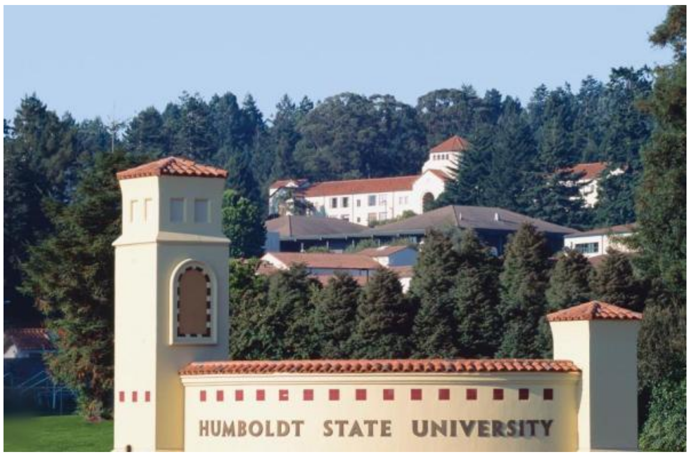

A PROPOSAL FOR A SUSTAINABLE RESIDENCE HALL COMPLEX AT HUMBOLDT STATE UNIVERSITY

ABSTRACT

A new residence hall complex is planned to be built within the next five years in order to accommodate the expected increase in Humboldt State University's student population. Any building constructed on CSU campuses must be built to basic LEED™ standards. However, we propose striving for the highest LEED™ standards that are financially viable. This proposal suggests cost effective features which can be easily incorporated into the design of the building which can greatly reduce the amount of energy and water consumed. This proposal also incorporates a strong educational and social program for sustainable living to complement the efficient design of the building and further reduce the amount of natural resources used. Incorporating these design features and social programs into the new residence hall complex can greatly reduce the amount of natural resources consumed. Thus, reducing the ecological footprint of this complex, while reducing the financial burden of utility bills for the University.

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Environmental Science Capstone Class (ENVS 411)

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1.0 Problem statement

Humboldt State University is planning to build a new residence hall complex in the next five years. Student housing in universities, due to the large population of students and the general lack of incentive to save energy, require large amounts of electricity and water in addition to producing a lot of waste. In the alarming climate of mass environmental degradation, there is an urgent need for more energy efficient residence halls that showcase sustainable living and align with Humboldt State University's image as an environmentally conscious institution.

2.0 Introduction

2.1 Energy and Climate

Human industrial activity over the past 200 years has disrupted the equilibrium of the carbon cycle, which regulates the earth's delicate climate patterns. Global climate change, as a result of human industrialization, once widely criticized, has become an irrefutable reality. There have been many suggested action plans that aim to reduce CO_2 concentration in the atmosphere, to avoid global temperatures rising above critical levels. The International Energy Agency's (IEA) 450 Scenario (2010) states that by the year 2035, annual global carbon emissions would need to be reduced by 75% of the global carbon emissions of 2008 to prevent a catastrophic change in climate (Figure 1). To achieve this goal, 53% of the abatement could be provided by energy efficiency measures, the majority of which can be incorporated in buildings (OECD/IEA, 2010).

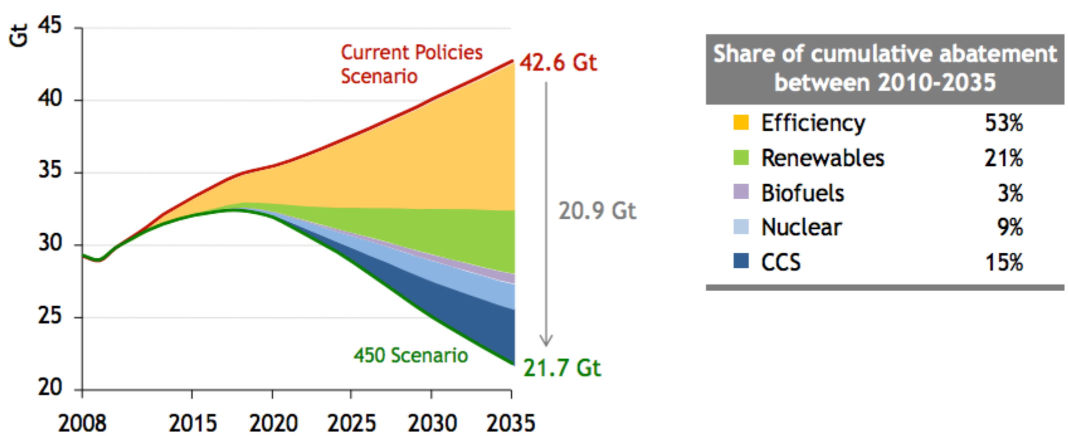

Figure 1. Shows the projected amount of global carbon emissions if there is no change in policy, versus the IEA's 450 Scenario and the abatement measures necessary to reach this goal. (OECD/IEA, 2010)

2.2 Global Warming Solutions Act

In response to rising concerns about the negative effects of global warming, California passed Assembly Bill (AB) 32, the Global Warming Solutions Act, in 2006, which requires the state to develop measures to meet greenhouse gas emission (GHG) reduction target by 2020 (CA State Legislature, 2006). This law reinforced California's leadership on environmental issues and created an action plan, and recommendations for major sectors to reduce greenhouse gas emissions. AB 32 calls all individuals, entities, and institutions to actively seek ways to reduce their carbon footprint.

Buildings account for a largest single sectorial use (40%) of energy consumed in the United States (Chen, 2009). The final recommendations report developed by the Economic and Technology Advancement Advisory Committee (ETAAC) states that one of the most economic and effective GHG reduction opportunities is investment in energy efficiency (ETAAC, 2008). To provide for the emissions-reduction opportunities in buildings and their associated investment costs, we reference the McKinsey curve, also called McKinsey's Marginal Abatement Cost Curve or MAC, (McKinsey & Company, 2013). This visual clearly identifies technologies and behaviors that provide negative costs while abating GHG emissions (Appendix C). A quick payback period is associated with many energy efficiency measures, including retrofitted HVAC systems and LED lighting, whereas low cost is associated with land use change measures (Appendix C). Higher costs are associated with large scale energy efficiency measures like hybrid cars and wind power. Therefore, negative to low cost would be associated with the construction of an energy efficiency building that incorporates cost-effective measure identified by the McKinsey curve.

In response to AB 32, Chancellor Charles B. Reed issued Executive Order 987, which states:

> *"The CSU shall design and build all new buildings and major renovations beginning in the FY 2006-2007 to meet or exceed the minimum requirements of the CSU Sustainability Measurement System, which shall be equivalent to LEED™[1] 'Certified.' Each campus shall strive to achieve a higher standard in the CSU Sustainability Measurement System equivalent to LEED™ 'Silver'*

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[1] LEED stands for Leadership in Energy and Environmental Design. The level of LEED certification is based on these main categories: Sustainable Site, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Awareness and Education.

within project budget constraints. Each campus may pursue external certification through the LEED™ process. Campuses that elect to pursue LEED™ certification shall seek nonstate funding sources to support that effort."

2.3 Sustainable Residence Halls: A Growing Trend

University campuses foster Research and innovation across all fields. Many colleges and universities in the United States and abroad are working toward combating the adverse effects of climate change by implementing green policies, pledges, and incorporating green technology at their campuses. A study done in 2009 looked at how this trend has grown between 1998 and 2009. It found 87 college campuses across the United States with residence halls that either promoted a sustainable lifestyle through education, were sustainably built, or were a combination of the two (Torres-Antonini and Dunkel, 2009).

Many colleges in California alone boast sustainable residential halls including Cal Poly Pomona, UC Davis, and Cal State Chico. One type of sustainable building is a zero-net energy building (ZNEB) which generates energy onsite using clean and renewable resources at or above the amount of energy being used (Robert and Kummert, 2012). UC Davis built a ZNEB, West Village student housing, which accommodates 800 residents. Many other campuses have been taking steps toward zero-net energy by first approaching carbon neutrality through their residence halls. Currently, 650 colleges and universities have signed the American College and University Presidents' Climate Commitment, which pledges to reduce carbon emissions by 80% within the next 40 years (Shin, 2009). These campuses will be the leaders in preventing the adverse effects of climate change in the future. Humboldt State unfortunately does not fall in these ranks.

Sustainable and efficient residence halls not only reduce the amount of money spent on energy and water use, they can also be used as a marketing technique to encourage students to attend these colleges and live on campus. HSU could benefit from the publicity to support its reputation as an environmentally friendly university, and attract more students to the growing environmentally-focused programs.

2.4 Proposed Residence Hall at HSU

Like many other CSUs, HSU is planning to increase its student population and build new residence halls on campus to accommodate a larger student body. As one of the smaller state universities, HSU is projecting a growth in the student body from just below 8,000 now (2013) to 12,000 in 2018. Residence halls can account for a large amount of the entire energy used on campus so creating very efficient buildings will greatly reduce the amount of energy and water used, waste produced, and GHG emissions of the campus. As an already huge energy consumer, HSU will need to address and compensate for the energy and resources it will be requiring in coming years.

HSU has made some strides to reduce its ecological footprint, but there are still opportunities for further reduction. As described above, many campuses across the United States have surpassed us in their efforts to reduce greenhouse gas emissions and become more sustainable. The need for additional residence halls to accommodate the projected increase in students will present an opportunity for the school to showcase its commitment to the environment by saving precious local water resources and lessening the need for electricity derived from fossil fuels.

Building a sustainable residence hall at HSU could help reduce the campus' use of natural resources, cut greenhouse gas emissions, reduce waste, and provide an educational opportunity for students. This realized proposal would help HSU become a leader in campus sustainability efforts and would create a living-learning community to greatly benefit the student population. Since the plans for the complex are still in their infancy, there is an opportunity to influence the design of the building to strive for a higher standard than what is minimally required by Executive Order 987.

3.0 Objectives and Constraints

3.1 Objectives

The main objective of this proposal is to make recommendations to HSU Facilities and Planning as to how they can make the new residence hall complex as sustainable as possible, while considering economic feasibility. Energy and water efficiency, education and awareness, and waste diversion will be the main focus of our project. There is no single way to define what a "sustainable" building is or what it incorporates but a common throughout these definitions is a focus on energy efficiency, environmental responsibility and resource efficiency. We want to clarify that in the context of our paper, we have come up with our own definition of a "sustainable" building as one that is:

> *Substantially energy and water efficient, produces as little waste as possible, incorporates "green" building materials, and raises the awareness of environmental issues in the campus community.*

The purpose of building a sustainable residence hall is to help HSU reduce the energy and water consumption, waste production and cost of running the new building. Another purpose of this project is to incorporate an educational campaign to increase awareness about sustainable practices not only for students in the residence hall, but also for the entire campus community. In order to comply with Executive Order 987, minimal Leadership in Energy and Environmental Design (LEED™) standards must be met but we suggest striving for the highest standard possible. HSU's image as a sustainable campus could be greatly improved if the new residence hall was built with the highest achievable level of LEED™ standards in mind. The new residence hall would be the fourth building on campus that is built to LEED™ standards and would help HSU become a leader in sustainability among California State Universities and the world.

3.2 Constraints

The biggest constraint to building a sustainable residence hall is the cost. Sustainable buildings employ designs and materials that can add considerable upfront cost. However, most of these green features have a short payback periods, (i.e. will pay for themselves over time) by reducing the amount of utilities used. Sometimes, issues concerning upfront costs must be foregone in the interest of the bigger picture, and the greater good. If we choose to rank cost-effectiveness before the wellbeing of our planet and our future generations, we will have compromised our morals as an institution of higher learning that encourages critical thinking and intelligent decision making. The Behavioral and Social Sciences (BSS) building (Figure 2.) and the Kinesiology Building (Figure 3.) (both built to LEED™ standards) cost $32.4 million (Arthurs, 2003) and $44 million (Lawlor, 2008) respectively. Although a large initial investment, the BSS building is projected to save $200,000 a year in energy costs compared to a building that was not built to LEED™ standards (Arthurs, 2003).

Figure 2. The BSS Building, one of HSU's one of HSU's buildings build to LEED™ standards

Figure 3. Kinesiology Building, one of HSU's buildings build to LEED™ standards

An additional constraint is that many commonly used energy efficient designs are not as conducive to concentrated living situations. Some energy efficient designs that employ natural lighting can require large amounts of open space, which reduces bed space, subsequently reducing the amount of revenue from the dorms. Therefore, we will only propose sustainable designs and materials that will be economically viable and can fit within the building design.

Green building certifications such as the LEED™ also add considerable cost to sustainable construction projects. Although all new CSU campus buildings will need to be built to Silver LEED™ standards according to Executive Order 987, HSU should strive to build the new residence hall complex to Gold or Platinum standards, the highest available within the LEED™ system. The amount of credits a building receives determines its LEED™ level; these credits are weighted based on various indicators such as indoor environmental quality, resource depletion, and water intake (USGBC). A significant amount of money is required to purchase the LEED™ certification for buildings, which is additional to the actual cost of constructing the building to LEED™ standards. Therefore, we propose constructing the building to the highest economically feasible LEED™ standard and foregoing the certification so that more funds can be allocated to making the building as sustainable as possible.

Students living in the proposed residence hall, as the defining feature of our proposal, will be encouraged to adhere to sustainable practices such as conserving water, composting, saving energy, and exhibiting all-around mindfulness of environmental issues. The present normative behavior of students living on campus does not necessarily tend toward an environmentally conscious lifestyle. The main constraint presented by instituting a lifestyle residence hall might be the capture of initial interest in living in the residence hall. Since many students are drawn to HSU by its environmentally conscious reputation, we believe this constraint to be easily amended. Also, any students not engaged in environmentally conscious behavior prior to moving into the residence hall could find it easy to incorporate these new behaviors into their daily routine through the hall's social activities and positive re-enforcement.

The new residence hall project is still in its infancy, so the project footprint and the number and style of rooms have not been determined yet. Because of this, there may be more unforeseeable constraints that cannot be addressed by our project at this time. Therefore, much of our proposal is going to address green building techniques that will be applicable to the new residence hall on a broad scale.

4.0 Implementation Plan

After a meeting with Mike Fisher, the University Planner for Humboldt State, we were assured that the following resource efficient elements would be integrated into the design of the building: low flow faucet aerators, low flow shower heads, florescent lighting, high efficiency HVAC units, as well as a high efficiency boiler. These are some of the very basic measures that can make a building more efficient because of their low to negative associated costs, and have large energy and water savings. Along with these basic measures there are many other affordable design features that would increase the building's energy and water efficiency, making the building more sustainable. Using green building materials can also reduce the ecological footprint of the building, often at a lower cost than traditional building materials. We have addressed a number of reasonable opportunities that can supplement the basic elements listed above.

The implementation of these efficient designs alone will play only a partial role in achieving and advancing sustainability at Humboldt State. We realize that the solution to environmental issues in our society and on campus hinge on the sense of social responsibility, environmental stewardship, and conservation efforts embedded in the common consciousness. Our implementation plan will focus on the perpetuation and practice of environmental mindfulness among students living in the new residence hall.

4.1 Green/Alternative Building

Existing buildings are often retrofitted or undergo additions that can be useful in achieving some level of sustainability. The construction of a new building presents an opportunity for its entirety to clearly demonstrate a purpose as a sustainable building. We suggest the use of sustainable building materials for the construction of the new residence hall to increase the efficiency of the building. Of course, the use of alternative materials must also fall within the realm of possibility. The building could then serve as an example for HSU to showcase its commitment to environmental stewardship from the inside out.

4.2 Local Materials

According to the USGBC (2013), 90% of LEED certified buildings are constructed with materials coming from less than 500 miles away. This would not be difficult in Humboldt County using timber, provided it is sustainably harvested. A building using responsibly harvested timber will receive two credits, as opposed to one, if the timber is certified by the Forest Stewardship Council (FSC). Another opportunity for credits is given for resources used that are rapidly renewable, i.e. bamboo. The use of bamboo for flooring would be sustainable in that it is a rapidly renewable resource.

If there is an existing structure, possible LEED points can be obtained by maintaining 75% of the existing building (Belsky, et al., 2008). Offsetting this severe environmental impact by using the existing Plant Operations building, or recycling what must be torn down, would save energy and earn LEED points in this category.

4.3 Water-Efficient Toilets

According to the Environmental Protection Agency (EPA), university restrooms account for 45% of the water used in the educational facilities (EPA, 2012). Installing efficient toilet systems in the residence hall would be an effortless and cost effective way of reducing demand for water and the energy used to transport it. These technologies would not only save money on HSU's utility bill (as we will discuss in depth below), they would give residents a sense that the conservation measures they take in simple, everyday activities like using the restroom have far-reaching beneficial impacts.

4.3.1 High Efficiency Toilets (HETs)

The Regional Water Authority of Northern California (2004) estimates that a single 1.3 gpf (gallons per flush) toilet saves 17,000 gallons per year that would otherwise be wasted in conventional 3.5 gpf toilets. Furthermore, according to Anand and Apul (2010), for each liter of urine passed, 6-15 liters are used to flush it under the standard system. The same study found that high efficiency toilets reduce water demand by 40%. Not surprisingly, using these technologies tends to be the first consideration in achieving LEED standards. Still, there are more promising alternatives.

4.3.2 Dual Flush toilets

Dual flush toilets further reduce water demands, flushing solids at the efficiency standard 1.6 gpf, and 0.8 gallons per half-flush for liquid. According to the American Water Works Association, dual flush toilets will use only 40% of the amount of water a conventional 3.5 gpf toilet would use over the course of a year (Chiras, 2008) (Figure 4).

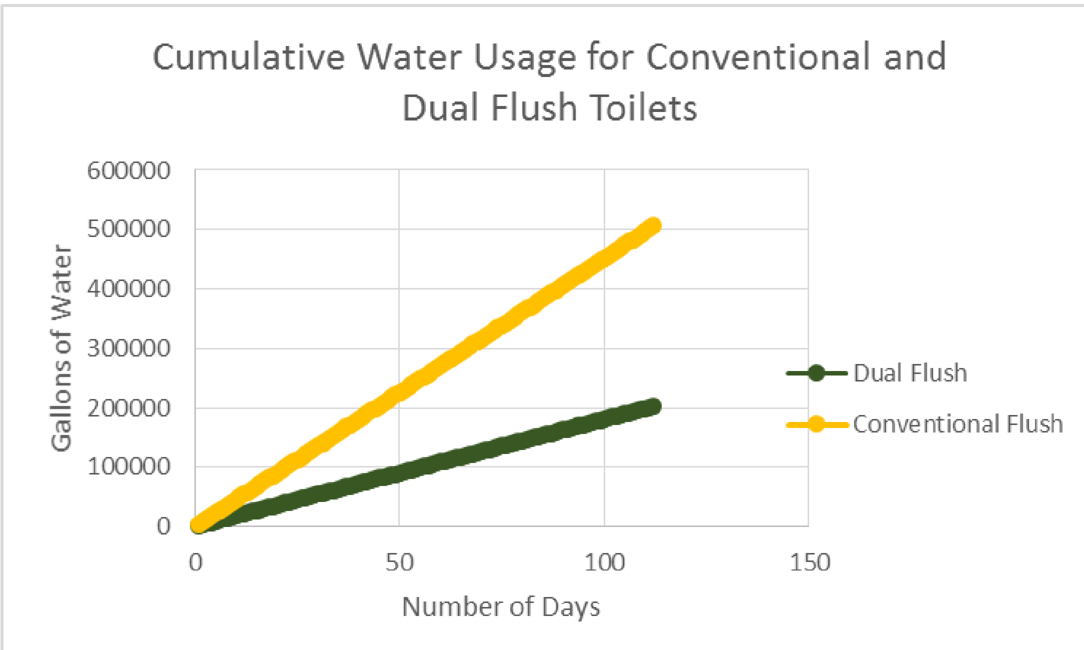


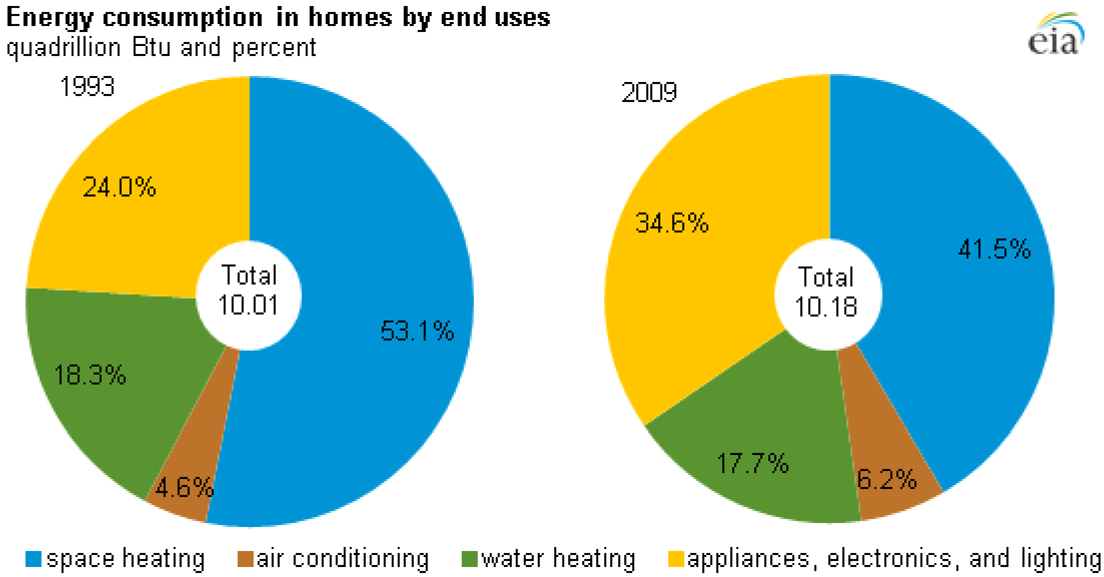
Figure 4. Shows the cumulative amount of water used by conventional flush toilets and dual flush toilets over the course of the semester (assuming 430 students with an average of four flushes a day and a ratio of 3:1 half flushes to full flushes for the dual flush toilets).

4.3.3 Waterless Urinals

Water consumption of urinals can be reduced by 100% with the installation of waterless urinals, which, as the name suggests, require no water at all to use. At a consumption rate of 45,000 gallons of water per year per urinal under the current model (EPA, 2012), no-flush urinals would prove a fast payback rate. According to the cost benefit analysis provided by Zero-Flush® waterless urinals, if six units were purchased, with only 100 males using the urinals once a day, the amount of water saved over 3.2 years would pay for the purchasing cost (Appendix A).

4.4 Daylighting

Lighting and maintaining a comfortable temperature account for a considerable amount of the energy used by residential buildings (Figure 5). Through better building design that allows for the maximum sun exposure (also known as daylighting), the amount of energy used for heating and lighting can be reduced by upwards of 40% (Miyazaki, 2005). In cool climates, large windows on South-west facing walls receive the most benefit from solar radiation because they are exposed to the sun during the hottest part of the day, and are able to capture the last moments of sun as it is setting (Radetsky et al., 2012) (Figure 6). To maximize energy efficiency, an optimum window size must be found. While large windows are able to let in more light and subsequently more heat, large windows also create surface area from which heat can be lost. Heat loss through windows can be reduced significantly by installing double paned windows or commercially available low-e glass. Double paned glass has a U- factor (heat loss measurement) of roughly 0.5, which is half that of single paned windows. Commercially available low-e glass U-factors range from 0.10-0.35 depending on the amount of glazing and the filling between the glazing layers (Zachman, & Carlisle, 2008). Unfortunately, windows are more expensive features to install and glass with low U-factors have a higher associated cost than other window products, creating a higher upfront cost. It is difficult to estimate the exact cost of daylighting the building and how much energy will be saved because these are both dependent upon the building footprint, the exact location and intended use of the building. However, with careful planning, large energy savings from daylighting can be actualized and the energy savings over time will pay for the extra expenditure. Large windows with low U-factors benefit the most from the solar radiation and are good for common areas. Smaller windows with higher U-factors are less expensive and work well in areas that will not receive as much sun throughout the day. Common areas, such as hallways, will benefit the most from daylighting, because the light will not need to be augmented by artificial light as much as rooms which are used for studying.



Source: U.S. Energy Information Administration, Residential Energy Consumption Survey.

Figure 5. Shows heating, lighting, appliances and electronics are the biggest consumers of energy in the average home.

Energy efficient lighting with multiple power levels can be used in conjunction with sensors which are able to adjust the lighting level based on the amount of natural light entering the building and can greatly reduce the amount of energy used for lighting. The use of motion sensors along with the light sensors will further reduce the length of time that lights are left on, by only lighting the hallway at night when people are present.

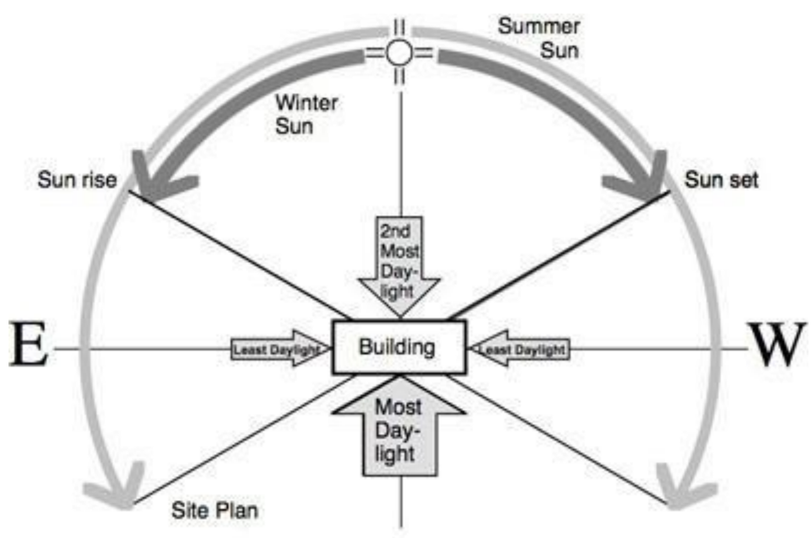


Figure 6. Shows that a south-facing building receives the most sun exposure.
"Daylighting." Whole Building Design. National Institute for Building Sciences, n.d. Web. 11 Apr. 2013.

4.5 Recycled Countertops

Countertops made from recycled materials have been growing in popularity and are considered more eco-friendly because they divert materials from landfills and prevent fabrication of new materials.

4.5.1 Recycled Glass Countertops

Recycled glass countertops use 80-90% post-consumer glass which is held together by cement and sanded down and sealed to create unique and elegant countertops that are durable and stain resistant (Figure 7). Recycled glass countertops can range in price from $50 to $125 per square foot (Counter Top Guides, 2013). These countertops are comparable to stone countertops in style and strength which can range in price from $100 to $225 per square foot for granite or $100 to $185 for quartz countertops (Counter Top Guides, 2013).

GREEN FIELD PRODUCTS. APRIL 29, 2013

Figure 7. An example of a recycled glass countertop

4.5.2 Paper Stone

Paper stone is another durable, beautiful and eco-friendly countertop material that is comprised of post- consumer paper waste that is saturated with resin and heated (Figure 8). This type of countertop is comparable to sturdy acrylics in style and strength. Paper stone countertops can range in price from $35 to $90 dollars per square foot (Yagid, 2009), whereas sturdy acrylics can range from $75- $125 per square foot (Counter Top Guides, 2013).

DOERFLER, KRISTA.2009.FINE HOME BUILDING. APRIL 11, 2013

Figure 8. An example of a paperstone countertop

4.6 Sustainable Living and Social Responsibility

There are three crucial parts of the social and educational aspect of this proposal: sustainable living theme for the complex, social responsibility of the residents, and residence hall sponsored activities.

4.6.1 Sustainable living theme for the complex

We recommend that the buildings be named after famous environmental stewards to inspire students living in the residence hall. Some names for consideration include Carson, Leopold, Thoreau, Muir and von Humboldt. The names would also help with easy recognition of the theme of the building by students. There could be a model room (or apartment) showing what a sustainable room would look like for incoming students and campus visitors to tour. The room could be furnished with signs identifying efficient aspects and eco-friendly products. This room can be set up with help from the Office of Sustainability and groups on campus such as CCAT and WRRAP. This model room can be an example for how residents in the building can incorporate eco-friendly products and decorations, efficient lighting, and more eco-friendly appliances.

4.6.2 Social responsibility

We also recommend that the students who choose to live in this residence hall be asked to sign a pledge before they move in to ensure that they are committed to sustainable living in the residence hall. This pledge would be available online and must be completed along with their housing move-in packet. Studies have shown that people are more likely to follow through with behavioral changes if they have made a commitment on paper (McKenzie-Mohr and Smith, 1999). To reinforce the behavior changes the residents commit to, there should be signs in the residence halls reminding students to conserve resources such as energy and water. There should also be signs educating students about what can be recycled and composted to discourage unnecessary waste.

Considering the social atmosphere of HSU and Arcata as generally ecologically conscious communities, we believe that students will be encouraged by positive peer pressure to adhere to the residence hall's green practices. We will also use methods of Community Based Social Marketing (CBSM) to further encourage and ensure the behavioral changes. This would include certain methods previously used by CBSM. For example, to offset superfluous electricity use in a residential San Marcos neighborhood, researchers provided households with normative information about their energy use, the use of their neighbors, and ways to reduce the energy consumption (Schultz, et al., 2005).

In following this example, we believe that the installation of real-time energy meters would help encourage behavior changes and help facilitate community events such as energy reduction competitions. Real-time energy meters can allow students to see how much energy they are using at any given time of the day. These meters would make energy reduction competitions easy because all the energy data is tracked online and is easily accessible. Energy competitions would help hold buildings and individuals responsible for their energy use and would create a competitive spirit among the residents.

4.6.3 Residence hall sponsored activities

The Resident Advisors (RAs) should be advocates of sustainable living for their residents. All RAs are already required to put on at least one sustainability related event for residents each semester. The RAs of the new residence hall should be encouraged to put on more than one and to get creative about getting residents involved in these events. Some potential activities could be getting residents to volunteer in the community with organizations such as Friends of the Dunes, the Natural Resources Club, and Humboldt Baykeeper. These volunteer activities support the theme of the residence hall and allow community integration. RAs should also put on some sustainability themed events and workshops for residents to learn how to be more eco-friendly. RAs should partner with on-campus groups such as Campus Center for Appropriate Technology (CCAT) and Waste Reduction and Resource Awareness Program (WRRAP). These groups have the resources and background to help facilitate workshops to teach residents valuable skills and information that will help them live sustainably.

5.0 Monitoring and Evaluation Plan

The success of the project will be gauged based on its effectiveness in encouraging social change among residents, which will be determined by surveying residents before moving in and after inhabiting the residence for one semester (Appendix D). The amount of energy saved by efficient features incorporated into the design of the building will also be used to assess the project's effectiveness. The Resident Advisors (RA's) in these residence halls can help evaluate the effectiveness of signs, programs, and workshops on the residents' behavior through observations and surveys. Quantitative evaluations will be used to determine the amount of energy and water being consumed and the amount of waste produced as compared to the other residence halls on campus. Real-time energy monitors could be installed in each building so energy use data will be readily available and easy to understand. The energy and water usage of the entire complex can be divided by the number of occupants to get a per person usage estimate. This can then be compared to the per person usage in the College Creek complex to assess how much more efficient the new residence halls are. We also recommend that the energy savings be converted to monetary savings so the school can track how much money the new residence hall complex is saving them per year.

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Appendix Index

Appendix A: Cost savings analysis from ZeroFlush Waterless Urinals

Cost Saving Analysis

Payback Analysis

Location: Arcata
City/Zip Code: 95521

Installation - Data

Number of urinals	6	units
Users per day	100	males
Users frequency per day	1	times
Water Volume per flus	1.5	gal
Number of day`s per week	7	days
Water and sewer charges	$ 2.50	per 1000 gal
Maintenance cost per year	$ 75	
Installation cost per urinal	$ 0	

	Existing Water System	***ZeroFlush System***
WATER CONSUMPTION		
Water use per day	150 gal	0 gal
Water use per Year	54600 gal	0 gal
Water & Sewer Cost		
Water cost per urinal	$ 23	$ 0
Total Water cost	$ 137	$ 0
Maintenance cost	$ 450	$ 0
Total Operational cost	$ 587	Odor Barrer : $ -100

Annual savings with ZeroFlush: $ ***687***

INVESTMENT

Purchasing cost : 6 units at: $ 369 Total : $ 2214

Payback time with ZeroFlush urinal system: *38.7* Months

INSERT KIT CONSUMPTION

Insert Kit Life Cycle: 15,000 uses

Annual Consumption: -1 units per urinal

Total Insert Kit Cost: -4 units at: $ 28 Total: $ -100

IMPORTANT: This payback analysis is based on certain assumption on number of users and flush volume of the urinal(-s) lin the facility. This payback analysis does not take into consideration of the infrared/sensor valve or a magnetic switch that is highly likely to flush more often and various other factors that can contribute to even larger water consumption than estimated here.

Appendix B: List of Acronyms

(BSS) Behavioral and Social Sciences

(ETAAC) Economic and Technology Advancement Advisory Committee

(GHG) Green House Gas

(HVAC) Heating Ventilation & Air Conditioning

(IEA) International Energy Agency

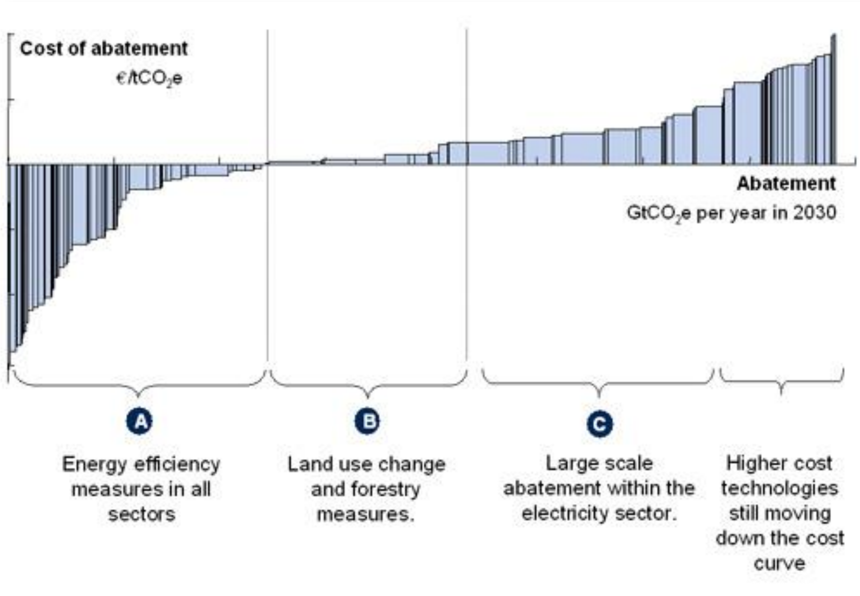
(LEED) Leadership in Energy and Environmental Design

(RA) Resident Advisor

(USGBC) United States Green Building Council

(ZNEB) Zero-net energy building

Appendix C: McKinsey Curves



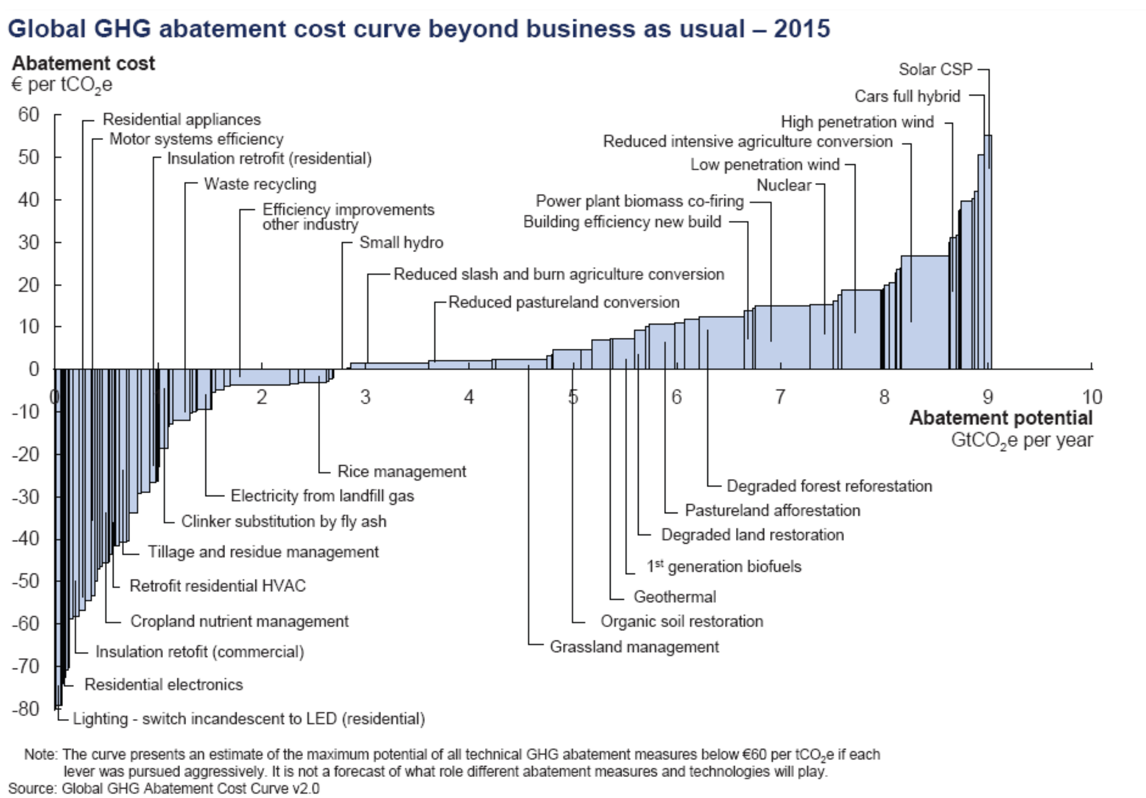


FIGURE 6 MAC CURVE "ENERGY REDUCTION FROM VISIBILITY." - *ENVIRONMENTAL LAW NEWS*. N.P., 13 DEC. 2010. WEB. 02 MAY 2013.

Appendix D: Survey for Residents of the Sustainable Dorms

1) On a scale of 1-5, how much does resource conservation factor into your daily behaviors. (e.g. what you throw away, what you buy, how much energy and water you use)

Not at all All the time

1 2 3 4 5

2) How much time do you spend outside each day?

Less than 1 hour 1-2 hours 3-4 hours More than 4 hours

3) When it's cold inside your house, what do you do?

a. Put on a sweater

b. Turn on the heat

c. Use a space heater

d. Other ____________________

4) On average how long do you shower for? _________ minutes

5) What temperature setting do you usually wash your clothes on?

6) How often do you get a beverage, in a disposable container in a week?

Never Less than five More than five More than ten

7) Indicate which of these items you think can be composted.

Apple Cores	Dairy	Bread
Egg Shells	Tea Bags	Veggie Scraps
Meat	Napkins	Coffee Grounds

8) How many plastic water bottles do you buy in a week?

Never Less than five More than five More than ten

9) How often do you recycle on a scale of 1-5? 1=Never, 5=Without fail

1 2 3 4 5

10) List a few things that you do on a daily basis to conserve resources (e.g. water, energy, waste).

Additional Questions for post survey

1) After a semester of living in this residence hall, do you feel that resource conservation factors into your daily behaviors ___________:

More than before About the same Less

2) Do you feel that the workshops contributed to your understanding of resource conservation or environmental issues?

Not at all Somewhat Very much

3) Do you have suggestions for activities or workshops would be more helpful?