load of laundry per week on average. One wash cycle costs $1.50, and one may presume that one dry cycle costs $1.50, on average. During the 32-week semester year, the approximately 2,100 student residents collectively spend over $160,000 in residence hall laundry rooms. While the business negotiation between HSU and the said third party laundry company are unspecified, the project group is curious about how that negotiation is negotiated. The project group poses the following questions: Does HSU profit from the laundry services provided to HSU student residents? Where along the line is the cost of water heating for laundry machines incorporated into price?

The progression of the project has highlighted several issues and areas of concern that can be of use to future projects dealing with similar campus institutions and infrastructure challenges. The decentralized nature of much of the campus' points of energy use and distribution, combined with reliance on cooperation between university departments and private companies, makes accurate data collection and monitoring difficult. Future initiatives and projects on campus seeking to reduce energy use will need to deal with these hurdles in particular in order to be effective, as the 'easy' reductions in energy use have already been attained by now and further reductions without large-scale scaling back of the energy being used on campus will require significant changes in resident behavior and efficiency. These kinds of 'soft-path' methods are preferable, however, to the costs associated with simply using more natural gas to keep up with demand.

References

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Appendix

The project group collected data on the natural gas consumption at the Creekside Lounge from October 22nd to November 19th. The natural gas meter is measured in 100 cubic feet of natural gas per revolution at least once a week, and was taken by in-person measurement of the exterior gas meter:

Table 1) Gas Readings

Date Taken	**Cubic ft. Natural Gas**
10/22/2013	4253400
10/29/2013	4260600
11/5/2013	4268000
11/7/2013	4270200
11/12/2013	4275000
11/19/2013	4282500

Weekly Average: 7275 ft^2
Total Since Beginning of Monitoring Period: 29,100 ft^2

Table 2) RESnet Laundry Data

Month	**Loads/Month**	**Loads per Week**
December (2012)	8782	3512.8
January (2013 onwards)	3855	2570
February	14474	3618.5
March	11418	3806
April	12418	2,887.91
May	8261	3304.4

Average: 3283.27 loads laundry/week

Creekside Lounge Analysis

- $250\ residents \times \frac{0.81\ load}{1\ week\ per\ residents} \times \frac{5.5\ gal}{1\ load} \times \frac{1\ hot}{3\ cycles} \times \frac{3.785\ L}{1\ gal} \times \frac{1000\ g}{1\ L} \times \frac{4.18\ J}{g\ ℃} \times 45℃ \times \frac{1\ therm}{105480400\ J} \times \frac{1}{0.725} = 3.46\ {therms}/{week}$

  *The current water heating system operates at a 72.5% thermal efficiency rating

  *ResNet laundry cycle data from spring 2013: approx. 1,600 wash loads per month for 2,000 residents OR 0.81 loads per week per resident

  *Assuming the water is heated from 15°C to 60°C

  *According to the machine specifications that are utilized in College Creek laundry facilities 11 gallons of water per cycle. It is assumed that there are two chamber fills per cycle, as in one wash and one rinse, and that, for a hot water cycle, the first fill is entirely hot water.

  *Assuming 1 out of every 3 laundry cycles is run with the hot water setting. This basically assumes and even distribution across the machines' water temperature settings.

  http://www.speedqueen.com/media/256860/combo_qtm_flwfc_sfnlyfpump_am11-0740.pdf

- $3.46\ {therms}/{semester\ week} \times 32\ {semester\ week}/{year} \times {\$1.10}/{therm} = \$121.80$ per year

  *According to Silas Biggin, Campus Energy Manager, the University purchases gas at $1.10 per therm on average.

Creekside Lounge Analysis for Improved Water Heating System

- $250\ residents \times \frac{0.81\ load}{1\ week\ per\ residents} \times \frac{5.5\ gal}{1\ load} \times \frac{1\ hot}{3\ cycles} \times \frac{3.785\ L}{1\ gal} \times \frac{1000\ g}{1\ L} \times \frac{4.18\ J}{g\ ℃} \times 45℃ \times \frac{1\ therm}{105480400\ J} \times \frac{1}{0.95} = 2.64\ {therms}/{week}$

  *Assuming condensing water heaters operate at 95% thermal efficiency

- ${therms}/{semester\ week} \times 32\ {semester\ week}/{year} \times {\$1.10}/{therm} = \$92.93\ per\ year$

The potential savings of improving the Creekside Lounge water heating system is about $30 per year over the lifetime of the new water heater.

Cold Water Laundering Program in HSU Housing

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HSU needs a program directed at increasing the rate of cold water laundering among on-campus residents. The Cold Water Laundering Program would involve educating residents about the costs and benefits of using hot water and cold water, promoting the use of the laundry machines' cold water setting, and incorporating the cost of water heating into the price of using the hot and warm water options. This project may involve a before-and-after assessment of residents' laundry habits, including the frequency that residents use each temperature setting, as a means of measuring behavior change in result of the Program. Natural gas monitoring would provide a firmer metric for project success. The installation of gas monitoring technologies for laundry facilities could provide refined usage data.

Project Description

The education component of the Cold Water Laundering Program could be incorporated by a partnership between HEIF, one of HSU's student organizations involved with environmental education, and Housing's Residence Life (ResLife). Housing employs a student ResLife Coordinator specifically for education and engagement and a student Resident Sustainability Advisor that could participate in the development of a "Laundry Etiquette Workshop." ResLife's student Community Advocates and an environmental student organization could participate in the execution of the workshops in each of Housings living facilities. The HEIF would supervise the development and execution of the workshops.

The promotional component of the Program could involve a partnership between HEIF and University courses in Art, Journalism and Mass Communication, or Environmental Science and Management. For example, a campaign poster could be designed as part of an Intermediate Graphic Design student project. The poster would encourage residents to use the washers' cold setting and be installed in residence hall laundry facilities. More courses suitable for collaboration include Specialized Reporting, Environmental Communication, and Environmental Education & Interpretation Graphics; promotional devices produced by students from these classes could include a press release, a radio broadcast, a campaign pamphlet, a t-shirt design, or a flyer design. The objective of any promotional effort would be to encourage residents to launder with cold water. The HEIF would supervise promotional efforts.

The incorporation of water heating costs into the price of washing machines' temperature settings would provide a monetary incentive to use cold water and is likely to be the strongest determinant of residents' temperature choice. Residents currently pay the same price per load for hot, warm, and cold water. So, either the cost of heating water is external to the price of using the machines, or residents who use the cold water setting pay a disproportionately high price. Cost incorporation would ensure that one pays only for what one heats by setting a unique price for each temperature setting. Cost incorporation would likely decrease the frequency that residents choose the hot water option, which is the primary

objective of the Program. The HEIF would supervise the necessary facility changes for internalizing water heating costs.

Need Statement

The Cold Water Laundering Program addresses the mission of the HEIF by involving students, including in at least two of the three program components described above, and by definition of the program goal, to reduce energy consumption in residence hall laundry facilities. Thus far, the Program meets the first four of the five goals of the HEIF, as they are listed.

This project would be developed and implemented primarily by students, as described above. To some extent, the monitoring of the program would require assistance from Housing Maintenance or Facilities Management professionals. But, a student could be trained to conduct most of the necessary metering and analysis. Ideally, the Program would be maintained by formal incorporation into Housing's ResLife. The student Resident Sustainability Advisor and ResLife Coordinator for education and engagement would then manage the continuation of the Program. Otherwise, a new student position could be created under the oversight of the HEIF for the coordination of the Program.

Accountability of the Program goal would involve quantifying savings of natural gas by metering. Where possible, the installation of gas monitoring technologies for providing refined gas data would contribute to accountability. Additionally, the Program objective of increasing the frequency of cold water laundering among residents would be qualified by a before-and-after assessment of residents' laundry habits. This assessment could be conducted via online survey, move-in questionnaire, or direct observations.

This project would be incorporated into the curriculum of the University as described above. The promotional products of the Program would be designed by students as part of a class assignment. With more investigation into University curriculum, it is possible that the education and cost incorporation components of this project could also involve class assignments.

Dissemination of information through public outreach and educational activities is already incorporated into the project design. The Program will be promoted through a variety of media outlets that will reach both the target and non-target audience. The "Laundry Etiquette Workshop" described above further satisfies the dissemination of information through educational activities.

Outcome

A conservative estimate of the energy consumed for heating water for the use of the hot setting on laundry machines in Housing laundry facilities, not including the warm setting, is 110 therms per year[1] for an estimated cost of $120.00 per year[2]. There are assumptions associated with those values, which are listed below.

Partners

Jeremey Davis, Housing Assistant Director; Silas Biggin, Campus Energy Manager; TallChief Comet, Director of Sustainability; Morgan King, Sustainability Coordinator; Colleen Butterfield, Alliance to Save Energy Program Associate; Jenn Tarlton, Environmental

Management and Protection (EMP) Lecturer; Jennifer Ortega, EMP Lecturer; Anna Rhoads, Resident Sustainability Advisor; the Alliance to Save Energy's PowerSave Campus Program

Appendix

- $2100\ residents \times \frac{1\ load}{1\ week\ per\ residents} \times \frac{1\ hot\ load}{3\ loads} \times \frac{32\ weeks}{year} \times \frac{0.9\ gal}{1\ load} \times \frac{3.785\ L}{1\ gal} \times \frac{1000\ g}{1\ L} \times \frac{4.18\ J}{g\ ℃} \times 35℃ \times \frac{1\ therm}{105480400\ J} = 110\ {}^{therms}/_{year}$

  *Assuming 100% efficiency of the water heating system
  *Assuming each resident washes one load of laundry per week on average
  *Assuming the water is heated from 15°C to 50°C
  *Assuming 1 out of every 3 loads is washed on hot
  *According to the machine specifications that are utilized in College Creek laundry facilities, the hot cycle uses 0.9 gallons of hot water: http://www.speedqueen.com/media/303850/combomdc_flwrc_swry71_am11-0344.pdf
- $110\ {}^{therms}/_{year} \times {}^{\$1.10}/_{therm} = \$120.00$

  *According to Silas Biggin, Campus Energy Manager, the University purchases gas at $1.10 per therm on average.