The Sustainable University/Sustainability in Higher Education
Final Course Report, Fall 2012

EN 103 The Sustainable University
IDCE 30185 Sustainability and the Role of Higher Education
Clark University, Worcester, Massachusetts

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Introduction

Stephen McCauley

Offered for the first time in 2006, The Sustainable University course was one of Clark University's first project-based courses, and it served as an exemplar for the learning-through-inquiry model that was emerging on campus at that time. That model has now blossomed fully into the university's LEEP initiative – Liberal Education and Effective Practice – and The Sustainable University course continues to be one of the most exciting learning opportunities on campus. Students in the course engage in both the theory and the practice of advancing sustainability transitions in the university context. The central activity of the course is a team-based, sustainability action project, in which students work in small groups to take on some sustainability initiative on campus. They work closely with campus staff, administrators, faculty and other students to develop and implement innovative solutions to sustainability challenges on campus. At the same time, through reading, writing and discussion activities, they explore intellectually the challenges and complexities of sustainability transitions in general, and in particular in the context of higher education institutions. Clark University provides an on-going case study through the semester.

The Sustainable University course is unique in the level of interaction it involves from the Clark community, and many people contribute to making the course a success. We are extremely grateful to all these people for the time and energy they give to the course. In particular, I wish to thank Jenny Isler, Clark's Sustainability Coordinator, who is a critical partner in making this course happen. Since arriving on campus in 2011, Jenny has grown and fostered a great deal of excitement and a high level of coordination among sustainability initiatives on campus, so that all initiatives contribute in some way to the broader transition happening on campus. The projects undertaken in this class were all designed in close collaboration with Jenny to ensure that they would leverage other sustainability efforts on campus. Jenny also offered instruction in the course, and she led several field trips around campus. Sharon Bort was the Peer Learning Assistant for the course and she was a tremendous asset to the course. As an experienced student sustainability leader on campus, she offered valuable guidance to each of the projects and she maintained coordination between the projects and other sustainability initiatives on campus. I would also like to thank Jennie Stephens, Associate Professor at Clark, who designed this course and continues to teach it regularly. I also wish to thank the numerous people on campus who contributed to the projects and the course content by working closely with students on projects, hosting field trip visits, and coming to class as guest speakers.

We are all extremely pleased to contribute these projects to the ongoing effort to transition to sustainability at Clark University. It is exciting to see the strong commitment to sustainability among all parts of the Clark community, and we hope these projects will make meaningful contributions.

Thank you for your interest in these projects and in the sustainability movement at Clark University. Please continue to support this transition in whatever ways you can.

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Take Back the Tap

Sustainable Action Project to Reduce the Use of Bottled Water on Clark University's Campus

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Abstract

One-time use plastic water bottles waste an excessive amount of energy, overflow landfills, cause negative health effects, and increase CO2 emissions. In order to combat these issues, the Take Back the Tap campaign at Clark University led a three-component project, which consisted of research, educational outreach, and an action plan. They researched background information on the detrimental effects of bottled water, other universities that have banned bottled water sales, and Clark community's practices and beliefs about bottled water. Next, they educated the community through online sources, educational advertisements, and an open-forum. Lastly, they applied and were granted funds for water bottle filling stations in order to make filtered water more accessible, created an online petition for the Clark community to support their initiative, and submitted a proposal to ban bottled water sales from the Clark campus. The results of this project proved that Clark University is in demand for more educational outreach even though many students are currently prepared and support a potential ban of bottled water sales. From their research, action, and findings, they recommend that there be more educational outreach, more refilling stations be implemented, and bottled water sales be banned from campus.

Tables and Figures:

Introduction

Plastic water bottles are expensive and unnecessary commodities that create an excessive amount of waste. The existence of bottled water on Clark's campus creates waste that is most often not recycled properly. Even if all plastic bottles on campus were recycled, the energy used to produce, ship, and recycle the bottles adds an expendable amount to CO2 emissions. Economically, it is impractical to pay more for a wasteful commodity when given the choice. As a University that often prides itself in its environmental consciousness, Clark University only has a 28% recycling rate. Students, staff, and administration often buy bottled water out of convenience. However, Clark's Dining Services and Physical Plant are working to eliminate the use of this wasteful commodity, ensuring that accessing water from other sources are more convenient. Clark's Dining Services committed to use pitchers of water instead of bottled water at catered events and Physical plant is planning to implement many water bottle filling stations around campus. The initiative to reduce the sale of bottled water on campus is crucial in reducing the use of excess energy and oil, diminishing waste, and decreasing CO2 emissions.

Clark University has been working steadily to reduce the use of individual bottled water on campus. It is well understood that effectively preparing a community (such as a campus) is necessary for a ban of a particular item. Clark students and faculty have already begun the planning stages for this preparation. There are two different aspects in preparing the Clark community for a ban on bottled water: educational outreach and ensuring water accessibility. Our group is committed to educating the Clark community with information on the environmental, health and social reasons for banning bottled water. As part of the efforts to ensure water accessibility, Clark currently has one "hydration station." This is a water bottle filling station that has two spouts; one to refill reusable water bottles and one to be used as a traditional water fountain. Clark has also budgeted for eight more hydration stations. Physical Plant is currently planning the locations and timetable of when these will be installed. However, our student body possesses the passion and the commitment to ban bottled water from campus and the majority of campus members already refrain from purchasing bottled water. Now it is only a matter of educating the rest of the Clark community who don't consciously think the same way and providing evidence to the Clark administration that the university has the support needed for eliminating the sale of bottled water on campus.

The aim of our project was to research potential methods that could successfully ban the sale of bottled water from campus. With this research we established these four main objectives: to educate the

Clark community on the harmful effects of bottled water, gather information on student water preferences, collaborate with other initiatives on campus to reduce bottled water usage, and produce a proposal to ban bottled water sales from campus. For educational outreach, we provided the Clark community with information about the environmental, social, and economic consequences of buying bottled water through an open forum session and informational advertisement. For our second objective, we held two water taste-tests and conducted a survey. Our third objective was to collaborate with other Clark students to apply for grants that would be used to purchase hydration stations for the residence halls and provide reusable water bottles for all students. For our last objective, we produced a proposal to ban bottled water from the Bistro, Jazzmines, and all on-campus vending machines, which we sent to the Clark administration. This project is critical in reducing CO2 emissions by eliminating energy waste from bottled water production, transportation and disposal. Our mission is to limit and reduce plastic bottled water usage on Clark's campus in order to make both our campus and world community a more sustainable place.

Background

Bottled Water as a Product

Plastic water bottles are one of the most wasteful and unnecessary commodities American consumers buy. Energy is necessary to extract, package, transport, and recycle plastic bottled water containers. The Pacific Institute in California conducted a study, which determined that "producing bottled water (including all stages from manufacturing the plastic to chilling the bottles for use) takes approximately 2000 times the energy required to produce tap water" (StoryOfStuff, 2012). The energy used to create these bottles is dramatic. According to the Ban the Bottle organization, "It takes 17 million barrels of oil per year to make all the plastic water bottles used in the U.S. alone" (BantheBottle). To put that number into perspective that's enough oil to fuel 1.3 million cars for an entire year. Furthermore, the production of bottled water uses three liters of water to create one liter of bottled water. In 2007, 8.82 billion gallons of bottled water were sold in the United States (Gies, 2012).

Waste and Recycling

Despite the fact that plastic water bottles are recyclable, 80% of all plastic water bottles are thrown away and end up in landfills (StoryOfStuff, 2012). Furthermore, only plastic bottles made out of

PET, generally used for half or whole liter bottles, can be recycled. Larger plastic water containers are usually made out of other types of non-recyclable plastic. According the Container Recycling Institute, it takes over 700 years for these bottles to decompose in landfills (BanTheBottle). The 20% of empty bottled water containers that is recycled is often sent overseas. Not only does the shipment of old bottles to other countries use an excessive amount of energy, but also the bottles are often not even fully recycled. Instead of being turned into water bottles again they are down cycled, which creates other products that cannot be recycled and will eventually be thrown into landfills.

Expense

Not only does bottled water use an excessive amount of energy, but it is also incredibly expensive. According to Ban the Bottle, the price of tap water for a year of drinking 8 glasses of water every day costs $.49. However, the equivalent amount of water put in plastic bottled water costs $1,400 when bought in stores (Banthebottle).

Health Effects

Bottled water companies have tried to convince the general public into believing that tap water is unsafe and unhealthy and that bottled water is a much better alternative. However, in reality this portrayal of information is false. The Environmental Working Group conducted a study that revealed that bottled water is not safer than tap water and that in the ten brands they tested there were 38 chemicals detected in the water. In addition to the chemicals found in the water, the plastic from the bottles also leak into the water (Harmful, 2012). According to the documentary, Tapped, the PET plastic used to produce bottled water uses oil that includes the chemical benzene. Studies have shown that benzene is correlated with the development of cancer and other health problems (some including: prostate cancer, low sperm count, diabetes, and ADHD) (Tapped, 2012).

According to a four-year scientific study recently made public by the Natural Resources Defense Council (NRDC), bottled water sold in the United States is not necessarily cleaner or safer than most tap water (Environment, 2012). Bottled water regulations are inadequate and do not ensure consumers of either purity or safety (Environment, 2012). Bottled water is regulated by the rules of the Food and Drug Administration (FDA), which means they are subject to less rigorous testing and purity standards than

tap water (Environment, 2012). For example, bottled water is required to be tested less frequently than city tap water for bacteria and chemical contaminants.

Barriers to Eliminating Bottled Water

One of the potential barriers to people drinking tap water are people's perceptions about water quality. Case studies show that people who perceive tap water as unsafe tend to consume more bottled water (Amberg et al., 2011). However, municipal tap water in the United States is safe to drink. There is a network of government agencies whose job is to ensure that public water supplies are safe. Public drinking water is regulated by USEPA under the Safe Drinking Water Act. Nationwide, drinking water systems have spent hundreds of billions of dollars to build drinking water treatment and distribution systems. Most community water suppliers deliver high quality drinking water to millions of Americans every day. Although there are sometimes contaminants in drinking water, it is at such low levels that they are not harmful. The water quality report from the Public Water Supply Office provides adequate information about the drinking water in specific communities, tells how safe the drinking water is and explains the level of contaminants. For example, the results of the 2011 Water Quality Report for the City of Worcester showed that the tap water is safe to drink and that the existing contaminants in water comply with the strict regulations (DPW&P, 2011).

Implementing a University Initiative to Ban Bottled Water

In order to combat the pressing environmental and health concerns of bottled water many universities have already banned the sale of bottled water from campus. The "Ban the Bottle" website, reported over 27 universities have either completely banned bottled water on campus or have begun the movement towards banning bottled water. In addition, many more are in the process of joining this initiative. Each school has taken similar steps in the process of reducing bottled water use on campus. The process commonly begins by writing a proposal that addresses the reasons to ban bottled water sales and recommendations on how to execute this project (Ellsbury, "Update: the New…" 2012).

Before the bans were implemented, many universities purchased water bottle refilling stations to make the process of refilling reusable water bottles more convenient. In addition to these installments, they initiated a refurbishment of already existing water fountains to make them more accessible and more sanitary. The stages of these bans included extensive negotiating with administration and those who control installments and maintenance of refilling stations. Universities' approaches to these steps

vary from college to college, but they all work towards making the transition most convenient and well suited for the campus community. Rochester Institute of Technology for example, requires that reusable water bottles be distributed during freshmen orientation. The University of Vermont has replaced the soda options in vending machines with healthier options so that the removal of water bottles would not become a health debate. Hampshire College took this initiative to an even greater level and included their students in the testing of local tap water. The water that was EPA approved will continuously be tested by Chemistry classes in order to support their claim for safe water as well as allow the verification to be provided at a more equal level (Ellsbury, "New Policy.." 2012).

Following the decision to remove bottled water, many universities send out letters addressed to the campus community discussing the logistics of a ban and why it is important to implement a ban of bottled water sales. Letters typically include the negative effects mentioned above, such as the health, environmental, and economical problems. All of the rules pertaining to bottled water usage on campus are included in this letter as well. RIT for example, which has yet to completely ban bottled water, has kept water bottles in vending machines and continues to sell them at major events, but refuses to distribute funds to clubs or organizations to purchase bottled water. Other colleges, who have succeeded in banning bottled water sales from their campuses, require that all events on campus be catered by their dinning services. For example, Rochester Institute of Technology 's dining company, Amarak, provides pitchers of water as an alternative to bottles (Ellsbury, "Update: the new…" 2012).

As can be expected, there are mixed feelings about the ban of bottled water from campuses. This is also why implementing a ban on campuses is such a long process. It not only requires a physical change (referring to the removal of bottled water) but a cultural change because those who do not feel as passionately about the movement have trouble understanding why the removal is important (Ellsbury, "Mixed Opinions…" 2012).

Methods

The final outcome of this project will be to limit plastic bottled water usage on campus in order to reduce both resource and energy use associated with the production and transportation of bottled water. In order to achieve this, our team divided our methods into three components: research, education, and action. We researched through a collection of articles about the negative consequences of using bottled water. These consequences included health risks and environmental degradation. We also

researched other schools that banned the sale of bottled water from their campus. In addition, we explored the practices and perceptions of the Clark student body in regards to a possible ban on bottled water sales. After reviewing our research we were able to determine the direction in which we wanted our project to proceed. The next dimension of the Take Back the Tap project was to create an educational awareness campaign about the relevance of banning bottled water sales. As a part of our action plan we collaborated with other initiatives on campus to help reduce the use of individually sold bottled water. The final component of our action was a written proposal to the Clark administration to ban the sale of bottled water from campus facilities.

Research

The act of reducing bottled water use was not a new concept for the Clark community. Our group benefited from talking with current activists who have already begun the process of bottled water reduction. We first reached out to the collaborators of the Sustainable University class. Professor Steve McCauley, Jenny Isler (sustainability coordinator), and Sharon Bort (peer learning advisor) were all great resources for information. They provided us with information such as statistics needed for support in our proposal and recycling rates at Clark. Next we met on multiple occasions with Paul Wykes, the business manager of Clark. He assisted in the editing of our proposal to be submitted to Clark administrators. The associate director of physical plant, Derek Lundstrom, was another key figure in our research process. He provided information about eight water bottle filling stations that are budgeted for and are in the planning stages of being installed. These conversations helped us understand what has already been done and, more importantly, what needs to be worked on.

In order to understand student water preferences on campus, we distributed a survey (See Appendix 1). Our survey was distributed in two forms. First we distributed a paper copy to students walking through the University Center. We received 47 completed surveys. Next we developed an online version of this survey and distributed it through email and Facebook. For this distribution, 57 students completed the survey. Both surveys asked how many students already owned reusable water bottles, how many would be less willing to purchase bottled water when water bottle filling stations are provided, and how many students support the ban of bottled water sales from campus. In addition to these surveys, we conducted two taste tests (See Appendix 2). We tested student's ability to identify the differences between tapped, filtered, and bottled water, while also documenting their water preferences.

All of the results from the surveys and taste tests were compiled into an excel sheet and statistics were run for further evaluation (See Results).

Education

Our project included a focus on outreach, education, and behavioral change. This project has been made visible to the Clark community through educational outreach that emphasized the environmental, social, and economic need to switch from the use of bottled water to tap water. We created a slide that was displayed in the Clark Dining Hall to educate students on why tap water should be used instead of bottled water (See Appendix 3). We also held an open-forum for the Clark community to discuss their ideas and concerns of utilizing tap water, implementing water bottle filling stations, and banning bottled water sales. This open forum also provided a platform for more people to become involved in the campaign and provided opportunities for the project implementers to interact with people who are interested in bottled water issues. During this discussion, we showed short educational video clips to further the student body's understanding of the issue. In order to ensure awareness of this event, we: tabled in the UC with information during meal times, made a second cafeteria slide to advertise this event, and promoted it through Facebook (See Appendix 4 & 5).

Action

Our group focused largely on taking direct action in order to reduce the use of bottled water on campus. We first utilized the Internet as a promotional tool by producing a Facebook page entitled "Take Back the Tap at Clark" (See Appendix 6). This page was used to share information, distribute an online petition, and an online survey. We also shared educational videos and web pages, as previously mentioned in our educational outreach section above. The online petition was distributed through Facebook so that students could electronically sign to show their support for banning the sale of bottled water on campus. We produced this petition in order to have a presentable showing that Clark students largely support banning bottled water sales (See Appendix 7). Finally, in order to gather more participants for our surveys, we created an online version through "Survey Monkey" and encouraged all of our Facebook followers to complete it.

In addition, we collaborated with two other students outside of the Sustainable University Class. We applied for funds from the Student Sustainability Collaborative (SSF) to implement water bottle filling stations in each residence hall on campus (9), provide recycling bins to all suites (59), and supply

students with reusable water bottles (See Appendix 8). This project's goal was aimed at creating a behavioral change among students. By providing reusable water bottles and recycling bins, students would likely find sustainable actions more convenient and therefore be more inclined to act in that manner. On December 12, 2012, the SSF formally granted our group $7,000 to implement water bottle refilling stations in all nine residence halls and provide reusable water bottles at a subsidized price for Clark students. However, money was not allocated to provide recycling bins for the suites. This was because they felt that sent a counter-active message to the Clark community about our stance on using one-time use plastic water bottles.

Finally we produced a proposal to ban the sale of bottled water on campus, which has been submitted to Paul Wykes, the business manager of Clark (See Appendix 9). He is in the process of helping us edit it so that it can be submitted to other Clark administrators. The proposal presents the necessity and feasibility of banning bottled water sales based on the results of our project. The proposal also provides some suggestions for making the ban most feasible and effective.

Results

The University Center Survey

The University Center survey sample consisted of 47 random participants. Although this sample was reflective of students who use dinning services, mainly lower classmen, this survey is still valuable because there is enough of a variance in who uses the dining hall. Our survey concluded that approximately half (24 out of 47 participants) of our sample occasionally purchases bottled water, almost a third (15 out of 47 participants) never buy bottled water, and at least a quarter (8 out of 47 participants) purchase bottled water frequently (Figure 1). Eighty percent of our sample own reusable water bottles. In addition, approximately 84% said that they would purchase less bottled water if water bottle refilling stations were readily available. Our most striking finding was that 100% of our participants prefer refilling water bottles to purchasing bottled water.

In the UC we distributed additional questions to the basic three included in the online survey. Following are the results we received from these questions: 26.7% marked that they believed Worcester tap water to be safer than bottled water, 30.3% believed that tap water tastes better, 88.1% think that it is more sustainable, and 46% prefer tap water over bottled water (Figure 2). Fifty-two point two percent of

the surveyed population said that they support a ban of bottled water sales on campus. This reflects our finding that the majority of students do not regularly purchase bottled water. Overall, these findings prove that our educational outreach was a necessary component of our project.

Figure 1.
Frequency that Clark student's purchase bottled water

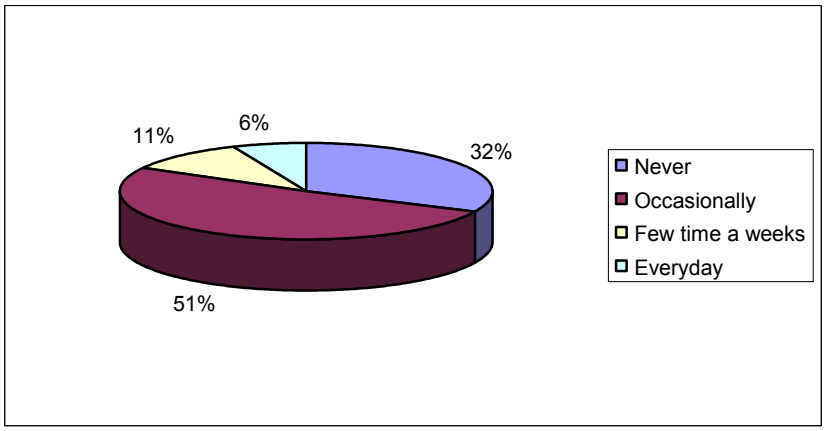
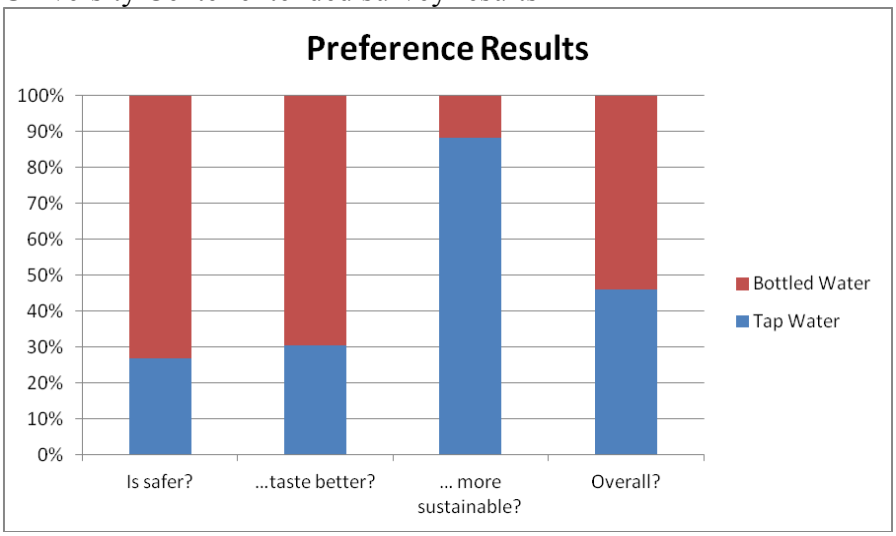


Figure 2.
University Center extended survey results

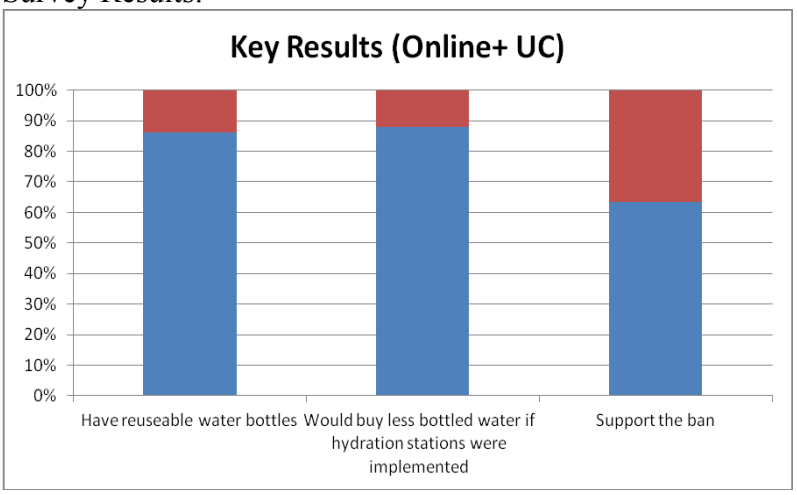


The Online and UC Survey

We implemented an online survey in order to collect more data on student preferences pertaining to the topic of bottled water. In addition, figure three shows the combined results of the basic three survey questions distributed in both the UC and online. Eighty-six percent of our sample reported that

they own a reusable water bottle. Eighty-eight percent noted that they would purchase less bottled water if water bottle refilling stations were implemented. Lastly, sixty-three point three percent supported banning the sale of bottled water from campus.

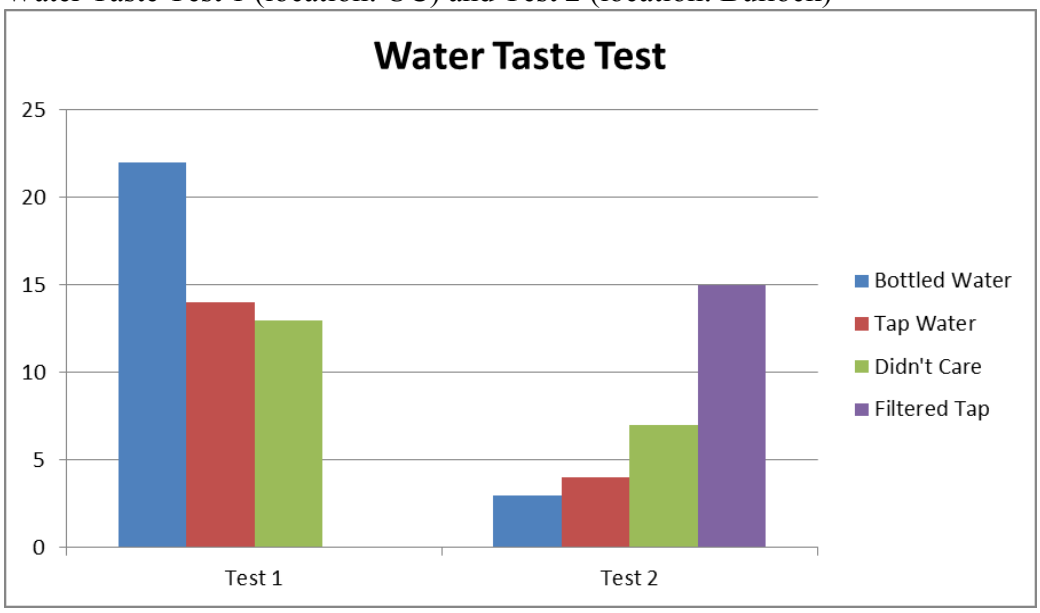
Figure 3.
Survey Results:



Taste Tests

We administered two taste tests. One was in the University Center and one was in Bullock Hall. The majority of our sample in the first taste test preferred bottled water (22 out of 49 students). The rest of the sample either did not express a preference for a certain type of water (13 students) or preferred tap water (13 students). Our first taste test did not provide a sample of filtered water. We later decided that it was necessary to conduct a second taste test that included filtered water because this type of water is what will be provided in the filling stations for which we have advocated. In this second taste test, our results concluded that the majority of students preferred filtered water when available (15 out of 29 students) (figure 4).

Figure 4.
Water Taste Test 1 (location: UC) and Test 2 (location: Bullock)



Petition

Our final finding to report is from our online petition to implement more water bottle filling stations and ban the sale of bottled water from campus facilities. Two-hundred and thirty-one Clark University students electronically signed this petition to support our "Take Back the Tap" initiative. This concludes that we have support from approximately 10% of the student body. Although this may seem like a low percentage, our online method may have inhibited our outreach to the entire student body, as we did not have access to all of the Clark community online. This represents a clear bias, which can be similarly seen in our surveys and will be elaborated on in the discussion section.

Discussion

Although we believe strongly about the validity of our results, this project may still suffer from some biases. For example, the survey distributed in the University Center may be subject to location bias. The sample is reflective of students who use dinning services, mainly underclassmen (34 out of 47

students) (See Table 1). Through personal experience and observation, we feel that in addition to athletics and international students, underclassmen are the third main source for the use of single serve water bottles. Due to this finding, more research should be done targeting upperclassmen because they are more familiar with the culture of sustainability at Clark. In addition, this data may suffer from a non-response bias because not everyone was willing to participate in the survey.

Table 1.
Students who took our survey
47 total students

Class	Number
First Years (2016)	23
Sophomores (2015)	11
Juniors (2014)	9
Seniors (2013)	2
N/A/ blanks	2

In addition to our UC survey, we distributed an online survey as an effort to reach out to a wider population. This process may have also created a network bias because the majority of those who participated were either friends or supporters from our Facebook page. This is also why a continuation of networking is important for the success of this project. After talking to many students, we found that many are highly supportive of our initiative but never signed our petition or took our survey. This inactivity is another reason why we believe that we received less support than we had anticipated.

Due to our time limitation, we were not able to reach out to as much of the Clark community as we would have liked and couldn't complete as many activities as needed to fully educate the student body. However, from the understanding of our findings, we identified the direction in which future activists should proceed in order to continue the process of taking back the tap. Following are recommendations for student activists and the Clark administration.

Recommendations

Despite the Take Back the Tap team's work on educating the Clark community about the detrimental effects of using bottled water, the support for a ban on bottled water sales was lower than expected. As a result of this, we believe that more education is needed in order to reduce bottled water sales on campus. Our team believes that it would be beneficial to educate students about sustainability at

Clark immediately upon their arrival. We recommend there be two sustainability programs; one during international student orientation and one during Week-One.

Although we understand that both of these orientations are already packed full of very important sessions, we think sustainability programs are critical in teaching students about Clark's commitment to the environment. These sessions would teach students about all aspects of sustainability on campus. During the session for the international students, there would be a major focus on tap water quality in Worcester. Many international students may have misconceptions about the safety of tap water in Worcester because they do not have access to safe tap water in their home countries. However, the session for all incoming students during Week-One would focus substantially on the depredating effects that bottled water has on the environment. This type of session would help reinforce a culture of sustainability on Clark's campus and help create a positive behavior change among Clark students.

In order to create a successful behavior change on campus, Clark University must offer their students the proper tools and resources to make that change. We therefore propose that, in addition to the nine hydration stations scheduled to be installed in the residence halls and the eight more that are included in next years budget, more refilling stations should be implemented throughout campus (See Appendix 10). Making filtered water more accessible will increase the probability that students will use their reusable water bottles rather than buy one-time use plastic water bottles.

The University is heading in a great direction by planning to install eight water bottle filling stations throughout campus and nine water bottle filling stations in the residence halls. Following the installation, advertisement and informational promotions should be implemented for these stations. The more students understand what these stations are and the purpose for being provided, the more likely they will be to use them efficiently.

Conclusion

These above suggestions will, if implemented, prepare Clark University's campus for a ban of bottled water sales. Clark University prides itself in its commitment to sustainability. Our University signed the Climate Action Plan in 2009 pledging to decrease its carbon footprint to net zero by 2030. As a university that pledges itself to sustainability, it should not support the production of goods that increase carbon footprints. Lets uphold our reputation and contribute to decreasing the carbon footprint in our surrounding communities. Small, innovative changes serve as catalysts to decrease carbon

emissions on Clark's campus and create long-lasting behavioral change among Clark students. Clark University challenges convention to change our world, so let's take back the tap.

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The Worcester Water Operations Division ofWorcester's Department of Public Works & Parks (DPW&P) . 2011 Water Quality Report. 25 Sep. 2012. http://www.worcesterma.gov/dpw/water-sewer-operations.

Appendices

Appendix 1.

Take Back the Tap Survey

Please answer carefully because the data collected will be use to persuade Clark's decision makers on its policy regarding the sale of bottled water.

What year are you?

First year **Sophomore** **Junior** **Senior**

Where are you from? **City:** _____ State:_____
Country:_____

Do you have a reusable water bottle? Yes No

How often do you buy bottled water?
Everyday A few times a week Occasionally Never

If you do purchase bottled water, would you buy it less frequently if more water bottle filling stations were provided on campus?
Yes No

When provided the option, would you rather purchase bottled water or refill your own bottle from a water bottle filling location?
Purchase Refill

Did you know that there is a water bottle filling station in the fitness center in the fuller gymnasium?
Yes No

If yes, do you use it to refill you water bottle(s).
yes No

Which do you think is safer? Bottled water Tap water (in Worcester) No Difference

Which do you think tastes better? Bottled water Tap water (in Worcester) No Difference

Which do you think is more sustainable? Bottled water Tap water (in Worcester) No difference

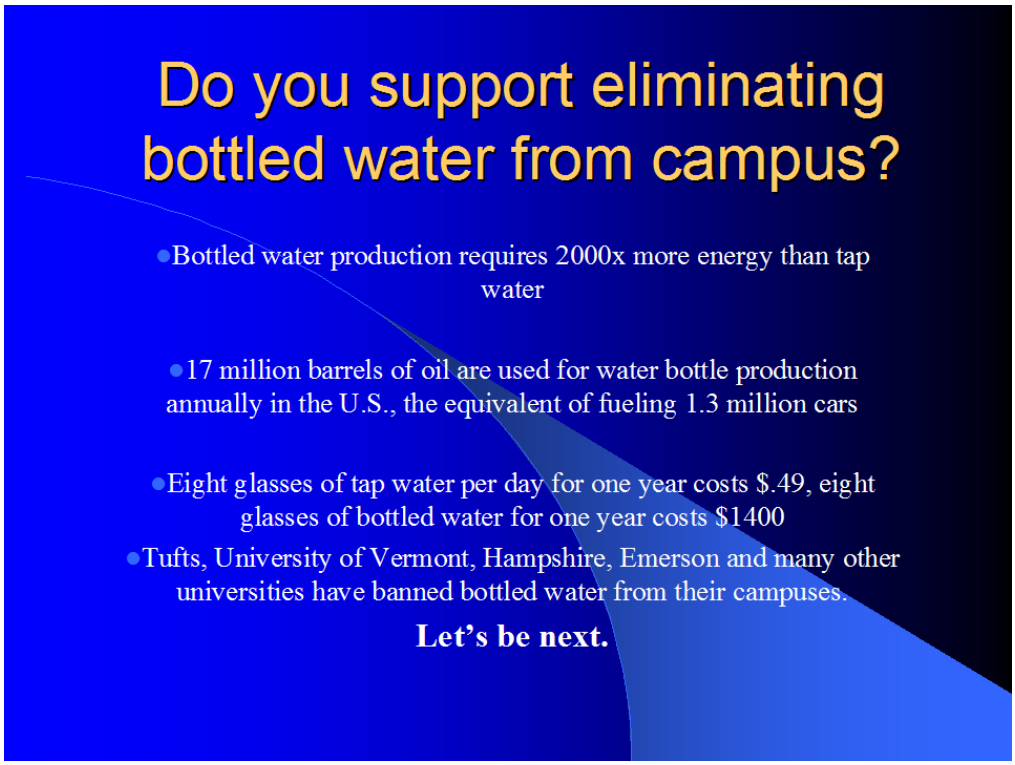
Which do you prefer overall? Bottled water Tap water (in Worcester) Don't Preference

Would you approve of a ban on all sales of bottled water on campus? Yes No

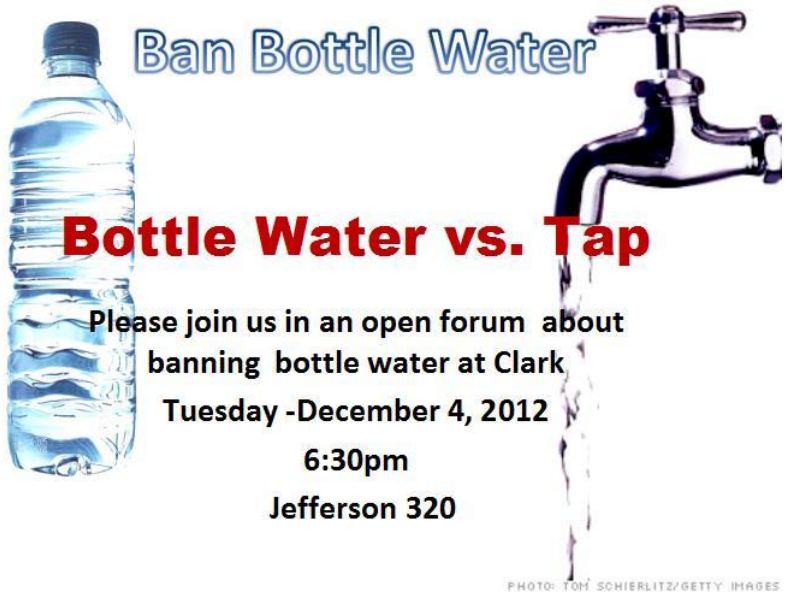
Additional Comments (if any)

Appendix 2.

Appendix 3.


Do you support eliminating bottled water from campus?
Bottled water production requires 2000x more energy than tap water
17 million barrels of oil are used for water bottle production annually in the U.S., the equivalent of fueling 1.3 million cars
Eight glasses of tap water per day for one year costs $.49, eight glasses of bottled water for one year costs $1400
Tufts, University of Vermont, Hampshire, Emerson and many other universities have banned bottled water from their campuses.
Let's be next.

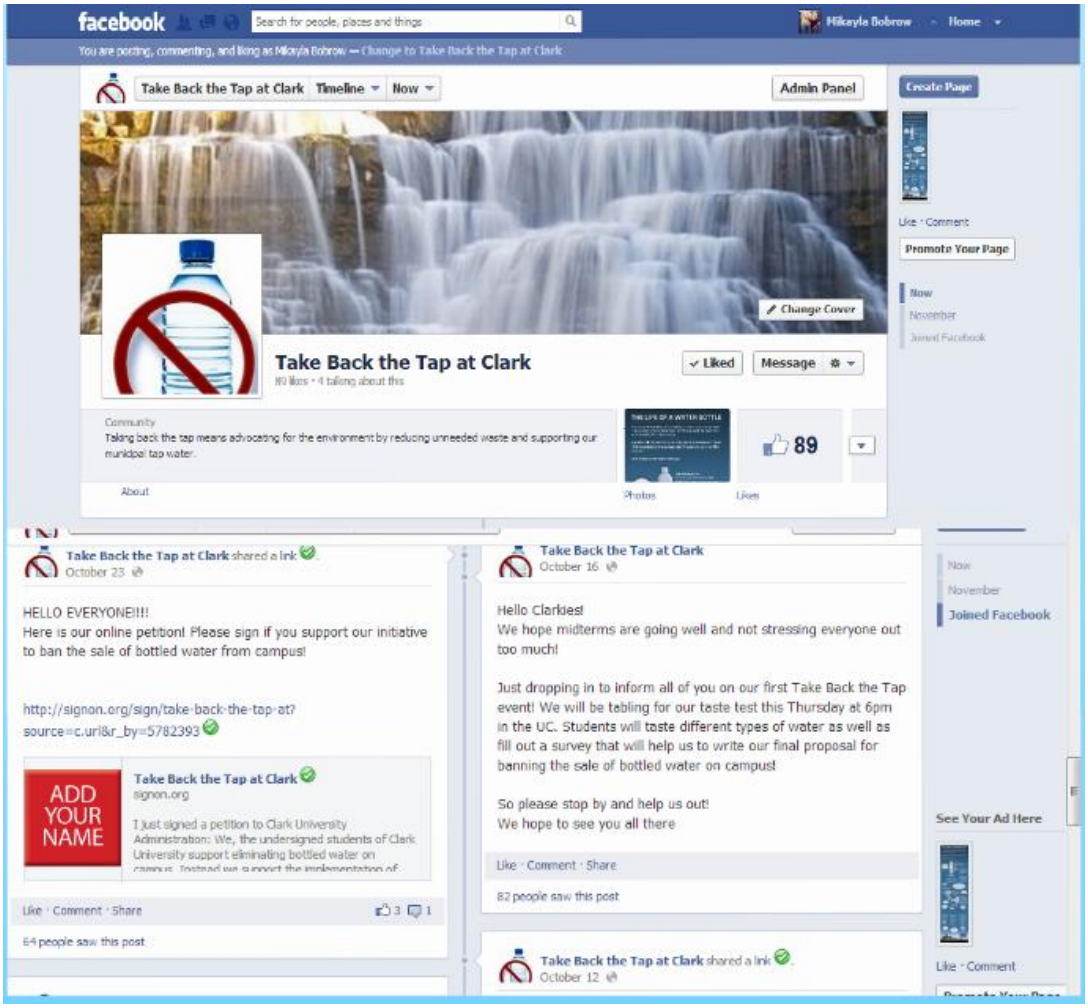
Appendix 4.


Ban Bottle Water
Bottle Water vs. Tap
Please join us in an open forum about banning bottle water at Clark
Tuesday -December 4, 2012
6:30pm
Jefferson 320
PHOTO: TOM SCHIERLITZ/GETTY IMAGES

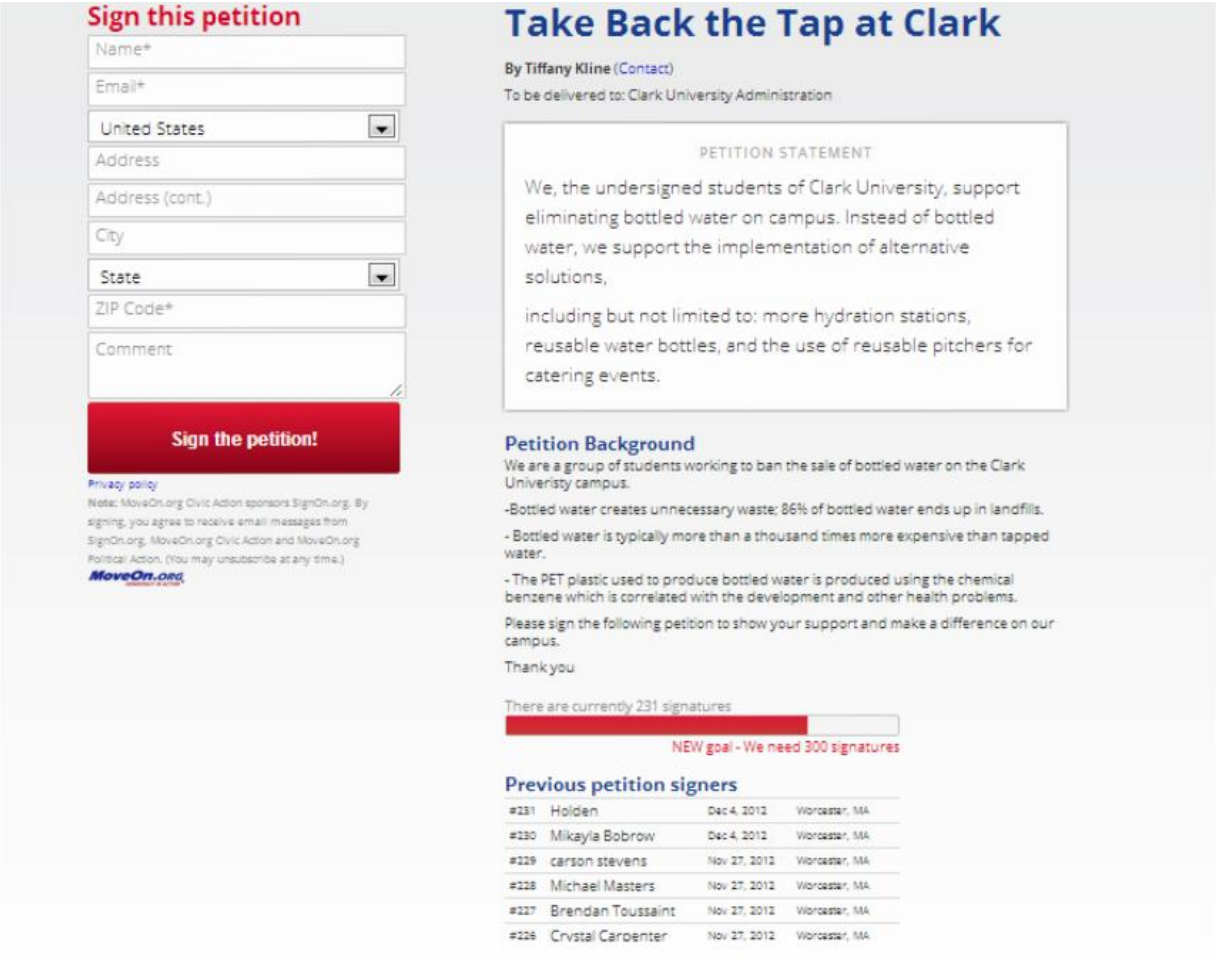
Appendix 5.


facebook
Search for people, places and things
Mikayla Bob
You are posting, commenting, and liking as Mikayla Bobrow — Change to Take Back the Tap at Clark
Take Back the Tap at Clark
Timeline
Now
Admin Panel
Where does YOUR water bottle go?
THE WATER BOTTLE
Bottled Water
LITTER
GROUND
LANDFILL
OCEAN
Like · Comment · Share
36 people saw this post
Take Back the Tap at Clark shared a link.
November 27
Hey guys! to make our proposal better we want as many
Take Back the Tap at Clark
December 4
Hi all! Just a reminder that the discussion about banning bottled water sales on campus is tonight at 6:30 in Jeff 320! This is a great opportunity for you to come and ask your questions, express your concerns, or give us your support!
Like · Comment · Share
52 people saw this post
Take Back the Tap at Clark shared a link.
December 1
Hey! Attached is a really cool link about bottle water from the Natural Resource Defense Council. Lots of cool facts and information!
http://www.nrdc.org/water/drinking/bw/bwinx.asp
GIVE A GIFT THAT WILL MAKE A DIFFERENCE
Long, Cool Drink
Green Gifts
NRDC: Bottled Water
www.nrdc.org
NRDC: Pure Drink or Pure Hype?

Appendix 6.


facebook
Search for people, places and things
Mikayla Bobrow
Home
You are posting, commenting, and liking as Mikayla Bobrow — Change to Take Back the Tap at Clark
Take Back the Tap at Clark
Timeline
Now
Admin Panel
Create Page
Like · Comment
Promote Your Page
Now
November
Joined Facebook
Change Cover
Take Back the Tap at Clark
Liked
Message
Community
Taking back the tap means advocating for the environment by reducing unneeded waste and supporting our municipal tap water.
89
About
Photos
Likes
Take Back the Tap at Clark shared a link
October 23
HELLO EVERYONE!!!!
Here is our online petition! Please sign if you support our initiative to ban the sale of bottled water from campus!
http://signon.org/sign/take-back-the-tap-at?source=c.url&r_by=5782393
ADD YOUR NAME
Take Back the Tap at Clark
signon.org
I just signed a petition to Clark University Administration: We, the undersigned students of Clark University support eliminating bottled water on
Like · Comment · Share
3
1
64 people saw this post
Take Back the Tap at Clark
October 16
Hello Clarkies!
We hope midterms are going well and not stressing everyone out too much!
Just dropping in to inform all of you on our first Take Back the Tap event! We will be tabling for our taste test this Thursday at 6pm in the UC. Students will taste different types of water as well as fill out a survey that will help us to write our final proposal for banning the sale of bottled water on campus!
So please stop by and help us out!
We hope to see you all there
Like · Comment · Share
82 people saw this post
Take Back the Tap at Clark shared a link
October 12
Now
November
Joined Facebook
See Your Ad Here
Like · Comment

Appendix 7.



Sign this petition

Name*

Email*

United States

Address

Address (cont.)

City

State

ZIP Code*

Comment

Sign the petition!

Privacy policy

Note: MoveOn.org Civic Action sponsors SignOn.org. By signing, you agree to receive email messages from SignOn.org, MoveOn.org Civic Action and MoveOn.org Political Action. (You may unsubscribe at any time.)

MoveOn.org

Take Back the Tap at Clark

By Tiffany Kline (Contact)

To be delivered to: Clark University Administration

PETITION STATEMENT

We, the undersigned students of Clark University, support eliminating bottled water on campus. Instead of bottled water, we support the implementation of alternative solutions,

including but not limited to: more hydration stations, reusable water bottles, and the use of reusable pitchers for catering events.

Petition Background

We are a group of students working to ban the sale of bottled water on the Clark Univeristy campus.

-Bottled water creates unnecessary waste; 86% of bottled water ends up in landfills.

- Bottled water is typically more than a thousand times more expensive than tapped water.

- The PET plastic used to produce bottled water is produced using the chemical benzene which is correlated with the development and other health problems.

Please sign the following petition to show your support and make a difference on our campus.

Thank you

There are currently 231 signatures

NEW goal - We need 300 signatures

Previous petition signers

#231	Holden	Dec 4, 2012	Worcester, MA
#230	Mikayla Bobrow	Dec 4, 2012	Worcester, MA
#229	carson stevens	Nov 27, 2012	Worcester, MA
#228	Michael Masters	Nov 27, 2012	Worcester, MA
#227	Brendan Toussaint	Nov 27, 2012	Worcester, MA
#226	Crystal Carpenter	Nov 27, 2012	Worcester, MA

Link to view all signatures: http://signon.org/sign/take-back-the-tap-at?source=c.url&r_by=5782393

Appendix 8.

SSF Final Application
Take Back the Tap

Rebecca Liebman
RLiebman@clarku.edu
860-966-4715
2015
Global Environmental Studies

Erin Glennie
EGlennie@clarku.edu

2015
Geography

Tiffany Kline
TKline@clarku.edu
2013
Psychology and Studio Art

Mikayla Bobrow
MBobrow@clarku.edu
2015
IDSC

Victoria Bruskin
VictoriaPaige21@gmail.com
2016

Watch this video for background info or just for fun…it's really good! http://www.youtube.com/watch?v=Se12y9hSOM0&feature=player_embedded#!

Project Overview

Specific: Providing opportunities for students to cease the use of plastic water bottles on campus by providing reusable bottles and water filter stations.
Measurable: Purchasing nine water filter stations (one for each residence hall), the number of suites that have a recycling bin, the amount of students who have reusable water bottles.
Agreed Upon: The participating party signs off on what we have discussed and decided in meetings.
Realistic: We are starting off with a reasonable amount of water filling stations, to see how it will go and only claiming to do what we know we can.
Timely: Be ready to purchase when we get back from winter break.

This project is aimed at creating a culture on campus where reusable water bottles are much more prominent than plastic bottles. Sustainability at Clark will go up and this project goes hand in hand with our Climate Action Plan, by reducing the amount of plastic water bottles on campus, which will create a lifestyle that will stay with people for a lifetime after college.

Tufts University (link here: http://sites.tufts.edu/tuftsgetsgreen/2012/03/30/hodgdon-reduces-plastic-bottle-usage-by-73/) has already done away with the sale of water is plastic bottles and have seen great results. After their first semester without bottled water, Director of Dining Services Patti Klos, estimated that there was a reduction of 133,000 disposable water bottles. The first two weeks of school, Tufts offered a free Nalgene water bottle with the sale of any beverage. They also have incentives for students

to receive a discount if they use their Nalgene. Clark would not offer these incentives right away, but after we get the initial plan in place, we will see what will happen from there.

This project goes with two other initiatives that have been taking place on campus. One is the initiative last year to bring many more recycling bins to campus. Since then our recycling rate has gone up drastically. Bringing more bins for each suite style living area would only increase the recycling culture on campus. Also, physical plant is currently working to have filtered water coolers in all of the academic buildings on campus for Spring 2013. This will match timing perfectly and allow students to have a myriad of ways to get water with their reusable bottles.

The recycling bins just need to be purchased and then they will stay on campus. The water bottles will be given out at each Week One so the incoming class has reusable bottles, and the rest of the student body will receive the bottles at the beginning of the second semester during a few days of mass distribution. The water filters are taken care of by Poland Springs and purchased on a monthly basis. We have not received funding from any other group on or off campus, so we will have to find another source of money in the future when we want to continue using the water filters, but this is just the first step. After we see how this goes, we can get the entire water filling system in residence halls, which just needs to be installed once and last long-term, but they cost $2,000 a piece, so we thought it would be a better idea to test out the idea with filters that are less expensive and removable.

This initiative is addressing three main issues. First, we are reducing the plastic from plastic bottles that end up in landfills. Second, we are providing filtered water, and third we are specifying a place for recycled plastic, so it doesn't end up being placed in the trash out of convenience.

Partners

We, the under signed participants agree to commit to the duties presented by the *Take Back The Tap* initiative at Clark University.

Paul Wykes	-Financial guidance and assistance with Poland Springs communication	pwykes@clarku.edu
Dining Services/Sodexo	-Work together to develop an agreement that will provide first year students with a reusable water bottle	hvaillette@clarku.edu
Physical Plant	-Assist in the planning process for where to install the filtration systems within the residence halls	dlundstrom@clarku.edu mdawley@clarku.edu
Eco-Reps	-Co-partnership to assure that	contact.ecoreps@gmail.com

	even after we leave, the initiative will be upheld through the years -Provide assistance in any voluntary needs when applicable (for example, educational outreach events or advertisement)	
Residential Life and Housing	-Approve the distribution of recycling bins to suites -Willing to help with the distribution and advertisement for recycling bins	kforti@clarku.edu
Student Leadership and Planning	-Willing to consider the replacement of Clark mugs in the week one package with reusable bottles	mmckenna@clarku.edu
Green Room Project	-Provide assistance in any voluntary needs when applicable (such as: educational outreach, events, advertisement, or distributing recycling bins to suites)	-lea lumpkin: lea.l@greeneru.com (this one is still pending, but n necessary for the project's success)

Budget and Fundraising

Budget and Fundraising (provide detailed budget and discussion as below) Amount Requested: $7009.19
The budget is attached to this email as a separate document.
Poland Springs water coolers https://eservice.polandspring.com/pages/ps/FAQWaterCoolers.aspx
http://www.accupure.com/AccupureAdvantage.aspx

The water bottles
http://www.bulletinbottle.com/all-bottles

The recycling bins
http://www.buygreen.com/curbsiderecyclingbins.aspx

If the SSF is unable to fund the full request of our project, we will be disappointed, but we will try to make as much of an impact as we can moving forward. We will purchase the minimum amount of water filters, bottles, and bins that we can and continue to grow in the future. We are simultaneously working with student council to pass legislation about where plastic water bottles will allowed at events and if

every student is not able to get a reusable water bottle, it will be very difficult to continue with that legislation.

Currently the only funds that we will have are coming from the SSF. As mentioned in this application, eventually we would like to install better water fountains with filling stations, similar to the one in the gym, in every residence hall. The money we are asking for is for one year, so we can gauge interest and see how beneficial spending a lot more money on those water appliances would be.

Recycling bin count:
Dana and Hughes=13 suites
Maywood=42 +4 RA=46 suites
TOTAL=59 total bins
Blackstone already has bins

Timeline

Talk To Collaborators- November 30th
Water Bottles
-Confirm water bottle to purchase for current students- Dec 7th
-Order water bottles- Jan 20th
-Distribute water bottles to students- Feb 2-12th
-Ensure water bottles will be purchased through dining services and Student Leadership and Planning for Week One in future years- Nov 30th

Recycling Bins
- Confirm bins to order- Dec 7th
- Order bins- Jan 20th
- Make educational flyer to attach to bin- Jan 25th
- Attach flyers- Jan 30-Feb 2nd
- Distribute Bins to suites in Dana, Hughes, and Maywood- Feb 2-12th

Filtration System
- Meet with Physical Plant to find suitable locations for units- Jan 20th
- Contact Poland Springs for specific price and installation information- Done but continuing communication
- Install Systems- By March 1st

Education
- Forum- Dec 4th
- Work on legislation for passing referendum- second semester

Metrics

There will be three methods for tracking and reporting the environmental benefits of the water filtration systems.

1. Measuring the amount of water used by each filtration system. Depending on the filtration system we chose to implement in the dorms, we may be able to directly measure the amount of water used by the filtration system. We can determine how many ounces are used in a day, a week, a month, and a semester. We will then compare the amount of water used by the filtration system to the equivalent number of water bottles that would have been used. The typical bottle of water contains 16.9 fluid ounces. We will calculate how many bottles of water would have been used if the filtration system was not available.

   If the filtration system is unable to independently measure the amount of water used, we can set up a tally system. We will place a chart within the proximity of the filtration system and every time a student fills their water bottle they will be required to add a tally to the chart. The chart will be checked on a weekly basis by a member of Take Back the Tap.

2. Bistro and vending machine sales. We will examine the sales numbers of water bottles in the Bistro as well as in the vending machines around campus. A drop in sales would suggest that more people are using the filtration systems rather than purchasing bottled water.

3. A survey. At the end of the semester we will require the students who live in dorms with the filtration system to take a survey. Sample questions from this survey include:

   a. How many times a day do you use the filtration system?
   b. Before the filtration system was in place did you buy bottled water?
   c. If you did not use bottled water in the past, how did you get water? Where? At what times? How frequently?
   d. Do you find the filtration system useful and convenient?
   e. Do you still buy bottled water even though there are filtration systems in the dorms? If so why do you buy bottled water?
   f. How many bottles of water do you typically drink a day?
   g. Do you have any suggestions, comments, or criticisms about the filtration system?
   h. Do you feel as though the filtration systems are effective in reducing the number of water bottles used on campus?
   i. If we installed a filtration on each floor in the dorm would you be more apt to using the device?

* A similar survey will be given to students in suites regarding the use of the recycling bins.

Outreach and Education

Our project includes a substantial focus on outreach, education, and behavioral change. The project will be most visible to Clark students who live in the on-campus residence halls because we will be implementing filtered water-bottle filling stations in the dorms and providing recycling bins for each suite. However, this project will also be made visible to the rest of the Clark community and the outside world through educational outreach that emphasizes the environmental, social and economic need to switch from bottled water to tap water. We have created a slide that will be displayed in the Clark Dining Hall that educates the population on reasons to use tap water. We will be holding an open-forum, during which we will have an open dialogue for students to discuss their ideas and concerns for utilizing tap water and water bottle filling stations instead of using bottled water. Lastly, we will be hosting an educational film screening of the documentary *Tapped.* In order to ensure attendance to these events and

guarantee that the Clark community know about the project, we will: make banners that will be displayed in the University Center (UC), table in the UC with information during meal times, and send information out through the "What's Happening at Clark" e-mail. In addition, this project is in collaboration with the Sustainable University Class. This perpetuates the idea that what we learn and study in a classroom can be implemented in our community. Furthermore, this project encapsulates the goals of LEEP.

Appendix 9.

To Whom It May Concern:

Proposal to Eliminate Sale of Bottled Water from Clark University Campus:

Clark University prides itself in its commitment to sustainability. Our University signed the Climate Action Plan in 2009 pledging to decrease its carbon footprint to net zero by 2030. As a university that pledges itself to sustainability, it should not support the production of goods that increase carbon footprints. Lets uphold our reputation and contribute to decreasing the carbon footprint in our surrounding communities. Plastic water bottles are expensive and unnecessary commodities, which create an excessive amount of waste. In 2007, 8.82 billion gallons of bottled water were sold in the United States (Gies, 2008). Bottled water production requires 2,000 times more energy than tap water production (StoryOfStuff) and utilizes seventeen million barrels of oil annually in the U.S., which is the equivalent of fueling 1.3 million cars (BanTheBottle). Many universities are already taking sustainable action by banning bottled water sales on their campuses. Given Clark University's long-standing tradition of supporting social and environmental causes, it is well positioned to be a leader in this initiative. We, the *Take Back the Tap Campaign* (a group of students in collaboration with the Sustainable University class), therefore propose an elimination of the sale of bottled water in the Bistro, Jazzman's Café and all on-campus vending machines.

Ensuring water accessibility throughout campus is critical to preparing the Clark community for a ban on bottled water. Filtered tap water may become more accessible within the next year because eight water bottle filling stations are already budgeted for and under consideration by Physical Plant. Four of these filling stations are tentatively planned to be installed in the University Center, Jonas Clark, the Academic Commons, and the Jefferson academic building. The Take Back the Tap Campaign at Clark also was granted $7,000 from the Student Sustainability Fund in order to install nine water bottle filling stations for each residence hall. Additionally, communication is underway with different companies to provide each Clark student with a reusable water bottle and ensure that all incoming students receive one in their Week-One orientation packages. These initiatives ensure alternative water options will be available for the Clark community by the fall of the 2013 school year, which will prepare students for a ban on bottled water sales.

This problem of wasting plastic water bottles has manifested itself here at Clark. The average recycling rate of bottled water is 23% in the United States (BanTheBottle). Clark mirrors this sub-par statistic with a general recycling rate of 29% percent. If bottled water is removed from the equation, the deviation of waste to recyclables will decrease favoring recyclables. However, even when items are properly recycled, the process of removing them from campus requires energy to transport to a recycling facility. Bottled water is an unnecessary exploitation of energy that Clark could easily decrease by removing bottled water sales from campus. Additionally, since bottled water containers are not redeemable in Massachusetts, plastic water bottles are recycled with commingled recycling, which costs $100 to transport per load. A bottled water sales ban will result in a smaller commingle

collection, which will ultimately save the university money. It is time to stop wasting time, money, and energy to remove such an unnecessary commodity when Clark is equipped with accessible tap water.

Through primarily quantitative methodological approaches, our group has measured student water preferences, support for a ban of bottled water sales on campus, the number of students who already own reusable water bottles and the percentage of students who would cease purchasing individual plastic bottles if filling stations were installed throughout campus. Our findings conclude that the Clark community supports the initiative to ban the sale of bottled water. We distributed a survey to students in the U.C. and online. Of the 84 students who completed our survey, 85.71% said they already owned a reusable water bottle. Additionally, 91% of students who completed the survey reported that they would not purchase bottled water if filling stations were implemented. Lastly, 229 students have signed our online petition (http://signon.org/sign/take-back-the-tap-at?source=c.url&r_by=5782393) supporting the implementation of water bottle filling stations and the ban of bottled water sales from campus.

Clark University was voted 17th in 2011 in the Princeton Review of the "Green Colleges" because our student body and faculty is full of passion and persistence in creating a sustainable university. Small, innovative changes serve as catalysts to decrease carbon emissions on Clark's campus and create long-lasting behavioral change among Clark students. Clark University challenges convention to change our world, so let's take back the tap.

Sincerely,
The Take Back the Tap Campaign:
Mikayla Bobrow, Tiffany Kline, Sam Mix and Fangmei Jin

Appendix 10.

The LED Light Bulb Giveaway

A Sustainability Initiative by: Michelle Reid (2013) and Kristina Nguyen (2013)
Environmental Science and Policy and International Development and Social Change
EN 120: The Sustainable University
Stephen McCauley
Fall 2012

Abstract

The LED Light Bulb Giveaway is a sustainability initiative established at Clark University to improve the energy use of the faculty and staff. 300 LED light bulbs were given to Clark by National Grid in order to initiate this program. The mission of the initiative is to invite the faculty and staff to participate in this free Giveaway. In order to be eligible for a free LED light bulb, the faculty/staff member must switch from overhead to task lighting. Once faculty and staff expressed interest in participating, the LED light bulbs were delivered and the overhead lights were inventoried for future energy savings calculations. Our team created a spreadsheet that documented the participation by department and the projected energy savings. At the end of our project, we sent a detailed report to National Grid with our calculated energy savings to demonstrate the affect of the LED light bulb at Clark University. For our project, we had 40 interested faculty and staff, 38 of which have already received their LED light bulbs. There were 59 LED bulbs distributed and the cumulative energy savings from the participants were calculated as 35,280 Watts/day.

List of Tables and Figures

Introduction

Energy and money are wasted every day just by lighting an empty space. According to the EPA, lighting makes up about 25% of total U.S. electricity uses. The illumination of empty areas in large spaces from overhead lighting is unnecessary and wastes energy. Energy-efficient lighting from LED light bulbs (including appropriate task lighting) will reduce electricity demand and therefore costs by more than 50%. Energy at Clark University is powered by the co-generation plant which burns natural gas. Lighting for offices and rooms is a major consumer of electricity on campus. Each 4 foot T-8 fluorescent bulb causes about 30 watts of electricity in a typical office ("F32t8/es/30 t8 ballast 2 lamp 30w mv," 2012). That accumulates up to 2,000 watts per day (8 lamps for 8 hours). Over a year, that adds up to 1/3 of a ton of greenhouse gas CO2 emissions. A green alternative for light energy savings is to switch to task lighting powered by LED light bulbs. This lighting not only wastes energy but it also contributes to an increase in greenhouse gas emissions and an increased carbon footprint for buildings and organizations. Usually, electricity comes from a power plant that burns fossil fuels and emits harmful pollutants into the atmosphere, equaling up to 1/3 of a ton of greenhouse gas CO2 emissions.

Task lighting provides a variety of beneficiaries ergonomically, economically, and environmentally. Task lighting is defined as lighting that focuses on a specific area in the room instead of illuminating the entire room (Tetlow, 2007). Natural light in a room changes throughout the day forcing your eyes to adjust focus to its variability. With task lighting, there is less of a chance for glare or shadows that can cause stress on your vision, making it harder for you to focus on work. With this adjustable task lighting, you are the controller of the light and therefore are able to optimize lighting to your comfort. The overall idea is that better light yields better sight and personal comfort contributing to increased productivity. Overhead bulbs have to be replaced frequently to avoid burning out and loss of luminosity. Because they contain mercury they also have to be carefully transported, stored, and recycled with a licensed company certified by federal regulations, creating another cost burden. LED energy efficient lighting is a smart alternative to incandescent bulbs. Its power is made up of 12.5 W and projects 800 lumens of brightness. With an average life of 23 years, this bulb provides low energy consumption while emitting

Figure 1: LED Light Bulb

essentially no heat. Its durable body supplies warm, white light without discharging UV/IR beams and it even can be dimmed. The LED light bulb is easy to install and contains no mercury so disposal costs are limited. The estimated energy cost per year is $1.51 which amounts to about 80% savings in energy costs (Philips, 2012).

As energy efficiency becomes increasingly vital to protecting our environment and promoting a sustainable lifestyle, more people are switching to task lighting and task lighting is increasingly becoming the norm in many offices. Modern office design even incorporates 'daylight harvesting', using natural light and windows instead of overhead fixtures. Unfortunately, not all office environments are suited to task lighting. Meeting rooms or reception areas may still require diffuse illumination. At Clark, many campus offices have already upgraded to energy-efficient overhead lighting. Although this contributes to the Climate Action Plan goal of zero emissions, there are still more efficient ways to decrease energy lighting. Our project, the LED Light Bulb Giveaway, promotes the action of switching to task lighting powered by a LED light bulb, and turning off unneeded overhead lights. Unlike overhead lighting which focuses light on the whole room, task lighting centers the correct light level on a targeted working surface by using a desk lamp. The result would be anticipated energy savings higher than that of energy-efficient overhead lighting.

For this specific project, our mission is to invite all faculty and staff to take one simple action to win an energy efficient, long lasting LED light bulb. Participation in this LED Light Bulb Giveaway will reduce Clark's daily and long-term energy consumption and help us toward our Climate Action Plan goals. The LED Light Bulb Giveaway is supported by Sustainable Clark and the university's Physical Plant in an effort to promote a more sustainable lifestyle. In order to win one of these valuable light bulbs for free, the participant will be required to bring in a desk lamp to switch from overhead lighting to task lighting. For those staff members that are interested, we will deliver the free LED bulb right to them so they can use it in their desk lamp instead of using the inefficient overhead lighting. By delivering these bulbs in person, we are able to discuss the information sheet and the benefits of the light, increasing awareness of our mission. A Clark student, Corrine Jachelski, originally started this project as part of her internship with Sustainable Clark and has remained an involved partner throughout the implementation of this project. A document with information on task lighting has been created as well as a "Giveaway Letter" that was distributed to all staff members as an introduction to our

project. Once recipients express interest in our giveaway, they will receive a light bulb and their information will be recorded on an excel spreadsheet to keep track of all the participants. Once we have their information, we will be able to compare light output from overheads with outputs from LED task lighting. By recording the energy draw from each of the light bulbs, we will be able to project energy savings achieved by switching to LED task lighting. If faculty members are made aware of these savings, interest in switching to these light bulbs is likely to increase. The main task of this project is to give away and record savings for no less than 100 bulbs. There are 700 staff (not all have offices) and 400 faculty on the Clark campus. As part of our outreach mission, we will talk to Jackie Capomacchio, Director of Human Resources, about the free LED light giveaway to staff and faculty and the task lighting benefits for employees. By keeping inventory of overhead lighting and recording the calculated savings of installing LED light bulbs and replacing overhead with task lighting, we will be able to analyze savings per department building/house and will award the most participative departments that demonstrate exceptional participation and savings with a certificate. A follow-up survey will be created in order to determine if people were satisfied with the task lighting and how they felt about their new LED bulb. Once our part of the project is complete, a report will be sent to National Grid, the sponsor of the bulbs, showing the level of energy savings Clark has achieved through the project. The future aim is to expand this project, eventually giving away LED light bulbs to all staff and faculty. This project is based heavily on behavior change. Many faculty and staff are not aware of the cost and energy savings of this implementation. However, with increased outreach and awareness, they can be informed about this available efficient alternative.

Background

The main objectives for this project are to initiate the program by distributing the light bulbs to participating faculty, to evaluate the potential savings from switching to LED bulbs, to evaluate the campus-wide impacts, to award departments with the highest participation and energy savings, and to report back to National Grid based on the findings of the energy savings calculations. This project was originally initiated by Corrine Jachelski and Jenny Isler, whom laid the foundation for this project. They were able to secure funding from National Grid to sponsor this project and provide 300 LED light bulbs for us to distribute. The project has currently been passed onto Kristina Nguyen and Michelle Reid to be carried out and finalized.

The overall goal is to give away and record savings for approximately 100 Clark faculty and staff. All staff members have already been sent the LED Light Bulb Giveaway Letter via Human resources, and interested members have been followed up on. In order to reign in interested participants, the letter indicated that staff could win a $54 LED light bulb for free so long as they bring in a desk lamp and contact the LED Giveaway team. The next step is to distribute the LED light bulbs in person and collect and analyze the data, in addition to talking to Jackie Capomacchio, the director of Human Resources, regarding the project as well as possible task lighting benefits for employees. Subsequently, certificates will be awarded to department buildings/houses that switched over and saved the most energy, and a follow-up survey will be created to determine if the task lighting was efficient and beneficial.

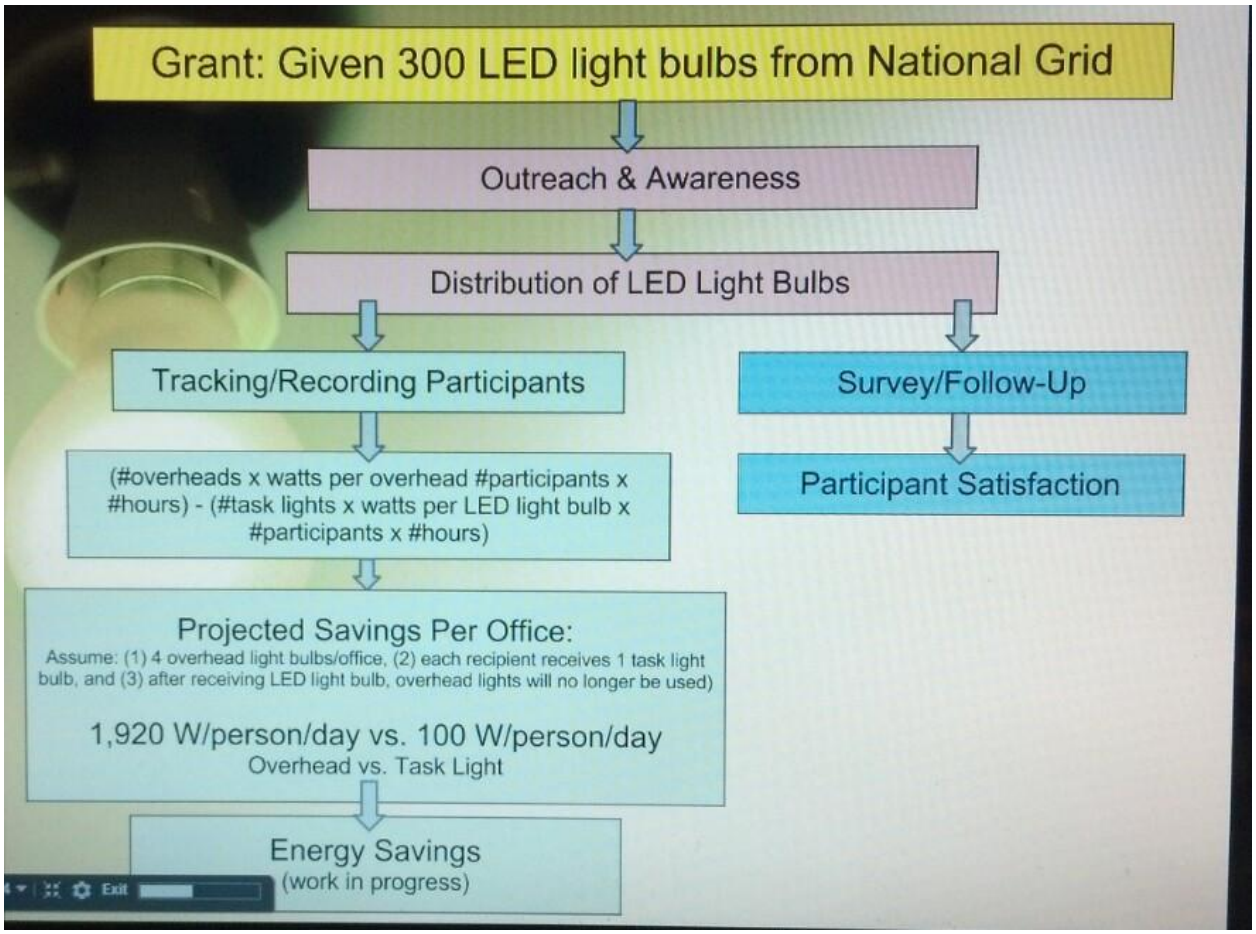
The switch from over head lighting to LED powered task lighting includes many beneficial factors. Task lighting yields ergonomic, economic, and environmental benefits. There are many light fixtures that are considered task lights. For example, desk lights and the pendant lights present in many kitchens. Overhead lighting illuminates a whole, which is an excessive amount of light and energy used. With task lighting, only the specific area that needs lighting is illuminated. Why waste energy and light on used space? (Refer to Appendix A for more information on the benefits of task lighting).

Methods

In order to project the potential of more task lighting, data was collected from participating Clark staff and faculty, and then analyzed and compared. The LED Giveaway team inventoried overhead light bulbs in the staff members' offices while distributing LED light bulbs, found the amount of energy the overhead light bulbs used, and calculated the energy savings based on this replacement and how many hours overhead lighting was being used. All data was recorded in an Excel spreadsheet (Refer to Appendix B for the Excel Spreadsheet). The overarching equation for total energy savings is the overhead energy draw minus the LED task light energy draw. Once the draw of energy for overhead light bulbs and LED light bulbs was found, which is 30W for the overhead light bulbs and 12.5W for LED light bulbs, the amount of energy saved was calculated. Essentially, the equation is the amount of hours overhead lighting is used multiplied by the draw per bulb, multiplied by the number of overhead light bulbs. The amount of hours is typically constant (9am-5pm) as well as the draw per bulb. The savings per

department house/building was then analyzed depending on how many staff members there were versus how many members made the switch from overhead lighting to task lighting. After savings had been calculated, a detailed report with our final energy savings was sent to National Grid, the sponsor of the LED light bulbs. Once we have recorded all of our participants and delivered the LED bulbs, a participant satisfaction survey will be sent out to collect feedback on the use of the LED task lighting (A link to the survey can be found in Appendix C). Below is a flow chart of our project:

Figure 2: Flow Chart of LED Light Bulb Giveaway Project



Results and Discussion

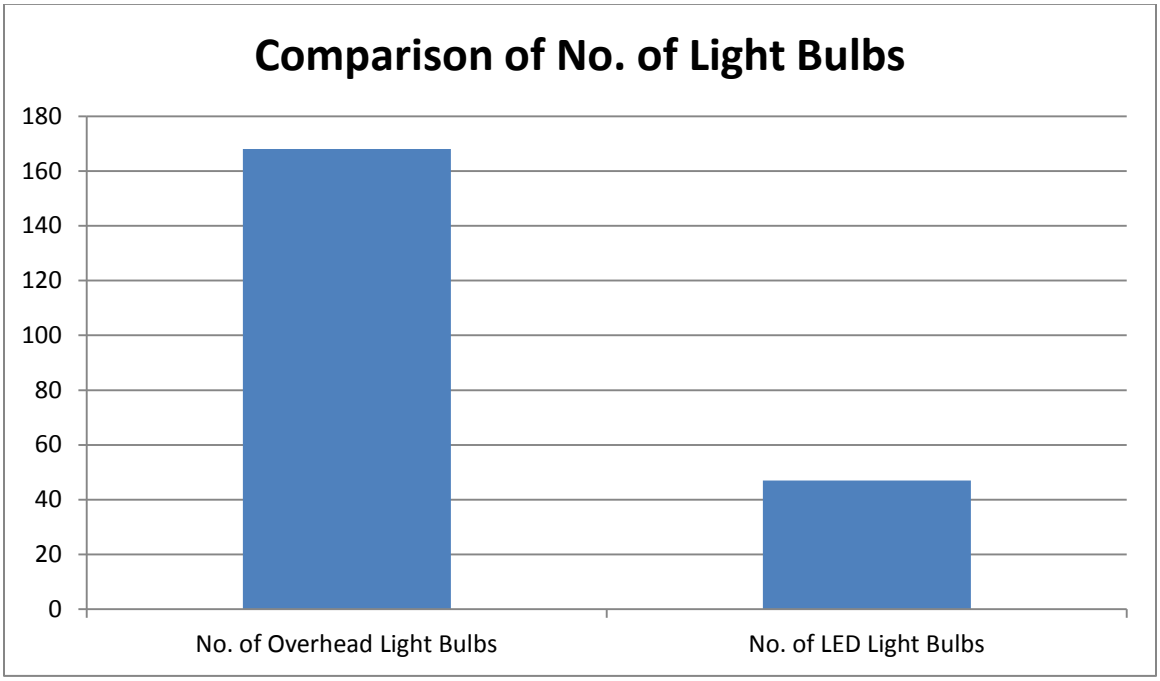
As part of the LED Light Bulb Giveaway, National Grid granted the project 300 free LED light bulbs to distribute among Clark. Since the mass email that went out to all Clark faculty and staff informing them of this opportunity, 40 Clark faculty and staff from 16 different department buildings/houses have shown interest in participating, 38 of which have already received the LED light bulb (see Table 1).

Table 1: Energy Savings per Department Building/House

Department Building/House	**# of Participants**	**Energy Savings per Department Building/House (Watts)**
Geography	8	10,700 Watts
English	1	860 Watts
Jefferson Academic Center	6	4,680 Watts
IDCE	3	3,300 Watts
Carlson Hall	2	860 Watts
151 Woodland	2	3,540 Watts
153 Woodland	3	2,380
Lasry	1	380 Watts
Dana Commons	3	1,140 Watts
Goddard Library	2	280 Watts
3 Maywood	1	860 Watts
Admissions	1	380 Watts
Jonas Clark	1	2,780 Watts
Gates	1	860 Watts
Corner House	1	N/A
24 Charlotte	2	860 Watts

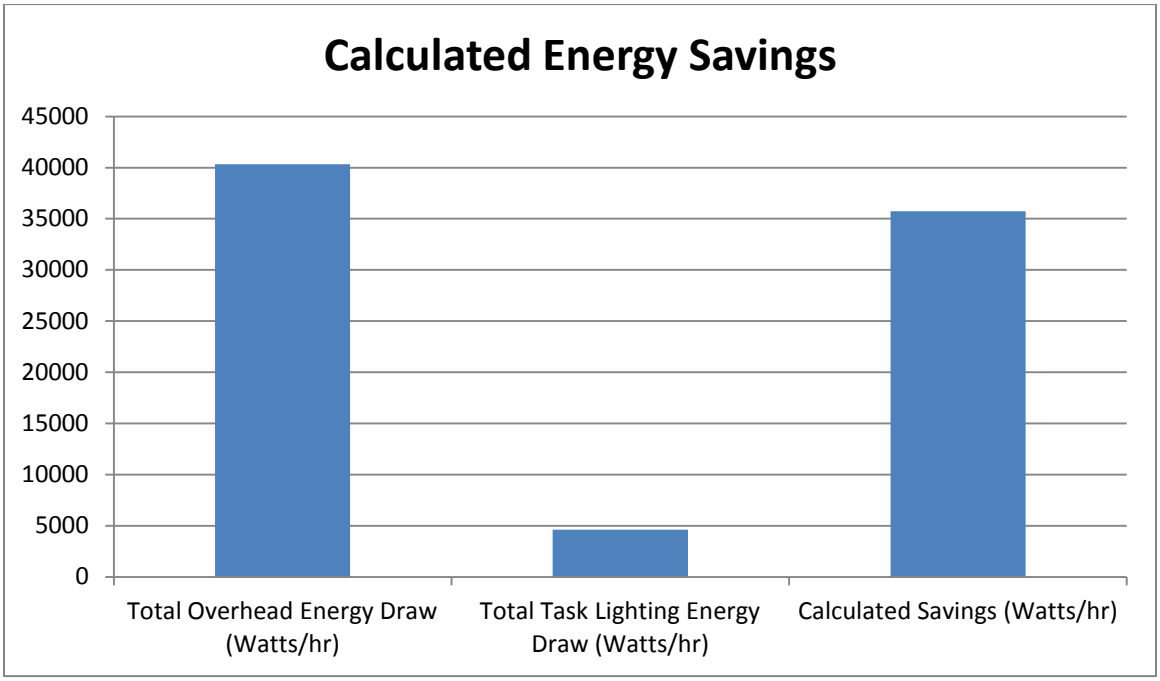
Overall, 64 LED light bulbs were requested and 59 LED light bulbs have been distributed as of yet. Among the 38 participants who have received their light bulbs, a total of 168 T-8 Florescent overhead light bulbs have been recorded (see Figure 3).

Figure 3: Comparison of No. of Light Bulbs



From this, we can calculate the overall energy savings from switching from overhead lighting to LED task lighting (see Figure 4).

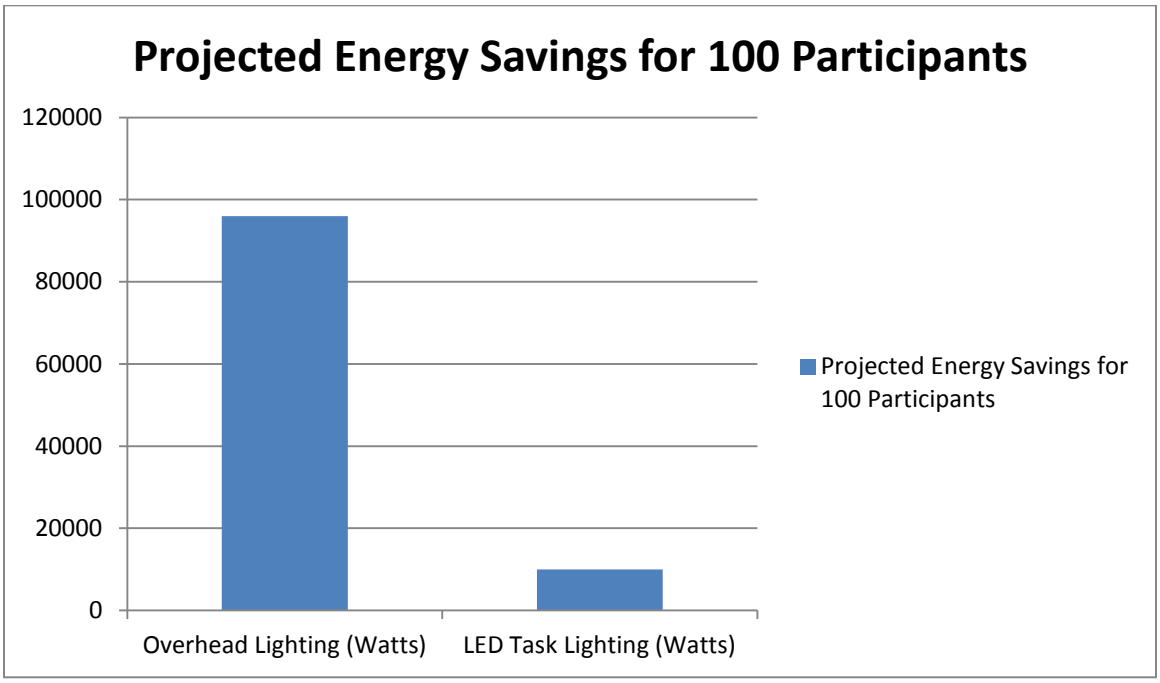
Figure 4: Calculated Energy Savings



Assuming that Clark faculty and staff work 8-hour days, and knowing that Clark uses 30 Watt light bulbs for their overhead lights, we can determine the amount of energy that was being consumed with overhead lighting for our 38 participants. According to Figure 3, overhead lighting for our 38 participants consumed 40,320 Watts. Assuming that their work hours remained the same and knowing that each LED light bulb only uses 12.5 Watts, we determined that the cumulative amount of energy used in LED task lighting was 4,600 Watts. This means that there was a total energy savings of 35,280 Watts per day for our small group of participants. If 100 Clark faculty and staff were to participate, Clark could potentially save 86,000 Watts per day, assuming that each participant works 8 hours a day, has 4 overhead light bulbs, each receives one LED light bulb, and no longer uses overhead lighting after receiving the LED light bulb (see Figure 4). It was interesting to talk to participates about this initiative during deliveries. One staff member said that he removed all his over head lighting and fully committed to using

task lighting. Another faculty member was very excited to see this initiative implemented at Clark as she already used task lighting fixtures at home.

Figure 5: Projected Energy Savings for 100 Participants



Referring back to Table 1, it can be seen that the Geography building is currently in the lead with the number of participants as well as the amount of energy saved, which is 10,700 Watts/day.

Recommendations

Since this project was initially started by Jenny Isler and Corrine Jachelski at the beginning of the Fall 2012 semester, the project objectives and methods were already set, and the actual carrying-it-out of the project by the LED Light Bulb Giveaway team took place towards the end of the semester since they came aboard the project towards the middle of the semester. Although Clark staff and faculty were informed about this giveaway during the most hectic time of the semester and therefore unable to meet their expectations of getting 100 Clark staff and faculty to get involved, the LED Light Bulb Giveaway team was essentially able to initiate the

project for later sustainable groups to continue. Later groups will fundamentally have entire semesters to reign in participants and distribute LED light bulbs.

The possibility of distributing these LED light bulbs to Clark students has been considered, but it was decided against mainly because students are transitory and may dispose of the LED light bulb after they move out or they may leave it at home. In our defense, the LED Light Bulb Giveaway team is focused on long-term pervasive campus-based savings.

In regards to the future of this giveaway project, three events will take place. First of all, the names of people who have signed on will be used as a client base when/if a Green Office program is piloted. These participants will be recruited as 'champions.' Secondly, the energy and emissions savings will be conducted by the future team, and these savings will be highlighted via Campus News and the Task Force other non-participating departments to encourage all departments to change their overhead/task lighting behavior. Hopefully in doing so, we can instill a friendly sense of competition between each department and consequently get more staff and faculty to participate. Lastly, another LED Light Bulb Giveaway will almost certainly take place mid-semester in Spring 2013 so long as there are students who are interested in continuing this project.

Conclusion

In conclusion, the LED Light Bulb Giveaway Project was a success, but it is far from finished. Of the 700 Clark faculty and staff members and the free 300 LED light bulbs in stock, only 40 have shown interest and 59 LED light bulbs have been distributed. Regardless, we have already attained our goal of creating awareness regarding the benefits of task lighting as well as saved energy from the overall switch from overhead lighting to LED task lighting. On the whole, Clark University has saved 35,280 Watts per day as a result of the lighting behavior change. As the project continues into the next semester, more faculty and staff will be encouraged and willing to join, especially with the showcasing of our collected data. With the simple act of switching from overhead light use to LED task lighting, Clark University will reach its Climate Action plan more quickly in addition to significantly saving energy to better serve the planet.

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Appendices

A) Task Lighting Information and Benefits

What is task lighting?

Think 'desk lamp'. With task lighting, the area you need to see the most, like a book or papers on your desk, is brightly lit. Task lighting focuses the correct light level on a targeted working surface. In contrast, overhead lighting diffuses light all over a room and can cause shadows or glare on your work surface.

Isn't overhead lighting the standard?

They were invented for big open rooms where rows of workers needed light shining from high ceilings above, beginning with factories and typewriter 'pools'. The new technology produced adequate amounts of quality light in large spaces – but these "adequate amounts" can be excessive for the lighting needs of today's office environment, with our illuminated computer screens and individual desks. OSHA stipulates 20 foot-candles for an office workspace. Overhead fixtures generally have upward of 50 foot-candles (more if you are under them) because they are designed to light the whole room. We just never changed our old habits to catch up to the times!

Why is task lighting better?

In a personal work area, task lights provide exceptional levels of bright, comfortable light and yield ergonomic, economic, and environmental benefits.

Ergonomic: Our posture changes during the day. Our tasks vary. Natural light in the room changes from morning to evening. All these changing conditions require eyes to continually re-focus. Plus overhead lighting can create glare, shadows, uneven light and other conditions that stress our vision. To reduce eyestrain and fatigue, we need to optimize lighting levels directly on our work. The key is adjustable-arm task lighting so you are in control of the light for your own optimal comfort. Simply put, better light = better sight = personal comfort = productivity.

Economic: The EPA estimates that lighting accounts for 25% of total US electricity use, and lighting for industry, offices, stores, and warehouses is 90% of that. Unnecessary illumination of large spaces can waste energy. Energy-efficient lighting (including appropriate task lighting) can reduce electricity demand and therefore costs by more than 50%. Plus those overhead bulbs have to be replaced frequently as they burn out or lose luminosity. And, since they contain mercury they have to be carefully transported, stored, and recycled with a licensed company in accordance with federal regulations, creating another cost burden.

Environmental: Lighting up empty space obviously wastes money and resources, but it also creates greenhouse gas emissions and a bigger-than-necessary carbon footprint. Electricity comes from a power plant burning fossil fuels which makes pollutants and greenhouse gases (Clark's co-generation plant burns natural gas; National Grid's fuel mix includes coal, oil and gas). Each 4 foot T-8 fluorescent bulb draws about 30 watts of electricity. In a typical office that's up to 2,000 watts per day (8 lamps for 8 hours). Over a year, that adds up to 1/3 of a ton of greenhouse gas CO_2 emissions! You can do your own carbon calculation on the EPA website. Clark has upgraded to energy-efficient overhead lighting in many campus offices. This helps get to our Climate Action Plan goal of zero emissions – but switching to a desk lamp and turning off unneeded overheads will help reduce our emissions even more.

If I turn off the overhead lights and use a desk lamp, will visitors think the office is closed?

More and more people are switching to the comfort and savings of task lighting. It's becoming the norm in offices everywhere as people and employers recognize the benefits and phase out overhead lighting. Modern office design even incorporates 'daylight harvesting', using natural light and windows in place of overhead fixtures. If it makes you more comfortable, hang a sign outside the office door to let visitors know the office is open. Chances are, you will get complemented on your desk lamp and energy efficiency! Note that not all office environments are suited to task lighting. Meeting rooms or reception areas may still require diffuse illumination. But if you work at a computer at a desk or cubicle, task lighting is the healthier choice – for you and the planet.

More information…

The LED Light Bulb Giveaway:
Philips Endura LED 12.5W product information: http://www.usa.philips.com/c/led-light-bulbs/ambientled-12.5w-a19-soft-white-dimmable-046677409906/prd/en/
Features:

- 12.5 W
- 800 lumens of brightness
- Provides low energy consumption and a superior life (~23 years)
- Supplies warm, white light and is dimmable
- Emits essentially no heat
- Discharges no UV/IR light in the beam
- Contains no mercury
- Easy installation

Estimated Energy Cost: $1.51 per year
Save up to $130.63(80%) in energy costs

B) See Attached Excel Spreadsheet for Participant Information

C) LED Participant Satisfaction Survey Link: http://www.surveymonkey.com/s/BGBGXSW

Rainwater Catchment

Kelli Stockmal, *Chemistry*

Gina Jenkins, *Environmental Science & Policy*

Chong Lin, *Environmental Science & Policy*

Sarah Sachs, *Global Environmental Studies*

The Sustainable University

EN 103

Prof. Stephen McCauley

Fall 2012

Abstract

The irrigation system at Clark was first evaluated to see how the sprinklers were connected to each other throughout the campus. Calculations that were done estimate that the sprinklers use anywhere between 180,000 and 4.8 million gallons of treated water per year, which is an expensive resource. In an effort to save water and money on campus, smaller buildings on campus were evaluated to determine which buildings were the most viable options for placing a rain barrel. A set of criteria was developed to rank the buildings and The Admissions House, Corner House, 1 Maywood Place and 3 Maywood Place were four of the buildings that ranked the highest and were the most viable locations to implement a rain barrel. Future rainwater catchment groups can use our criteria to implement a rain barrel on our campus.

Tables and Figures

Figure 1. A map of campus showing the locations of the ten best places to put a rain barrel.

Figure 2. The final set of criteria developed to establish a location for the rain barrel.

Introduction

The problems surrounding fresh water access and water security are a global concern. Fresh water is stored in glaciers, ice caps, snow, lakes, rivers, streams, and beneath the ground as aquifers and groundwater (EPA) and comprise less than 3% of the water on Earth's surface (UNEP). As the world's population grows and urbanization continues to increase, the global needs for freshwater is being exploited at a faster rate than at which it can be replenished. Universities and institutions are the forerunners in sustainable innovations and can serve as leaders in developing methods to obtain and use water sustainably.

As water becomes an increasingly challenging issue worldwide, college campuses will need to develop sustainable water management systems. New England is a relatively wet region, but some municipalities have experienced water shortages due to inadequate planning and oversight. In recent years, the Clark community has begun to discuss the need for commitment to monitor and upgrade the water systems around campus and the university has to consider the specific issues that a school will face in an urban setting. Clark purchases treated water from the City of Worcester, pays an initial fee for the water to come in, and a second fee for the water to go back into the sewage system. The irrigation system at Clark consists of a system of sprinklers that are fed from pipes connected to nearby buildings. In order to create a foundation for future development of rainwater catchment systems at Clark, data needs to be collected about water use and the impact that a rainwater catchment system could have on campus.

In the past, a 55-gallon rain barrel was installed outside of the President's office when it was located at the Corner House. While the exact area of where the rain barrel was supposed to irrigate is not known, the rain barrel was removed due to the fact that it would regularly overflow due to lack of use. This example demonstrates the importance of having the rain barrel in an area where irrigation is necessary as well as having committed individuals to maintain the catchment system in order to make sure that the water is used on a regular basis.

Before rainwater catchment systems can be installed on campus, sites need to be examined and judged on whether they will be suitable for a rain barrel. The irrigation system at Clark needs to be examined as a whole so that areas that would benefit from a

rain barrel can be identified. Our university currently has two 55-gallon rain barrels that are not in use but are available for future use on campus. Roof areas of buildings can be calculated and the amount of water that could be collected from those roofs can be determined in order to decide if those sites could sustain a 55-gallon barrel. Another issue to address is the act of raising awareness; the act of installing a rain barrel for rainwater catchment is a major way to raise awareness for ways that Clark can improve its practices and make those practices more sustainable.

This project is intended to develop a preliminary plan for installing a rainwater catchment system by identifying viable locations on campus and creating an implementation plan that can be utilized by the Clark University community in the future. We would like to show the Clark community how easy it is to conserve water on a small-scale, one step at a time.

Background

For most of the United States, access to fresh and clean water is not an everyday concern. Water has been used from rivers, lakes, and pumped from deep within the ground in order to keep up with the rate at which water is consumed on a daily basis. In some areas that are prone to drought, practices such as harvesting rainwater have been implemented in order to compensate for times when water is not readily available. Worcester, Massachusetts is located in New England, an area that in the past has received enough rainfall during the year to sustain the land and the people living there. Worcester is an urban city and depends on nearby rivers and reservoirs to provide water for its residents and businesses. The city gets an average annual precipitation of about 49 inches and the maximum average precipitation occurs in October (an average of 4.68 inches). Seasonality plays an important factor when looking at water use for irrigation. In the winter months, precipitation is primarily acquired in the forms of snow, sleet, and hail.

Clark University is a small liberal arts school located in Worcester, Massachusetts. Like many other universities, Clark uses an irrigation system consisting of sprinklers around campus to water its grass, flowers and trees. The sprinklers are hooked up to a water line from nearby buildings, while that same water is used in the dorms and other facilities for indoor use. Currently, the water Clark buys from the City of

Worcester is treated and this water is used both indoors and outdoors. The university is paying twice as much to use this water outside and there is no reason for this treated water to be used on landscaping. The monthly water use for Clark comes together as one bill, so it is difficult to calculate an amount of water that is being used solely for irrigation purposes.

Water is a valuable resource, especially in urban settings, and the use of water on the Clark University campus will become a larger issue, financially and environmentally, in the future. Using a rainwater catchment system would save the university money because water would be collected for free. As a result, Clark would not have to pay a fee to receive or dispose of water. If water restrictions were ever put into place in Worcester, having a catchment system already established for landscaping would also provide a restriction-free water source.

Rainwater catchment systems consist of a storage vessel that collects rainwater from the drainage system of a building so it can be used at a later time. Storm water is collected by directing rain from roof gutters and runoff into a storage tank. Rainwater systems used for indoor applications often require a filter system to remove minerals and other impurities from the water. The systems can be built above ground or underground to store the captured rainwater and are relatively self-sustaining systems. Underground systems are more appropriate for large-scale systems.

Overall, the systems require very little maintenance, are versatile, and have a large range in size to be suitable to hold large (or small) amounts of water. Furthermore, catchment systems can be placed at almost any location where a drainage system exists. These systems have benefits including reduced demand for untreated water, which can be used for irrigation and other uses, lower peak demand on public water systems, and reduced costs for the university (due to a reduced need for treated water in irrigation). These systems can also help decrease the amount of negative impacts that storm water runoff can have by storing the water and then slowly putting it back into the groundwater system. Collecting this water and using a filter with the system can help to lower the amounts of contaminants that enter back into the soil and groundwater and Clark University has the potential to make use of a system like this because it complements the university's goals to continue and expand sustainable methods across the campus.

Other universities are already experimenting with rainwater catchment systems. For example, at Rutgers University in New Brunswick, NJ there has been a lot of work done to successfully implement rain barrels on campus. Rutgers has also worked to help the environment with their initiative, the Rutgers Cooperative Extension Water Resources Program. One program in particular that has been successful is called the "One Barrel at a Time Co-op." Its goal is to help the environment by having residents bid on rain barrels that help save water and reduce rainwater from entering the storm drain system, which then prevents flooding and pollution from entering New Jersey's lakes and streams. To promote sustainable water use, local artists around the Rutgers campus have used recycled 55-gallon food-grade containers as rain barrels and painted them with artwork. The artists were partnered with Rutgers as they applied for selection to paint rain barrels. Once the rain barrels were painted and returned, they were on display for Rutgers Day, Duke Farms, and the Rutgers Cooperative Extension Water Resources Program website. The barrels were then auctioned off to the highest bidder, with the profit going back to the artists (One Barrel at a Time Co-op 2012).

Challenges that are faced following installation of a rain barrel must be considered in order for the catchment system to be effective. The location must be in a part of campus where the rain barrel can be easily maintained, but seasonality is also an important factor in considering usage of a barrel as a catchment device. If a rainwater collection system were implemented, rain would not be able to be collected during the colder months. An above ground system, like a barrel, would freeze in the winter months and could suffer damage as the water expands when it freezes. Rainwater catchment on Clark's campus can serve as a tool in educating the students, faculty, staff, and community on water use and sustainable practices. Having the support and enthusiasm about rainwater catchment systems is essential for expanding this project.

Methods

Criteria was developed and applied in order to survey possible sites for the future installation of a rainwater catchment system. This study took place within Clark University's campus in Worcester, MA. The first few weeks of the semester were spent researching the irrigation system already established on Clark's campus, along with

different types of rainwater catchment systems that were available. Data was then collected through various interviews with Clark personnel and the data analyzed. The primary objectives for this project were as follows:

1. Assessing the current water management system on campus
2. Developing criteria for evaluating possible buildings sites
3. Evaluating suitable sites based on the criteria
4. Creating a potential implementation plan
5. Producing data and planning tools to assist future implementation

1. Assessing the current water management system on campus

This first objective was done through the group's interviews with Jenny Isler, the Sustainability Coordinator, and Chip Pybas, the supervisor of the Ground Department in Physical Plant. They helped us to understand how much water we are using for irrigation on campus, as well as which buildings did and did not connect to the irrigation system already in place. Jenny Isler was able to direct us to other students who had previously done research on the water system at Clark, so graduate students Nick Rossi and Ashley Howard, who had been part of Professor Goldoftas' class, had shared their data with us.

2. Developing criteria for evaluating building sites

This second objective dealt with the "what" and "where" portions of our project. Initial criteria was established when we realized the 55-gallon rain barrel needed to be able to hold all of the water coming from the roof if it rained an inch or more. Sites were surveyed by walking around campus with a roller meter so the roof areas of buildings on campus could be estimated (See Appendix A for a picture). The roller meter was obtained through the help of Jenny Isler and Chip Pybas. Measurements were then taken to record a rough sketch of the building and to calculate the amount of potential runoff.

3. Evaluating suitable sites based on the criteria

The process of surveying sites on campus helped to develop some base criteria. This included that the building should be currently out of range of the current irrigation system, be able to use the water quickly, etc. This criteria helped us develop a checklist

that would help organize the data collected. Once the initial criteria were developed, a final ranking system was established for which the building was the best to consider rain barrel placement. Due to weather events, our measurements and calculations were re-done to ensure accuracy of the data. This process enabled us to start eliminating building locations that did not meet our criteria.

4. Creating a potential implementation plan

Objective 4 pertains to the "who", "when", and "how" aspects of the project. We wanted to create a potential implementation plan based on the criteria we created in the previous objective. Overall, Clark students would gain awareness about what a rainwater catchment system does, as well as how it could save water and money at Clark.

Potential people and groups were examined to see who could take on the catchment project in the future Eco-Reps, a student led sustainability group on campus, has a projects committee within their program. We contacted one of the leaders of the e-board, David Gross, as he is a good resource to speak with in regards to projects on Clark's campus. David Gross seemed to think it could be very successful as we talked about the project's life beyond this semester. In addition, our Sustainable University class was able to attend an event on campus that introduced the Student Sustainability Fund (SSF). This is a fund created by Clark student that allowed $20,000 from the student council budget to be used specifically for sustainable projects on campus. This event gave us more ideas for our potential implementation plan, as the SSF was created with the intention of funding projects like ours. The Eco-Carnival was also a good resource where we could speak more with members of the Eco-Reps group as well as develop more connections for our group. Lastly, our research on the expense of rain barrels helped us understand the costs of all the required parts to a rain barrel and the labor costs for the maintenance of the project by Physical Plant.

5. Producing data and planning tools to assist future implementation

In the fifth and final objective we recognized that our project could be very helpful for potential students, sustainability groups, and faculty in the future. We created data and planning tools by taking measurements of buildings and calculating the area of

the roofs (See Appendix B). Through months of hard work, our group was able to develop justifiable conjectures as where a rain barrel could be most viable. In addition, we have started to establish a supportive network of groups on campus that could potentially advance the project. Our proposal will be a deliverable for interested students in the future who are involved in this project.

Results

Water consumption on campus

Based on research done concerning the sprinklers on campus, it is estimated that Physical Plant uses anywhere from 0.02 to 0.09 gallons of water per square foot of grass every day. A full 55-gallon barrel of rainwater could provide water to anywhere between 600 to 2600 square feet of grass per day, depending on the type of sprinkler used. This means that a 55-gallon rain barrel could potentially provide 4% of the total water used on campus for irrigation for one day. In other words, approximately 25 of these barrels could be sufficient to completely provide water for landscaping purposes to the campus. More calculations regarding water use and cost can be found in Appendix C. The challenge becomes finding a suitable location for these barrels and implementing these systems.

Criteria

Forty-five buildings on campus were evaluated based on the criteria described in the previous section and ten of these buildings were found meet the minimum initial criteria for rain barrel placement. These ten buildings were further evaluated and a ranking system was developed to determine which of them would be the best place to put a catchment system. Figure 1 below shows the location of these building.

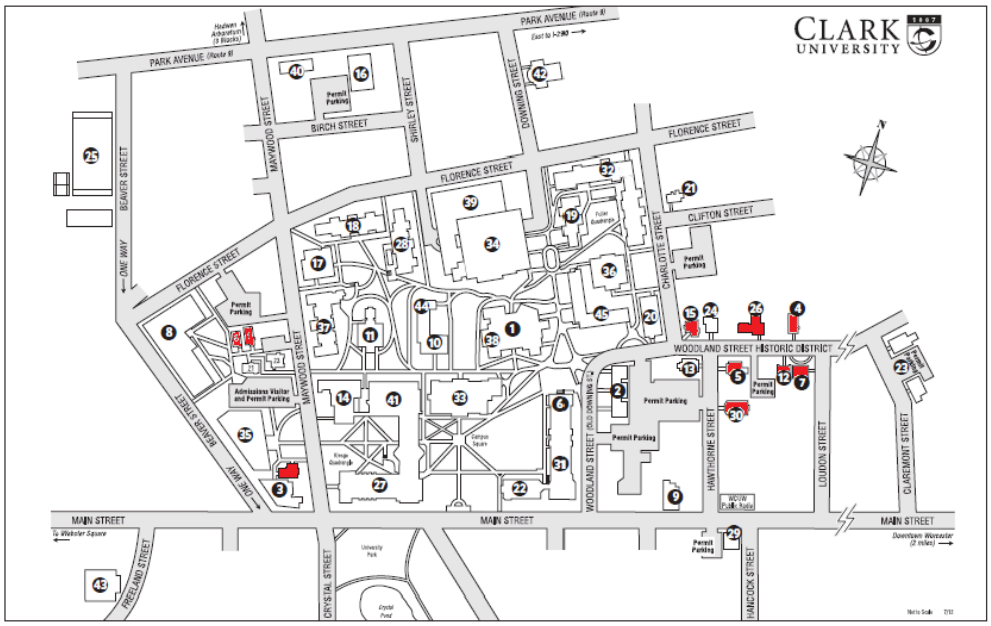


Figure 1. A map of campus showing the locations of the ten best places to put a rain barrel.

The final ranking system consists of the 5 following criteria: 1) the barrel will be implemented in a location that is not already being covered by irrigation, 2) the area is in a location that is easily maintainable by Physical Plant, 3) a gutter system is already in place, 4) whether it will be visible from the main campus, and 5) whether the area will need to be watered regularly. This list of criteria contributed to the formation of the five-star system in order to identify potential sites.

The criteria that were developed are essential for optimal rain barrel placement. The barrel will need to be in an area not already irrigated so there will be a use for the water that will be collected. This must be in an area close to the main campus so it is easily accessible by Physical Plant to undergo maintenance. It is important that a gutter system already be in place so the rain that ends up on the roof can be channeled down the gutters into a central location (i.e. the rain barrel). This needs to be visible to the main campus to raise awareness for sustainable options to save water on campus. The areas that are chosen will need to be watered regularly to avoid overflow of the rain barrels.

Five-star ranking system

The final set of criteria that were developed and the ten buildings that were evaluated are shown in Figure 2 below.

Building	Landscaping not already being irrigated	Area that can be maintained by Physical Plant	Gutter system already in place	Visible from main campus	Area needed to be watered daily	Stars
Old Admissions House	✔	✔	✔	✔	✔	★★★★★
Alumni Affairs	✗	✔	✔	✗	✔	★★★★
Anderson House	✗	✔	✗	✗	✔	★★★
Beck House	✗	✔	✗	✗	✔	★★
Carriage House	✗	✔	✗	✗	✔	★★
Corner House	✔	✔	✔	✔	✔	★★★★★
Harrington House	✔	✔	✗	✗	✔	★★★
IDCE House	✗	✔	✔	✗	✔	★★★
1 Maywood	✔	✔	✔	✔	✔	★★★★★
3 Maywood	✔	✔	✔	✔	✔	★★★★★

Figure 2. The final set of criteria developed to establish a location for the rain barrel.

Based on our multi-step criteria evaluations, we determined that the following sites are the most suitable sites on campus for placement of a rain barrel: the Admissions House, Corner House, 1 Maywood Place and 3 Maywood Place. These buildings ranked the highest on our ranking system while the Beck House and Carriage House ranked the lowest. These are all stand-alone houses on Woodland Street and Maywood Street. These results will help in deciding where the rain barrel can and will be placed.

Implementation plan

Implementation of a rain barrel can be approached in two ways. If the rain barrel is placed on the ground, it would be easy to implement, but it would require the purchase and use of a pump. This would help water move from the barrel to the sprinkler. However, the use of a pump could potentially neutralize the cost of savings due to operational costs. Alternatively, if the barrel was placed at the collection level (i.e. the

roof), it would be very difficult to place and maintain, but the height of the container would generate enough pressure needed for irrigation, thus eliminating the need for a pump and making the overall system energy and cost neutral in the long run. Through internet research, trade journals, and interviews with Jenny Isler and Chip Pybas, we understood the importance of the other accessories that will be necessary to buy for the rain barrel and some information about how to successfully maintain a rain barrel on a small scale. A timeline for the project's implementation plan is shown in Appendix D.

Recommendations

The implementation plan created during this project serves as the foundation for future placement of a rainwater catchment on the campus of Clark University. Accessories will need to be purchased for the rain barrel, depending on what type of irrigation system the landscape surrounding the barrel will require. If the water from the rain barrel is used for watering grass in that area, a pump would be necessary to in order to water the grass on a regular basis. Alternatively, in areas where landscaping or gardening is present, drip irrigation could be an effective way to irrigate the area around the rain barrel. These accessories could be funded with help from the Student Sustainability Fund. With our implementation plan, future groups at Clark University can make a rainwater catchment system on campus a reality. Students in future sustainability classes may also continue to expand this project as a part of the class. Anyone on campus will have access to this implementation plan and have an opportunity to continue our efforts towards installing a rainwater catchment system. Eco-Reps and Physical Plant were great resources for questions that we had about campus and rainwater catchment. Eco-Reps and Physical Plant also expressed interest in this project and should be contacted to evaluate their levels of interests when future extensions of this project occur.

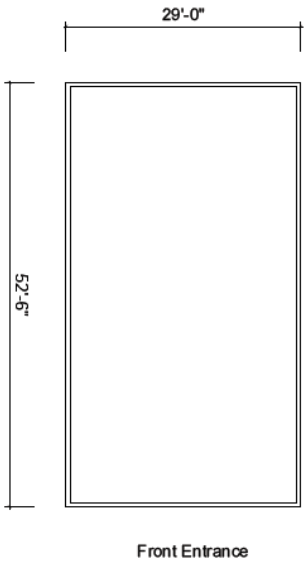
Appendix A: Roller Meter

Appendix B: Areas of Buildings, Estimates

Rainwater Catchement

Three Maywood Building

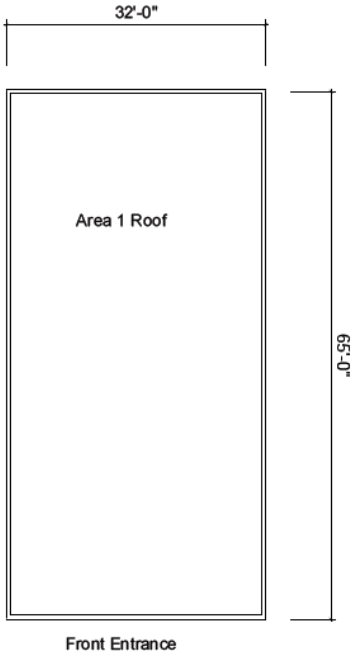
Total Area Roof Space
1522.5 Square Feet



Rainwater Catchement

One Maywood Building

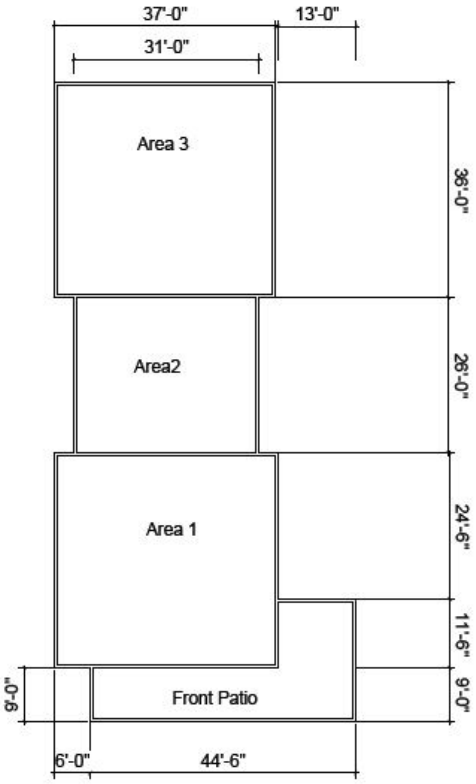
Total Area Roof Space
2080 Square Feet

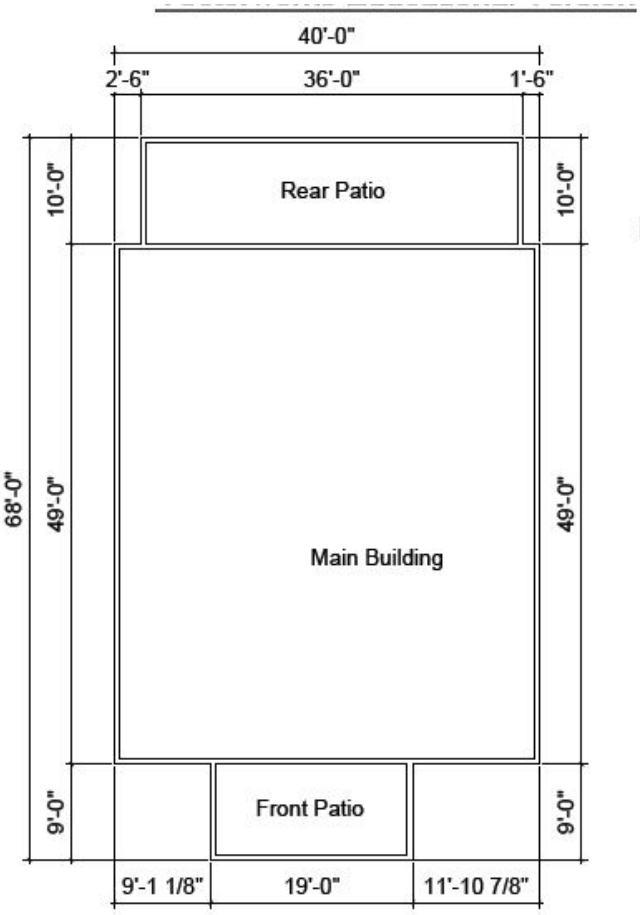


Rainwater Catchement

IDCE
#31

Total Area Roof Space
4074 Square Feet





Rainwater Catchement

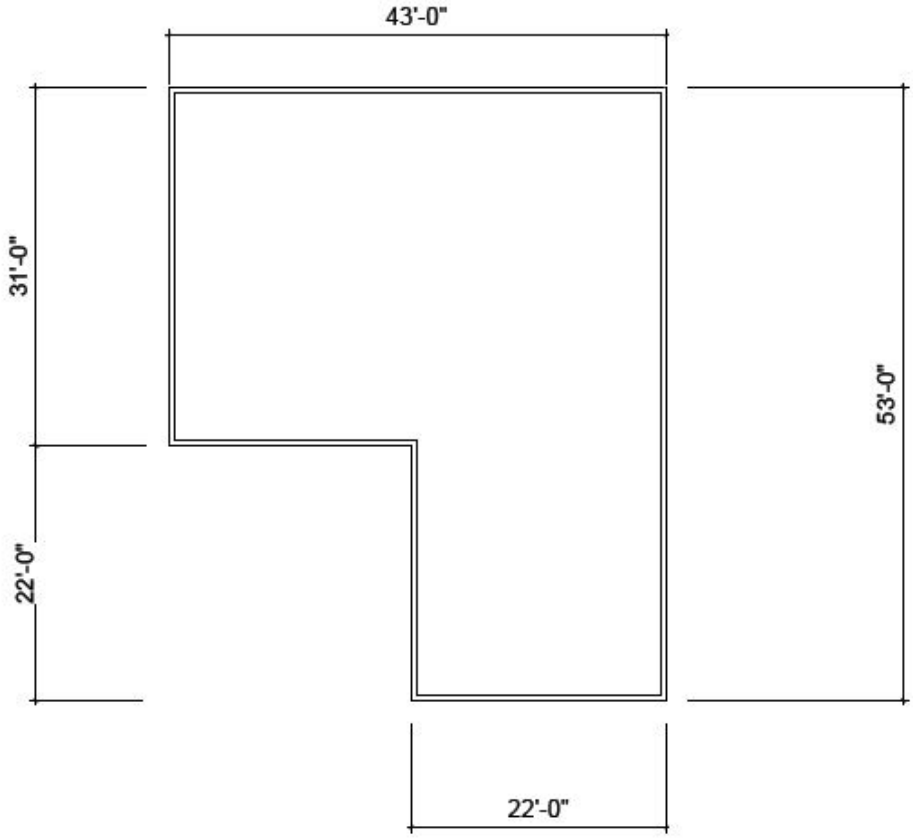
Cohen Lasry House
#13

Total Area Roof Space
2491 Square Feet

Rainwater Catchement

Corner House
#15

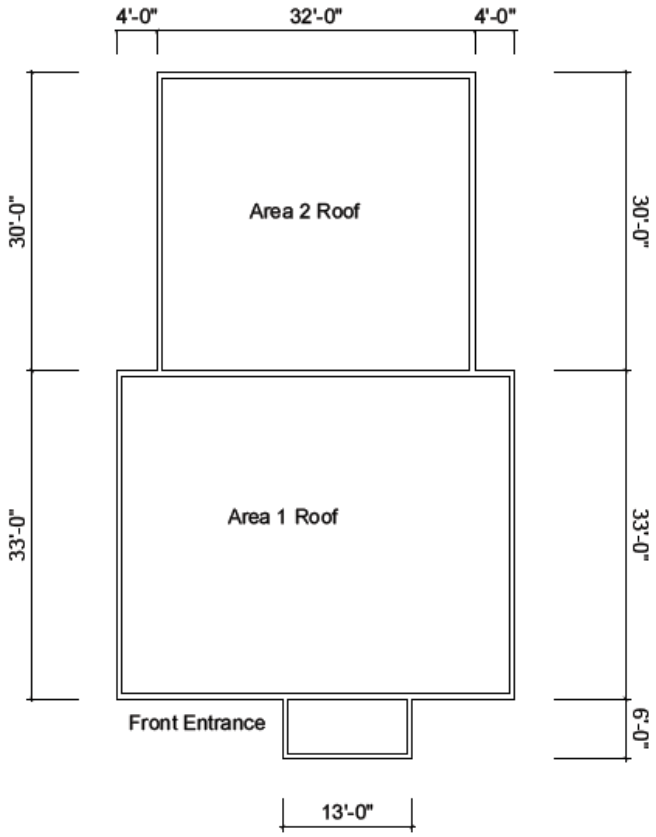
Total Area Roof Space
1817 Square Feet



Rainwater Catchement

Old Admissions Building

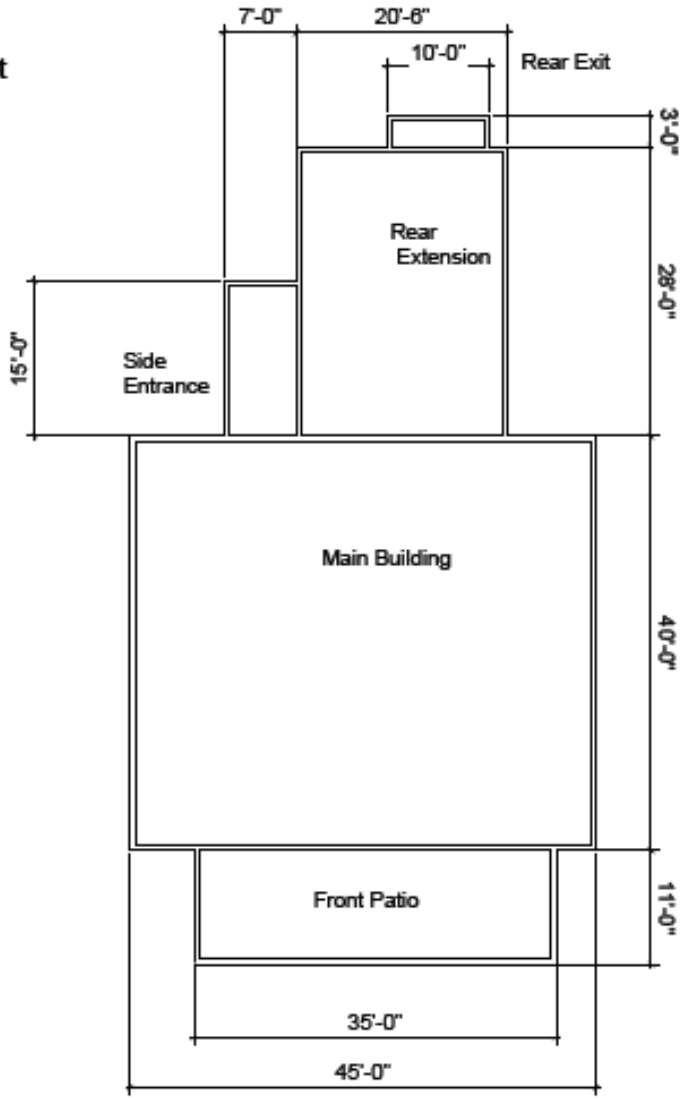
Total Area Roof Space
2094 Square Feet



Rainwater Catchement

Anderson House
#4

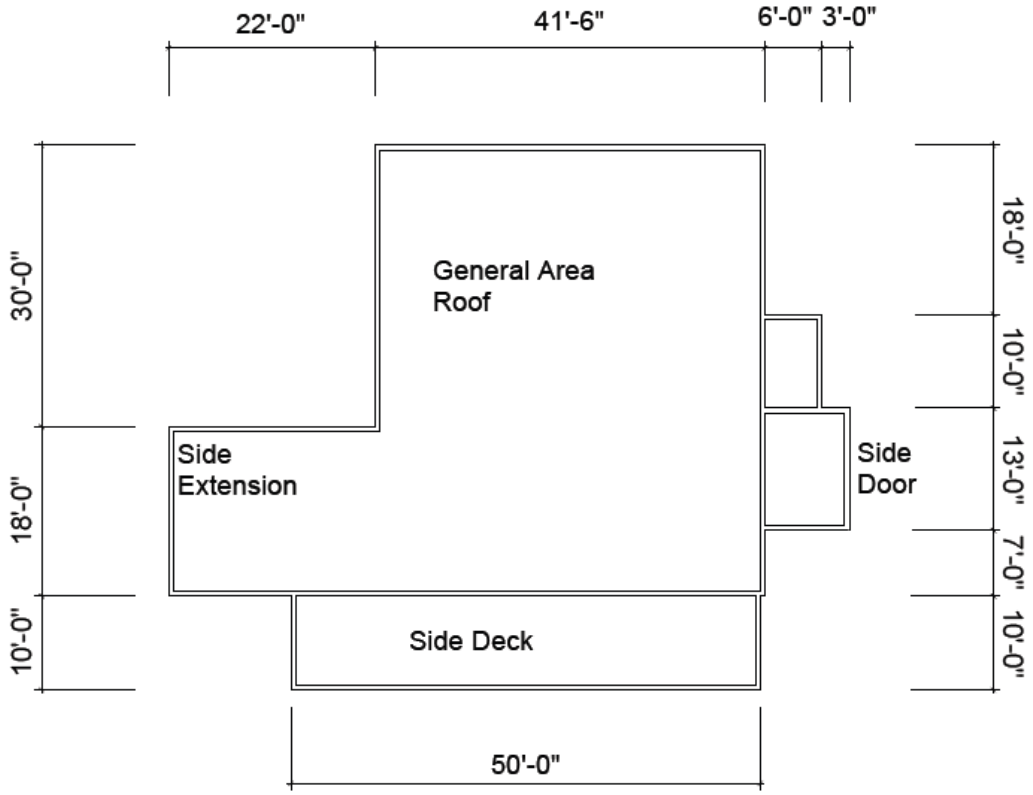
Total Area Roof Space
2894 Square Feet



Rainwater Catchement

Beck House

Total Area Roof Space
3480 Square Feet



Appendix C: Calculations

Potential Savings for Selected Buildings

Building	Roof Area (ft^2)	Amount of rainfall (ft)	Amount of water (ft^3)	Amount of water (gal)	Money saved ($) per 1 in rain	Money saved ($) per 49 in rain	Gal water collected per year
3 Maywood	1522.5	0.083	127	949	$4.96	$243.08	46505
1 Maywood	2080	0.083	173	1297	$6.78	$332.09	63534
Admissions House	2094	0.083	175	1305	$6.82	$334.32	63962

Actual Savings for Selected Buildings

Building	Roof Area (ft^2)	Amount of rainfall (ft)	Amount of water (ft^3)	Amount of water (gal)	Money saved ($)
3 Maywood	1522.5	0.083	7.35	55	$0.29
1 Maywood	2080	0.083	7.35	55	$0.29
Admissions House	2094	0.083	7.35	55	$0.29

Water Used per sprinkler

Sprinkler flow rate (gal/min)	Gal/day/ sprinkler	Gal/day/ 150 sprinkler	Gal/year/ sprinkler	Gal/year/150 sprinkler
0.16	9.6	1440	1200	180000
4.27	256.2	38430	32025	4803750

Cost per sprinkler

Sprinkler flow rate (gal/min)	$/sprinkler/ day	$/150 sprinkler/ day	$/sprinkler/ year	$/150 sprinkler/ year
0.16	$0.05	$7.53	$6.27	$940.85
4.27	$1.34	$200.87	$167.39	$25,108.83

Potential Savings

Sprinkler flow rate (gal/min)	Radius (ft)	Area (ft^2)	Gal/ft^2	Area 55 gal could provide	% water for irrigation
0.16	12	452	0.021	2592	3.82
4.27	30	2827	0.091	607	0.14

Appendix D: Implementation Timeline

Fall 2012: Finish rainwater catchment proposal

Spring 2012: Give the proposal to Eco-Reps to modify/work on to turn into administration

Fall 2013: Student Sustainability Fund Committee Application due September 14

Nov. 1, 2013: Expression of Interest Application (SSF) due

Nov. 30, 2013: Project Application/Budget Template (SSF) due

Spring 2014: SSF money allotted in the beginning of the semester, implement rain barrel

Passive Solar

A study of the usage and future of passive solar as a means of energy conservation on Clark's campus

EN103: Sustainable University
Professor Stephen McCauley
Fall 2012

Report Generated by:

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December 18, 2012

Abstract

The passive solar approach to energy conservation is a cost-effective way to move towards sustainability. Passive solar encompasses multiple design elements that aim to achieve efficiency, conservation, and improved health of buildings. It also utilizes technologies and human behavior in its approach in order to make buildings efficient solar collectors, heat storehouses, and heat traps. Passive solar is a cost-efficient way to reduce dependency on conversion technologies and move towards sustainability. Despite Clark's sustainable tendencies, total emissions at Clark are still growing at a rate of 1.2% a year which hinders Clark's goal of reaching climate neutrality by 2030 (Clark University Climate Action Plan, 2007). Our project is meant to move Clark closer to climate neutrality by spreading awareness of passive solar and setting the frame work for longer-lasting passive solar innovations and impacts to be felt on Campus. In order to do so, we conducted interviews with faculty and staff in order to establish current passive solar practices and views, observed shades and light use in Jonas Clark, and conducted a brief student survey on passive solar behaviors. From our data we were able to draw meaningful conclusions that help us lay the framework for passive solar incorporation on Clark's campus. With the incorporation of passive solar and education of its uses on campus, Clark can move towards becoming an even more sustainable university.

Introduction

Climate change has become a pertinent issue and choosing one ultimate solution is impossible. There is a need to research and invest in new technologies and power sources, but societies must assess their current energy consumption. Conserving energy helps reduce the overall emission output and can save money (Mass Save, 2012). The principals of passive solar aim at reducing energy consumption by harnessing the heat and light from the sun. Planning well designed buildings and using the buildings effectively can help contribute to the overarching goal of reducing climate change impacts. Passive solar can be implemented in any new or existing buildings, including the Clark University campus.

Clark's campus consists of buildings built at the turn of the 20th century and newer buildings from the last decade. Over a century ago heating and lighting buildings could be helped by planning a well oriented building with windows on south facing sides. The basic principles of passive solar can still be used today and help Clark achieve the goals proposed in the Climate Action Plan. Every step large and small will help, from building well-designed new buildings to instituting innovations and behavior changes in existing buildings. Older buildings on campus are still not energy-efficient compared with buildings constructed recently that have benefitted from green technology innovations. With the knowledge of passive solar Clark can combine old building techniques with the latest innovations in materials and technology to achieve optimal

building efficiencies. In order to promote these changes opening a space for conversations about passive solar was a necessary step.

Preliminary research identified faculty and staff members as extremely pivotal in the role of decision-making regarding windows and shades, so we decided to target them specifically. Further, because the staff and faculty at Clark will ultimately feel the longest lasting effects and benefit most from passive solar implementation, they will hopefully help advocate in support of passive solar building techniques. With the base knowledge acquired we can begin to recognize trends and obstacles to instituting changes on campus. Our project is the first step in achieving greater efficiencies and will help lay the groundwork for future projects related to passive solar.

The data we collect will hopefully be used to support the use of passive solar as a building technique on campus in the future. As a part of the Climate Action Plan, Clark plans to reduce its greenhouse emission by 20% from the 2005 levels by 2015. Because passive solar is such a simple and cost affective building method, it would certainly be invaluable building technique. According to a study done by The University of Arizona, implementing passive solar techniques, such as orienting a building with the longer facade facing south (or at maximum 15° from south) doesn't cost any more in initial or maintenance costs than it would cost if it were oriented without passive solar in mid. Furthermore, it has a pay back period of zero years. That is something that would be beneficial to the university. Clark is on its way to achieve the Climate Action Plan, and every small step that leads to a sustainable direction is an essential component of achieving the end goals.

Background

The passive solar approach to sustainability utilizes the sun's energy to heat and cool indoor spaces without use of conversion technologies in order to cut down use of other energy sources. Although passive solar has expanded in recent years, it is not a new concept. The Greeks and Chinese were the first to employ fully developed solar architecture and urban planning methods by orienting their buildings facing south to harness natural light and warmth (treehouse-serbia, 2009). In earlier years when there were no heating and cooling ventilation systems, passive solar was a practical way to control household temperature and lighting. Today, passive solar is viewed as a central component of sustainable energy design. The term passive solar had evolved to encompass technology, architecture and design and has become a part of green building initiatives and LEED certified buildings. Passive solar encompasses multiple design elements that aim to achieve efficiency, conservation, and improved health of buildings. It also utilizes technologies and human behavior in its approach in order to make buildings efficient solar collectors, heat storehouses, and heat traps. The main aspects of passive solar design as site, building orientation and shape, window placement, building color, glass design and solar greenhouse (University of Alaska Fairbanks, 2011). Within those aspects lies the recommendation that most windows face south, have a cool overhanging in the summer, be clear of trees and buildings that could obstruct sunlight from striking the building's surface, have high emissivity glass, dark exterior color, light interior color, and an optional solar greenhouse (University of Alaska Fairbanks, 2011).

Technology to utilize passive solar includes innovative shades of the appropriate size, high emissivity glass, solar greenhouses, overhangings, and proper insulation (US Department of Energy, 2000). Furthermore, the success of reducing dependence on fuels by using passive solar also relies on human behavior. Opening and closing windows and shades as well as turning off lights at the appropriate time of the day help reduce the use of other energy sources in a building. Therefore design, technology, and human behavior are all important elements of the passive solar approach.

Debates/Complexities

There is a prominent debate about costs and benefits of green building. There has been a widespread belief that green buildings, however environment and health positive they are, are substantially more costly than conventional building design. "This perception has been the single largest obstacle to the more widespread adoption of green design" and should be examined from a cost benefits perspective (Kats, 2003).

As green building becomes more widely adopted, there is a trend toward reduction in costs for such buildings. "Portland's three reported and completed LEED Silver buildings were finished in 1995, 1997, and 2000. They incurred cost premiums of 2%, 1% and 0% respectively. Seattle has seen the cost of LEED Silver buildings drop from 3-4% several years ago to 1-2% today (Kats, 2003)." Passive solar design could incorporate only the basic consideration of orienting windows to face south, which costs nothing. In densely populated urban areas it can be difficult to find areas without obstructed light from other buildings. On Clark's campus, there is increased land area, allowing major academic buildings to receive plenty of daylight. In the surrounding environment it can be helpful to choose deciduous trees that offer more light in the winter and have leaves return in the spring to offer shade in the summer. Beyond choosing to have your windows face south you can consider having well insulated windows and floors under the windows that absorb and reradiate sunlight. Although building and landscape renovations can be costly, it offers the opportunity to gain long-term savings in energy use for heating and cooling. "Buildings are also a major user of materials and energy. They account for as much as a third of all the flow materials (water, metals, minerals, et cetera) each year in the United States and are also responsible for 40 percent of the country's greenhouse gas emissions (Bainbridge, Haggard, 2011)." Choosing to design and build sustainable buildings can have a far-reaching impact on our environment.

Case Studies

There can be positive or negative sides for a solar project to be installed on campus. Actually, according to Kessler, the greatest single obstacle to a solar project is the upfront cost (Kessler, 2009). Depending on size and type of a system and how a system is paid for, the time to payback may be anywhere from 5 to 50 years (Kessler, 2009). This is the reason why there is no consistent data till now showing how a solar project installed on campus can save annual bill, because many on-campus solar projects are still calculating data to see if solar projects installed are real cost-effective or not. Besides the initial investment on solar panels, maintenance fee is the other obstacle many universities may consider and opt not to set up a solar project on campus. However, the motivation of building a solar array on campus is often a school initiative on sustainability.

University Context

Clark's energy needs are met by a combination of a central boiler, which heats the campus through steam and hot water and the cogeneration plant, a duel diesel and natural gas fuel system which provides the majority of the electricity on campus. As of 2005, total energy usage at Clark was 20,442 MTCO 2e, a figure Clark's Climate Action Plan has committed to reduce by 2015 (Clark University Climate Action Plan, 2007).

Although Clark is amongst the 'greenest' universities in the nation – 17th by The Sierra Club's Cool Schools 2011- there is still a vast amount of wasted energy at Clark and true improvements that can be made through building innovations and energy awareness – something our project aims to address (Sierra Club, 2011).

Despite Clark's sustainable tendencies, total emissions at Clark are still growing at a rate of 1.2% a year which hinders Clark's goal of reaching climate neutrality by 2030 (Clark University Climate Action Plan, 2007). Our project is meant to move Clark closer to climate neutrality by spreading awareness of passive solar and setting the frame work for longer-lasting passive solar innovations and impacts to be felt on Campus. Although Clark's energy system is efficient by today's standards, as 90% of our energy needs are created on campus by the co generation plant – a system which saves waste and uses fuel twice as efficiently by recapturing waste and using it for other energy purposes – and the central boiler system, ultimately, these systems still produce a large amount of CO2 and could be more efficient. The central heating and cooling plants have been identified as the largest contributors of emissions on campus and have been targeted in the Climate Action Plan as two major areas for improvement (Clark University Climate Action Plan, 2007).

To address this, Clark has "committed to a continuing and on-going review of energy options that reflect the anticipated further development of renewable technologies" (Clark Climate Action Plan, 2007). Our group plans to help this pursuit by raising awareness for the ability of the proper usage of passive solar to cut energy usage and costs. Because solar energy is one of the most potent forms of renewable energy we have today, the implementation of passive solar techniques in the classroom and office would be huge towards Clark's development of renewable technology and push towards climate neutrality. Specifically, our group plans to advocate for a larger role in the usage of windows and shades in classroom and office settings.

Clark is an ideal campus for the implementation of passive solar given the small campus size, commitment to renewable energy, considerably eco-aware staff and faculty. Several passive solar innovations have already been implemented at Clark through the 2005-2009 initiative to replace many on the windows on campus, install new airlock doorways and upgrade the HVCA system in Goddard Library in order to make heating and cooling more efficient. Our goal is to advocate for the proper use of these innovations and push for more innovations of this kind to happen in the future.

The introduction of a new concept however, often takes a good deal of time to manifest itself and catch on. This is one of the major caveats of doing an awareness campaign and something that could certainly hinder the manifestation of passive solar at Clark in the future. However, by establishing current practices of passive solar on campus, spreading awareness of the principles of passive solar and making recommendations for

future incorporation of passive solar methods, we are able to lay the foundation for a passive solar campus.

Process

Mission

This project is intended to increase on-campus awareness of passive solar technique in order to assist Clark University in furthering their energy efficiency. The team will analyze observational data as well as conduct informal interviews to gain an understanding of the current energy consumption of Jonas Clark. The project will utilize behavior change methods in order to produce a new energy outcome.

Objectives

1. Establish current practices of passive solar on campus
2. Spread awareness of the principals of passive solar
3. Provide the groundwork for future passive solar innovations

Tasks for Each Objective

1. Interview faculty and staff
2. Eco-Carnival presentation, and "Please De-Light Me" stickers
3. Conduct background research on passive solar design elements & technology and gather observational data on use of JC's windows, shades & light

Project Boundaries

We chose one building on campus as a case study. Jonas Clark is an older building where simple innovations for the use of current shades could greatly impact energy usage. The observational data was collected over the course of one academic week at different times of the day. Our interviews were done throughout one month at the times most convenient for participants.

Tasks Explained

1. Conduct informal interview with faculty and staff: We met with various faculty and staff to discuss different ideas and methods for using passive solar.
2. Survey Students at Eco-Carnival: At the Eco-Carnival held in Bullock Hall we provided background information about passive solar principles and practices. Students read our poster that detailed the principals of passive solar. We had another poster with the question "Do you consider the use of windows and shades as means to conserve energy?" The students could paint a symbol next to the options yes, no or maybe. This worked as an informal way to survey about twenty Clark students, with the majority of students saying maybe.
3. Record building observations of window and shade use: In the JC building we wanted to collect baseline information about current shade usage based on our own collected observations. Our goal is to have every room with lights off and shades down at the end of the day to help conserve heat within the room. During both daytime and nighttime we checked each classroom and a few offices to record our observations.

Target Population

- 5-10 randomly selected faculty and staff members: We chose faculty and staff based on conversation with Jenny Isler about the agency that faculty had versus students to control the learning environment. The staff we emailed worked in Jonas Clark, our study area, under different disciplines. Our response rate to randomly selected faculty was not as successful as we had hoped, which led us to email professors that we knew personally. Our sampling strategy once we met with professors was to inquire about their attitudes towards passive solar, any past personal usage or experience with passive solar, and their thoughts for the future usage and passive solar innovations on campus.
- Students attending Eco-Carnival: Our target population was any student who we could engage in conversation with. Our sampling strategy was to have each student mark down a yes, no, or maybe to whether they considered the usage of windows and shades towards conversing energy. The audience at the Eco-Carnival may have been biased towards agreeing with our survey question because fellow "green groups" came by to answer our question. However some students had never heard of passive solar principles and we tried to emphasize that they could answer our questions honestly and not just mark a maybe because many other students did.

Ethical Considerations

Deciding upon the nature and climate of the questions we would ask our target population and how we would reach out to this population. Although our class received IRB approval to send out surveys to the larger Clark population, as a group we decided informal interviews would be our best format.

Data Collecting Procedure

In the informal interviews we often attended the meetings in pairs. One team member could keep conversation going while the other person recorded responses to questions. Collecting data in JC was conducted both during the day when the sun was out and later in the evening after the sun had set. This was done in order to observe if the shades and lights are being used most efficiently during the two different times of the day.

Data Management Process

We gathered all interview notes to organize responses into trends. The JC data was organized into an Excel spreadsheet.

Data Analysis Method

We analyzed all interview notes and created a table, which allowed us to analyze the general opinions staff and faculty had for passive solar usage and innovation. The spreadsheet we made for the JC data allowed us to qualitatively analyze shade use by category. JC data resulted in 305 entries separated by daytime observations and nighttime observations. We broke down each time of day into the status of the shades and created pie charts to illustrate the results.

Results/Discussion

Faculty and Staff Interviews

As a group we conducted six interviews with faculty and staff, and short conversations with students at the Eco Carnival in order to gain an understanding of Clark Campus' knowledge of passive solar. We separated them into two groups: the faculty and staff group and the student group. According to responses from faculty and staff, we listed six key points serving our main goals and organized them into a table:

Table 1

Key Interview Findings	**Yes**	**No**
Background knowledge of passive solar	3	3
prior awareness of energy saving techniques	6	0
Prefer natural lighting	5	1
like current design of buildings and offices	1	5
want improved design of buildings and office space	5	1
In support of de-light me stickers	5	1

We can see from Table 1 that although only half of the participants of faculty and staff had prior knowledge of passive solar, we found that all of them had embraced prior energy saving techniques in their daily lives. One interesting finding is that the majority of faculty and staff wanted improvements to existing building design. They pointed out a lot of office designs on campus with heating and air vents near the windows, which blocked heated air from coming up. Others mentioned that in north facing offices and classrooms that lights were necessary during most of the daylight hours. A simpler problem was about the layout of rooms with desks being oriented in front of windows and this caused a glare when using computers. Thus most of them wanted improved design of buildings and office space on campus.

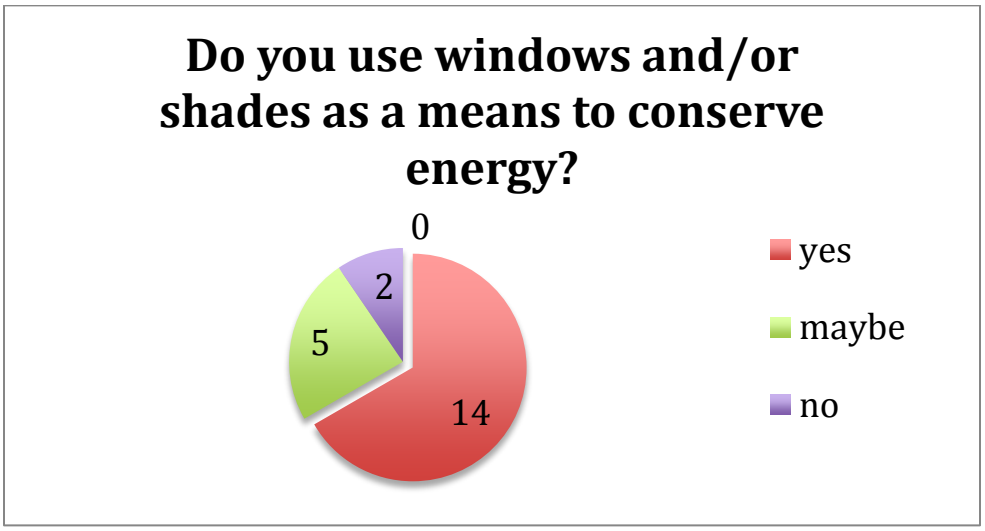
The majority of participants stated that they preferred natural lighting because they have to read for a long time and natural lights are better for their eyes. Half of the participants admitted that they gave greater consideration to energy use in their homes than their offices. One reason why faculty and staff paid more attention to energy use in their homes was because they have complete control over their space, and the second reason was that they do not have to be as mindful about conserving energy in their work space. In class faculty members mentioned that shade and light use depends on the type of media and the requests of students. One faculty member stated knowing what was better for their students and therefore would turn off overhead lights and open shades to let natural light in during the day. At the end of each interview we mentioned the use of "de-light me" stickers as a method to remind people about light use. Faculty and staff agreed the stickers would help create mindfulness about energy use and conservation.

Eco-Carnival Brief Student Survey

To gather more information, we took the opportunity to present principals of passive solar to students at the Eco-Carnival. We found that only a few students had prior knowledge of passive solar, but all were open to learning about it during the Carnival. Our interactive piece was a question about students daily shade use and if it is connected to conserving energy. The majority of students chose to select yes for their answer. Some claimed they currently practice energy saving techniques and others interpreted the

question as a future goal they would aspire to. Chart 1 shows the responses to the question we set:

Chart 1



Jonas Clark Observations

Our last set of data collection focused on existing practices of shade and light use in Jonas Clark. We conducted observations across one week at different times of the day so as to have data from when the sun was out and when the sun was set. From our excel sheet of 305 observations we were able to analyze current shade practices. Our charts are shown below.

Chart 2

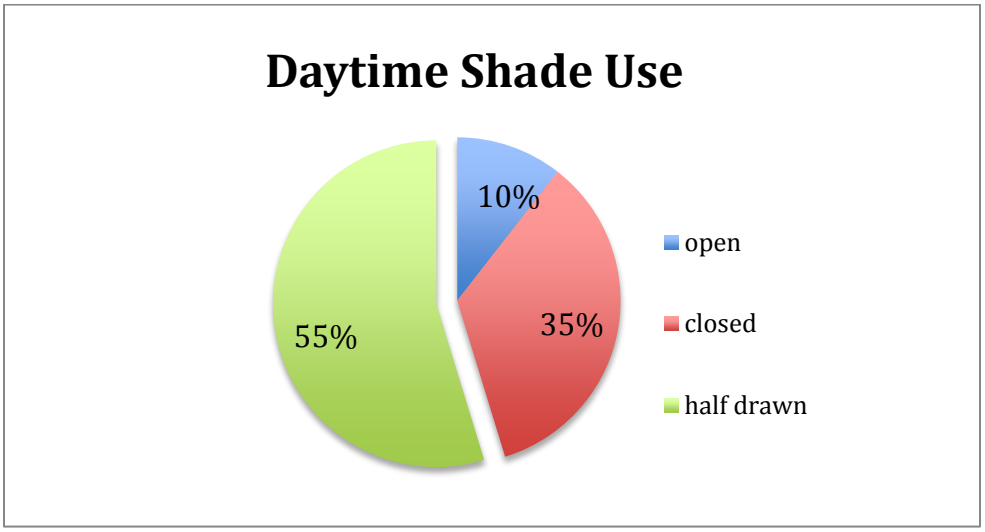
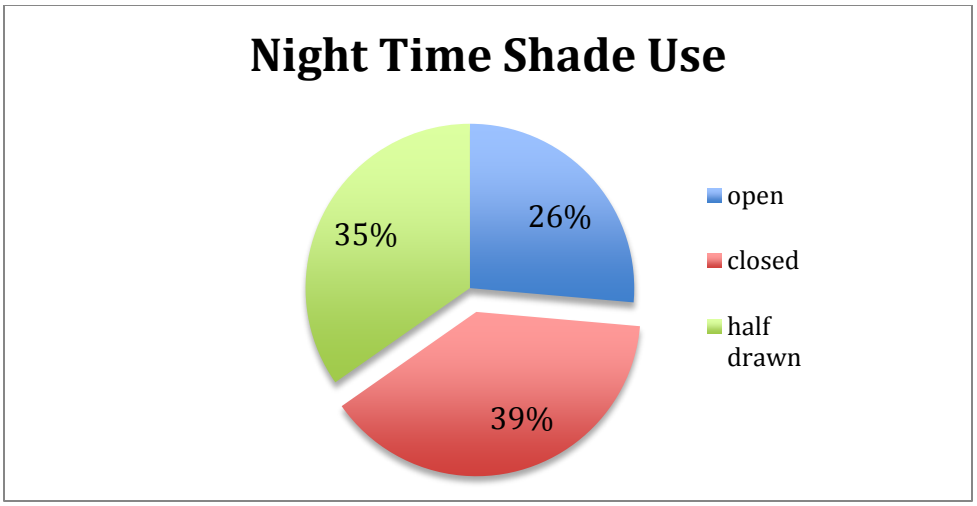


Chart 3



Source: from passive solar group of sustainable university 2012

We found that most shades were half drawn during the daytime while most shades were closed during the nighttime. From our observations, it was clear that staff and faculty close rooms for the night by shutting off lights and closing shades. The light data showed us that light use is considered more often than shade use during the night and day.

Discussion

It is evident from the faculty and staff interviews that most are aware of the important of utilizing energy saving techniques in their daily lives. However, it is concerning that only half of faculty and staff interviewed had knowledge of passive solar. Even then, not everyone who had the knowledge applied it to his or her daily practices. Therefore, there needs to be increased awareness of passive solar on campus. This could happen in the form of a behavior change campaign with informative presentations, pamphlets, and other forms of social outreach. One approach to passive solar outreach that was particularly favored by faculty and staff is the increased presence of the "Please De-Light Me" stickers that are on a few light switches on campus. As one staff member said, there are "two groups of people": those who don't pay attention to energy conservation and those who "just do," as if by nature. For those who don't pay attention to it, constant reminders like stickers on the light switches or informative signs by the windows on how to properly use shades could be useful in helping form lasting habits.

One other key finding from the interviews is that most faculty and staff paid more attention to energy use in their home spaces. The heightened awareness of the need to conserve energy at home seemed to be directly related to cutting down energy expenses. This is not the case for most faculty and staff on campus, who are less aware of the impact of their daily habits with lights and shades. In order to make strides with passive solar on campus, it is important to increase faculty and staff awareness of the relationship between their classroom/office behaviors and energy consumption.

Recommendations/Design

The "de-light me" stickers were created before our proposed project, and have been a great tool to pass along. Simple stickers on paper towel dispensers, light fixtures, and recycling bins are a creative way to pass along important information

about sustainable practices. Another sticker our group would find helpful involves illustrating correct shade use. Shades are a low-tech option for climate control of rooms, seasonality and time of day are key factors to shade use. We would propose that each office and classroom come equipped with a simple diagram about opening shades fully during the day to let in light and heat and closing the shades at night to conserve thermal mass during the winter months. The opposite would be true for spring and summertime use.

A major component of our project was opening a space for conversation with faculty, staff and students. Collecting more feedback and possibly holding a forum for Clark University students, faculty, and staff about future building designs would be a great next step. The feedback from faculty and staff focused on improving office and classroom spaces. Examples of glare caused by screen orientation to windows was a possible area for improvement, which could help highlight considerations for layout of rooms to maximize natural lighting options. Beyond lighting reminders it is beneficial to examine shade use at Clark.

Our campus could invest in using two types of shades that are appropriate for the seasonality changes we experience in the northeast. The new white, lightweight shades are useful in summer to reflect back sunlight and keep rooms cooler. "For greater efficiency, use dual shades—highly reflective (white) on one side and heat absorbing (dark) on the other side—that can be reversed with the seasons. The reflective surface should always face the warmest side—outward during the cooling season and inward during the heating season, and they need to be drawn all day to be effective (US Dept. Energy, 2012)." In the winter shades that insulate the window during the night are helpful for energy conservation. There are honeycomb shades, quilted shades, and drapery options. Creating a tight, custom fit shade helps to insulate windows. "Drapes that are snug against the wall and block vertical airflow as well cut heat loss up to 25% (Green Energy Efficient Homes, 2012)."Within the next year a CBA (cost benefit analysis) of purchasing winter shades could offer helpful analysis for the proposed plan.

Window treatments at Clark could combine the use of existing white shades with draperies for winter and summer use- "During summer days, you should close draperies on windows receiving direct sunlight to prevent heat gain. Studies demonstrate that medium-colored draperies with white-plastic backings can reduce heat gains by 33%. Draperies also stay cooler in the summer than some other window treatments because their pleats and folds lose heat through convection (US Dept. Energy, 2012)."

Our feedback and results show that shade use in rooms is arbitrary, while light use is considered as a way to conserve energy. Spreading awareness about the simple changes of shade usage will help to promote passive solar behaviors on campus. The faculty, staff and student body were open to learning about the energy conservation achieved through passive solar techniques and with a wider reaching awareness campaign we would hope to see changes in shade use. Our observations conducted in Jonas Clark are the basis for deciding more awareness about shade use is necessary. This awareness can be spread through conversations, forums and posted reminders next to windows.

Conclusion

Our ambitions for this project were to investigate the current use of passive solar on campus through the observation of window and shade use in JC alongside interviews with faculty and staff members on campus. By doing this, we hoped to establish the ground work for a culture of passive solar at Clark which would plant the seed for future passive solar building innovations. At the conclusion of the projected we learned that passive solar is not yet a technique which is widely used at Clark but members of the Clark community are very interested and willing to learn more about to concept. In order to turn this interest into action, our group has recommended the implementation of subtle reminds – such as the 'de-light me' sticker above light switches - to turn off lights and close shades when not in use. By encouraging the Clark community to be cognizant of their light use through cheerful, passive methods, our group is helping to decrease energy use on campus wide while setting the group work for future building innovations which will help decrease energy use on campus even further. By laying the groundwork for passive solar to be a topic which is talked about throughout the Clark community, our group is helping in a small way to make sustainable energy techniques something which are encouraged and treated as second.

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Green Office Certification Program

Submitted to

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IDCE, Clark University

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A Report

Submitted in Fulfillment of the

Class Requirements of

SUSTAINABILITY & HIGHER EDUC - IDCE 30185 – 01

Clark University

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Abstract

Universities have been playing an important role concerning dealing with problems posed by global warming; Clark University has had a long history of environmental engagement. This program is intended to develop "a green office" at Clark University with seven sustainable wheels that acts according to global bio-capacity, understands economic and environmental prosperity, respects the immediate values and recognize future needs, ultimately supports Clark carbon neutrality 2030. This research successfully met two objectives that include the development and pilot of green office certification program at Clark University and identification of the challenges of the green office certification program. Based on universal practice and Clark University requirements, the "Green Office Certification Tool" identified seven wheels of "green office. Forty-seven green office tools from various universities, more than thirty emails and phone interviews and two pilot studies at Clark made possible the development of the green office tool. We have innovated seven green wheels of a green office that will support sustainability at Clark University and elsewhere. This innovation is a step forward over other sustainability rating practices as such green office programs in other universities. Many other sustainability-rating tools rate an office or a building as a whole and ignore the opportunities of green practices available on specific categories. The innovation of this tool is to accept the sustainability practices in each category. This means an office can be "green or sustainable" by either energy use wheel or water use wheel, waste management wheel, Networking, Leadership, and Participation wheel, transportation wheel, convenience wheel, and kitchen wheel. This tool considered both the LEED and STARS credit system along with other universities practice focuses on impacts as well as sustainability actions.

1. Introduction

Greenhouse gas emissions are major contributors to climate change, which is one of the most serious problems of present generation. Greenhouse gases are generating from burning fossil fuels including natural gases, oil, and coal for energy generation, landfill, and other activities. In the U.S., buildings consume 40% of total energy use for a wide range of purposes like heating, cooling, and lighting systems (Seltzer 2012). Landfilling is one of the common ways of municipal solid waste disposal. Air pollutants emitted from landfills contribute significantly to the amount of greenhouse gas emissions. For example, methane emission from landfill accounts for 15% of current greenhouse gas emissions (Chalvatzaki and Lazaridis 2010). In term of architecture, a sustainable building using energy, water, and materials more efficiently than a common building has been considered for recent and future buildings (USGBC 2010). A sustainable building has emerged as a promising solution. There are a variety of standards for sustainable buildings like site development, water efficiency, energy efficiency, waste reduction, materials and resources, and indoor environmental quality (EPA). Behavior change has emerged as an imperative component of carbon dioxide emission reduction strategies by minimizing energy use, waste, and improving energy efficiency. Increasing material consumption and waste generation is growing concern globally; only in the United States, 209.7 million tons of municipal solid waste is generated (USGBC 2010) annually. Waste reduction is by consuming less or in an efficient way not only saves money but also protect the environment (EPA 2002). Energy use and waste management are an important component in sustainability circle; both make a big impact on the environment.

Universities have been playing prominent role in change making and improvements of goods and services for human and non-human animals and plants. Universities are taking leadership in sustainability being a hub for wise and scholars. In 1990, the president of Turf University, John Mayer participated into the first conference of 22 universities in France to discuss what the role of universities would play to achieve a sustainable future (Seltzer 2012). In the United States, the American College and University Presidents' Climate Commitment (ACUPCC) established in 2006 to network higher education institutions with two goals; reduce greenhouse gas emission from campus operations; and promote sustainability programs by educating students and creating solutions.

The Association for Advancement of Sustainability in Higher Education (AASHE) developed the Tracking, Assessment Rating Systems, which was "designed to provide the framework for understanding sustainability for all sectors of higher education (STARS 2012). STARS and "Green Office Programs" adopted by many universities in the United States contributing an effort to curb greenhouse gas emission. Integration of environment and sustainability related courses by universities not only engaging students and scholars in the global sustainability marathon but also preparing green leaders. Clark University has been involving in environmental issues for a long time (Clark 2012); in 1970s, Clark demonstrated its leadership in the area of technological change to save energy (DeCarolis, Goble et al. 2000). It offered and provided institutional mechanism for supporting sustainable activities in Clark through offering courses, running initiatives, and research on sustainability. Clark has tracked and reduced carbon emissions since 2005 (Seltzer 2012). In June 2007, Clark University signed the ACUPCC (Clark 2009). As a result, Clark University became a charter signatory to a national initiative, which has commitment to reduce carbon emissions. In 2009, the Climate Action Plan was approved by the Clark University Board of Trustees with the two goals including to reduce carbon emission by 20% below 2005 levels by 2015 and to achieve carbon neutrality in 2030, one of few schools to choose such an early date (Clark 2009). Regarding waste treatment, there are many green activities implementing by students and faculty in campus. Clark has its own sustainable commitments which focus on three aspects (Clark 2012). Preparing student as responsible citizen of the world; encouraging faculty and students to conduct environment-related research are two important aspects of Clark sustainable commitments. Most important aspect is to realize carbon neutrality in Clark University, which requires active participation of students, faculty and university authorizes. Green office programs at Clark, a practice of real sustainability, possibly help to achieve this arena of sustainable commitments.

Recently, like many other colleges, Clark is promoting behavior changes to minimize ecological footprint through organizing a sustainable competition, providing green tips at Clark Campus, sustainable policies (building heating policy, building design policy, commitment to sustainability), and many other practices. Students and faculty in Clark have conducted sustainable projects and researches. These projects have been concerned about energy use through change behavior. In 2010, the sustainable competition between residence halls in Clark Campus with an aim to educate students how to save energy through change behavior helped to

identify opportunities of sustainability. Consequently, during the competition time, seven of nine halls decreased electricity consumption. With regard to waste treatment, putting recycling bins in halls contributed to reducing 22% landfill of the total hall waste. An action of raising awareness in saving energy and reduce waste, Clark initiated energy saving CFLs campaigns, employing recycle bins in common places. As regarded many other universities, green office certification is emerging as a promising way to promoting the behavior change to reducing energy consumption, water using, and waste, and improving energy efficiency.

Clark Campus has 53 departments and program offices, which have work stations located in different buildings. The occupants working in these offices are the major decision-makers regarding energy use and waste production. A pro-environmental behavior change; reducing carbon emission among occupants in offices, sustainable competitions or green office certifications in Clark Campus will potentially add value to sustainable initiatives. A green office audit tool is important to establish a baseline of practices and behavior change, which will contribute to minimizing ecological footprint in Clark. Therefore, an appropriate green office audit tool, which determines how green an office, is essential to encourage people to participate in environment friendly life style.

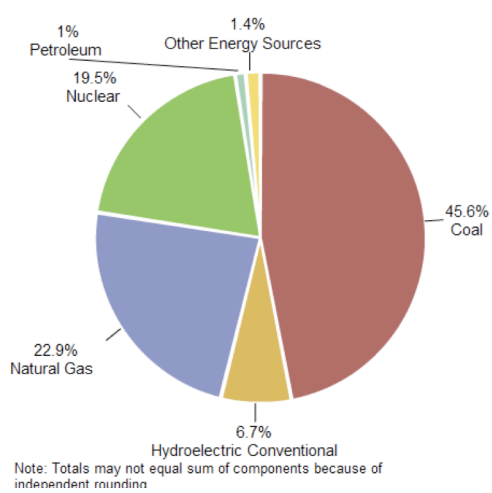
2. Background

2.1 Energy use in the U.S

Human Development Index (HDI) and electrical energy have a strong correlation with each other (Mechtenberg, Borchers et al. 2010). The higher the HDI is, the higher the reliability and availability of electricity countries will be. For example, in many high HDI countries, the reliability and availability of electricity is approximately 95%; in contrast, the low HDI countries, those vary from 5 to 50% (Mechtenberg, Borchers et al. 2010). In 2011, the US was the fourth highest HDI in the world (Keim 2011). Therefore, it is likely that all the US citizens are accessing electricity. In 2008, the US was the biggest electricity consumption country at 4,401,698 GWh (worldfactbook 2009). The most energy in the world comes from fossil fuels. For example, some 83% of the total nations' energy come from fossil fuels, 8% energy is generated from renewable energies, and 9% is produced from nuclear energy (CSS 2011). Like many other countries, the energy in the US primarily comes from fossil fuels (coal 45.6%, natural gases 22.9%) (EIA 2010). The US is one of the biggest polluters in the world by greenhouse gas emission. The fossil fuel-based power plants emit a huge amount of greenhouse gases including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofuorocarbons (HFCs), perfuorocarbons (PFCs), and sulfur hexafluoride (SF_6). Moreover, many hazardous, toxic gases generated from power plants are responsible for killing many lives. All these gases contribute significantly to global warming, air pollution, acid rain, and other environment issues.

There are many sectors, which consume energy including manufacturing energy consumption, residential energy consumption, and commercial building consumption. The building in the US consumes 40% of US primary energy use and 72% of electricity consumption (USGBC 2010). Human life has become much more convenient due to technology

Figure 1: The Sources of energy in the US (EIA 2010)



innovation, scientific achievement, and economic growth. Offices are equipped and installed with a full range of devices, appliances that make people's life better. Temperature in buildings are always adjusted around 65- 75 ^{0}F, even outside temperatures are above 90^{0}F or below 40^{0}F. Every building received heating and cooling systems. Offices are equipped many energy-consuming devices like printers, photocopy machines, computers, lighting systems, microwaves, fridges, and electric kettles which consume significantly energy in buildings. For example, Clark University, in 2004, 9.27 kilowatt hours of electricity were consumed per square foot of campus buildings (Stephen 2011). Consequently, buildings ranked at top in energy consumption and generating a significant portion of greenhouse gas emissions. In the US, the buildings are responsible for 38% of all CO2 emissions (USGBC 2010). Reduction of energy consumption in buildings will contribute significantly to reducing greenhouse gas emissions and saving money. To meet the aim of reducing energy consumption, buildings tends to be renovated to become sustainable buildings which save energy and use energy efficiently. A sustainable building is a term, which means a building satisfies water efficiency, energy efficiency, waste reduction, materials and resources, and indoor environmental quality.

2.2 Sustainability and Universities

Schools have become a lead community which has paid special attention to the pursuit of sustainable programs, which reduce energy consumption and carbon emissions. In 1990, the first official statement about the commitment of sustainability signed by more than 429 universities from 52 countries in France made foundation of universities' commitment in sustainability. In the US, there are over 4,300 universities and colleges which always include many departments and office programs within buildings in a campus (Seltzer 2012). The American College and University Presidents' Climate Commitment (ACUPCC) was established in 2006 to network higher education institutions with two goals: reduce greenhouse gas emission from campus operations and promote sustainability programs by educating students and creating solutions. For example, schools provide funds for sustainable projects. The AASHE developed the Tracking, Assessment Rating Systems (STARS), which was "designed to provide the framework for understanding sustainability for all sectors of higher education. (STARS 2012).

Many universities have invested a lot of money to renovate buildings or constructed new buildings which save energy or use energy efficiently. Stanford University is the quintessential example of university that invests on buildings with purpose of becoming sustainable buildings. Sustainable buildings would be a promising solution, which contribute significantly to the reduction of greenhouse gas emissions in schools.

Another solution of the sustainable program in schools is to reduce waste through changing users' behavior. Waste treatment becomes a common strategy in the green office program in schools. The most common wastes in campus buildings are paper, plastic, deliverable items, foods, and used devices. Reduction of building waste contributes significantly to environmental sustainability. For example, 7,000 gallons of water, 4,100 kilowatt-hours of energy, three cubic yards of landfill space, and 17 trees will be saved if one ton of paper is made completely from recycled scrap (Seltzer 2012). In 2011, the research in Clark indicated that recycling and composting 443.54 tons of material led to save a total of 5,553.12 Million BTUs. This is equivalent to 651.66 barrels of oil, 30,422.43 gallons of gasoline, or 55 average cars off the road for a year is saved (Obermeyer 2011). The goal of promoting sustainability within the building is to achieve behaviors and practices, supports an office environment in which occupants strive towards a more sustainable state of mind and practice.

2.3 Clark and Sustainable Initiatives

Clark has had a long history of environmental engagement. Since 1970s, Clark has made technological change to save energy (DeCarolis, Goble et al. 2000). An effort to conserve energy in 1971 by installing spring-loaded lighting controls in library stack sections by physical plant's staff is a departure gate of Clark engagement in environment and sustainability. The switching from carbon-high fuels to carbon-low fuels resulted in the reduction of carbon emission between 1970 and 1980. The heating system improved by computerizing system to control the steam flow to campus buildings resulted in increased the efficiency from 60% to 80% (DeCarolis, Goble et al. 2000). In June 2007, Clark University signed the ACUPCC (Clark 2009). As a result, Clark University became a charter signatory to a national initiative, which has commitment to reduce carbon emissions.

In 2009, the Clark University Board of Trustees approved the Climate Action Plan. Slowing Clark's emission growth through footprint management was one of the missions of this plan (Clark 2009). This plan has primarily focused on improving energy efficiency through renovation. For instance, the first stage (2010 – 2015), the action plan focused on major energy consumption systems including cooling and heating systems. An investment grade audit conducted by Clark and its consulting firm focused on the central heating plant, distribution of hot water, decentralization of heating loads from the central heating plant, and fuel switching from oil to natural gas for heating purposes. Consequently, the central plant renovation, distribution system replacement, and fuel switching to natural gas will reduce greenhouse gas emission over 3,439 $MTCO_2e$ (Clark 2009). The fuel switch using alternative energy sources (bio-diesel, solar, fuel cells) instead of traditional energies (natural gas or oil) also exists in Clark University action plan. Energy and water efficiency have improved by recent capital investments throughout campus, such as motion sensors and dual flush toilets.

Clark has committed to all future buildings and renovations to obtaining LEED certification. The US Green Building Council awarded the Gold LEED certification for the Lasry Center for Bioscience and Silver LEED certification for Blackstone Hall. The Clark Building Heating Policy indicates that Clark is a leading sustainable university for heating or cooling policy. While other universities set up 70 – 75^0 F in winter months, Clark sets up 68 - 75^0 F (Clark 2012).

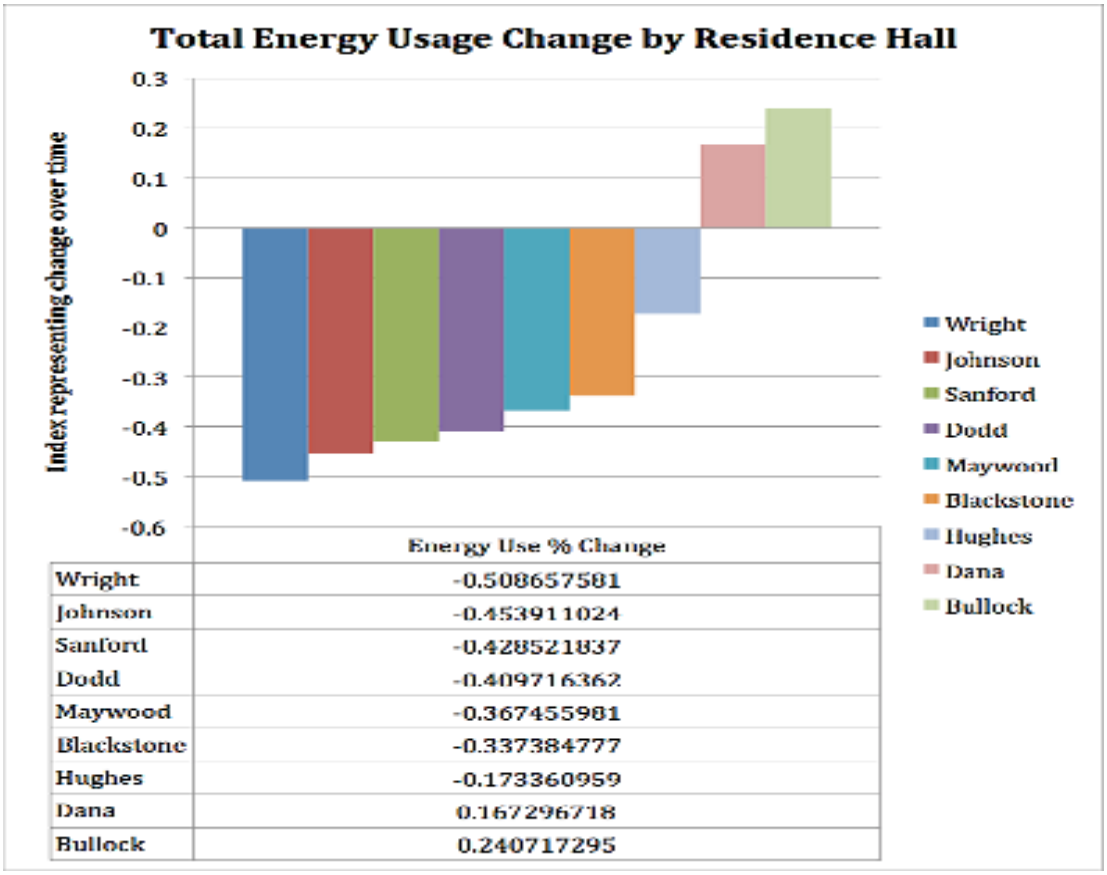
In the academic year 1971 – 1972, Clark introduced a new course which was related to energy usage named "Science, Technology, Society" STS which is the promising institutional involvement in sustainability. Clark offered and provided institutional mechanism for supporting sustainable activities in Clark through ordering sustainable courses, running sustainable initiatives, and research on sustainability. Students can choose from among 130 interdisciplinary courses or get involved in extra-curricular activities such as Eco Reps, while Clark's sustainability-focused institutes and programs (Marsh, Mosakowski, IDCE, CENTED, HERO) provide applied and action research opportunities for students on campus, in the community and across the globe.

The Thrift Store at the Clark University contributes significantly to decrease waste for landfill and saves a lot of money. In an academic year, 2011 – 2012, the thrift store sold nine

tons of donations. A collaboration of the Eco Reps, Recycling Crew, and the Clark Sustainability Collaborative to collect and store in a weekly basis moved 22% landfill to recycle bins.

In 2010, a sustainable competition was organized to educate students about energy consumption and promote energy-use reduction within residential halls in Clark Campus (Fitzegerald, Frias et al. 2010). Consequently, the project group found the seven of the nine residence halls decreased the energy consumption (figure 2). It is likely that the behavior change's users contribute to improve energy efficiency within these halls. Technological innovations and improvements, along with pro-environmental behavioral change, are largely affecting the sustainability at the Clark University; and are receiving limelight at Clark Climate Action Plan.

Figure 2: **Total energy usage change by residence hall during sustainable competition time in Clark University**



	Energy Use % Change
Wright	-0.508657581
Johnson	-0.453911024
Sanford	-0.428521837
Dodd	-0.409716362
Maywood	-0.367455981
Blackstone	-0.337384777
Hughes	-0.173360959
Dana	0.167296718
Bullock	0.240717295

Source: (Fitzegerald, Frias et al. 2010)

2.4 Sustainability Indicators/Green Office Categories

The word "green" is so trendy in environmental movements; nevertheless, an exact definition is remaining vague. In many cases, the word green is synonym for earth-friendly technology, behavior, and actions, which cause low or no harm on the earth. The sense of green and/or greening is different for different sectors but the basic understanding is to minimize the human impact on the earth. The definition, description, generalization, validation, prediction and adoption of "green" or greening" is evolving slowly. Greening is viewed, as process by which human activity is made compatible with biospheric capacity, is absolutely the most important phenomenon of our time, as human survival literally depends on it (Fischer and Schot 1993). Re+ words, such as reduce, recycle, reuse, rethink, recharge, and so on, are associated with the definition of green. As a sprouting and " big idea of general usefulness," green/greening is or involves all of the sectors from all dimensions, at one and, the same time (Rodale and Robert 1987). Several scholars range the ambiguity of "green" in a dynamic system, embroiling cognitions, emotions, and behaviors (Gladwin 1991). In addition, the green office is mixed up of greening by thinking, feeling, and behaving.

The concept of sustainable development is mostly discussed and practiced around the three principles; environmental integrity, economic prosperity, and social equity (Elkington 1998). Based on this principal many sustainability measurement tools have developed that are in practice to measure the impact of human beings and their activities on this planet. We have studied several sustainability-auditing tools to identify the major categories of an office that matters for Earth's sustainability and office operation.

LEED (Leadership in Energy and Environmental Design) is a voluntary, consensus-based, market--driven program, successfully established in 135 countries measures an impact of building. The three key principles of the sustainable development that have been addressed in the LEED program, incorporate, leadership, innovation, environmental stewardship and social responsibility in. The sustainability indicators are categories as sustainable sites, water efficiency, energy & atmosphere, material & resources, indoor environmental quality, and innovation & design process in the LEED program. These categories reflect the strategies that minimize the impact on the planet, increase performance of energy and other building's

activities, reducing waste, and promote better indoor air quality and access to daylight and views (USGBC 2012).

The Sustainability Tracking, Assessment & Rating System (STARS) adjusted their sustainability ratings in three categories. The first category "Education & Research (ER)" includes mainly curriculum, research, sustainability educators program, outreach campaign, orientation, materials and publications, enterprise, events, courses, incentives, promotions. The second category "Operations (OP)" reports the, indoor air quality, greenhouse gas emissions inventory and reduction, dining services, food and beverage purchasing, vegan dining, pre-and post-consumer food waste composting, clean and renewable energy, lighting sensors, LED lighting, tree campus, cleaning product purchasing, paper purchasing, bicycle, mass transit, telecommuting and etc. The final Category "Planning, Administration & Engagement (PAE)" documented sustainability coordination, climate plan and community service participation.

Many universities have developed the program green office and its certification required and suitable for specific university, in accordance with attitude, behavior, and practice on goods and services use. In case of green buildings, there are many definitions, which are acceptable at international level. EPA, define *green buildings* as the practice of maximizing the efficiency with which buildings and their sites use resources—energy, water, and materials—while minimizing building impacts on human health and the environment, throughout the complete building life cycle—from sitting, design, and construction to operation, renovation, and reuse.

We identified biodiversity, energy, recycling, transportation, purchasing, and kitchen, participation networking, as indicators of sustainability in 47 green office programs across the world include the United States, Australia, and Canada. As such, Australian National University in Australia biodiversity, energy, water, paper, pollution prevention, recycling, transport, outreach and evaluation whereas Harvard University, USA recognized energy, recycling, waste reduction, publications, events, transportation, kitchen, purchasing, and participation in their Green Office Programs as sustainability indicators. The description of some of the sustainable indicators is as below:

- Energy use: In the United States, the commercial sector, including office buildings, generates a significant share of greenhouse-gas emissions. In fact, companies have to

spend over 30 percent of a company's operating budget for energy use while office buildings contribute 20 percent to the nation's total greenhouse gas emissions (Energystar 2012). According to the Saving Calculator for Energy Star Qualified Office Equipment provided by EPA, one energy star desktop computer can save 20.8 kWh per year that will save $5.3 and reduce 32 pounds of CO2 (Figure 3). Many researchers concluded that energy star appliances could save around 33% of power consumption. In four years of lifetime, a computer will save 83.1kWh and reduce 128 pounds of CO2. A computer at sleep mode consume still 29% power and at off and plugged condition consume 4% of power when not in use (Meier 2012). Standby power in commercial buildings is roughly responsible for 1% of global CO_2 emissions (Lebot, Meier et al. 2000).

CFLs (compact florescent lamps), an energy-efficient lamps use 75% less energy than a standard incandescent bulb and last up to 10 times longer. It is found in a research that replacing a 100-watt incandescent with a 32-watt CFL can save approximately $30 in energy costs over the life of the bulb (EnergyStar 2012). People do not occupy office spaces for all time during working hours, and are not focus to control the lighting in their office spaces. This energy waste is particularly suited to control by occupancy sensors, which in turn reduce electricity consumption. These sensors discover the presence and absence of occupants by sensing motion, and turning on and off lights accordingly (EnergyStar 2007). In an office we can save 38% of electricity consumption with 5-minute time delay settings (VonNeida, Maniccia et al. 2000). Daylight harvesting is good potential for light energy saving. In a research, conducted in Albany New York, combined uses of day-light sensing and an automatic blind switch system saves, 24% of electricity consumption in comparison with manual switch operation (Leslie, Raghavan et al. 2005).

- Convenience: People enjoy a convenient life due to economic growth, technology innovation, and scientific advancement. A major contributor to energy consumption in offices is to use heating and cooling systems. These systems account for between 40 percent and 60 percent of total energy use (all forms of energy) in the commercial sector, making it the largest business energy drain. In Clark, this sector comprised of

65% of all emission in 2011. Clark has a special consideration on using heating and cooling systems by issuing a building heating policy. It is to set temperatures at 78 degrees for cooling, 68 degrees for heating and 130 degrees for domestic hot water.

Figure 3: Annual Electricity, Costs, and CO_2 saving by Using Energy Star Products

	Quantity	Cost savings	Savings (kWh)	Consumption by ENERGY STAR Unit(s) (kWh)	Emissions reduction (pounds of CO_2)	% Savings with ENERGY STAR
Desktop	1	2.2	20.8	49.9	32.0	0.3
Laptop	1	0.7	7.0	18.5	10.7	0.3
Monitor	1	0.7	6.6	25.2	10.2	0.2
Scanner	1	0.3	2.6	65.4	4.0	0.0
Copier Monochrome	1	7.7	73.0	73.0	112.4	0.5
Copier Laser	1	4.1	39.1	513.6	60.2	0.1
Printer Monochrome	1	2.8	26.1	52.1	40.2	0.3
Printer Laser Color	1	17.4	164.8	286.8	253.7	0.4

Figure 4: Life Time Saving by Using Energy Star Products

	Quantity	Electricity cost savings	Electricity savings (kWh)	Net cost savings	Assumed equipment lifetime (years)
Computer	1	8.8	83.1	8.8	4.0
Laptop	1	2.9	27.8	2.9	4.0
Monitor	1	2.8	26.4	2.8	4.0
Scanner	1	1.1	10.3	1.1	4.0
Copier Monochrome	1	46.2	438.0	46.2	6.0
Copier Laser	1	24.8	234.6	24.8	6.0
Printer Monochrome	1	13.8	130.4	13.8	5.0
Printer Laser Color	1	86.9	823.9	86.9	5.0

- Transportation: Millions of Americans commute daily to work, 78 percent of them use their own vehicles. Transportation accounts for 72% of U.S. oil use. In 2011, commuting accounted for 11% of total carbon emission in Clark Campus. Sharing cars, using public transportation and bike ride not only contribute to reduce greenhouse gas emissions but also save money. Clark launched student bike share program which encouraged people using environmental transportation

- Leadership, Networking and Participation: These activities promote awareness of what a sustainable office a green lifestyle should be and a role of each person can contribute to reduction of greenhouse gas emissions in offices. Leadership skills are critical in driving processes of change: "Producing change is about 80% leadership … and 20% management. We continue to produce great managers; we need to develop great leaders." (Kotterman 2006). A sustainability challenge requires broader partnership as the desirable changes outstrip the ability and competence of individual actors which necessities networking among school sustainable practitioners.

- Kitchen: Refrigerators are the biggest contributor to energy consumption in kitchen, responsible for approximately 14 percent of a home's energy use (Greenyour 2012). The average refrigerator consumed 1,281-kilowatt hours (kWh) of electricity per year, generating 1,832 pounds of CO2. In Clark, kitchens or break rooms also includes many other appliances like coffee makers, and microwave. These appliances consume significantly energy.

- Water conservation: Daily water usage in the typical single family home is 69.3 gallons. A toilet is responsible for about 28 percent of your home's total water usage. Americans buy 28 billion single-serving plastic water bottles every year, and 80% of those end up in landfills, according to the Container Recycling Institute (Clark 2012). Using simple faucet, fixing leaks, and learning to turn the tap off when water is not in use, installing water filling station are just a few of the ways to green-up your water use. According to American Water Works Association, leaking toilets can lose 30 to 500 gallons per day and 20% of all toilets leak in the United States (EPA).

2.4.1 Green Office Categories Credit Assignment

In sustainability assessment tools, all categories are important but some are more important than others are, because they make an impact differently. LEED assigned credits to different categories as such they reflect their "most effective common denominator," which are consistent and clear (USGBC 2012). In LEED ratings, credit weightings are made with a rule that more points for strategies that will have greater positive impacts on what matters most – energy efficiency and CO_2 reductions. The credit values are consensus based and intended to measure how each category contributed to mitigating each impact. STARS credit prerequisites that each credit must lead to improve environmental, social, and/or economic performance by colleges and universities. For the accommodation of diversity of institutions and universities, STARS credits remain flexible. Both performances credit and strategy are strong pillars of STARS program (AASHE 2012). The credits primarily focused on the impact, not the difficulty.

3. Methodology

3.1 Mission statement

This program is intended to develop green office with seven sustainable wheels that acts according to global bio-capacity, understands economic and environmental prosperity, respects the immediate values and recognize future needs, ultimately supports Clark carbon neutrality 2030.

3.2 Overall goal

This project aims at building a foundation for conducting further sustainable initiatives in Clark campus through inspiring participation, behavior changes, and technological innovations in energy, food, water use, and office supplies.

3.3 Research objectives

- To develop and pilot green office certification program
- To identify the challenges of green office certification program

3.4 Research questions

- What are the core components of green office in Clark University?
- What are the criterions to weight the different sustainability indicators?
- What are the challenges of green office certification program in Clark University?

3.5 Method

The prime objective of the "green office audit" is to develop the most appropriate tool for offices of the Clark University, based on underlying Clark policy, academic and administrative structures, and current green office practices in other universities across the globe. As a relatively new concept, the "Green Office Audit and Certification" cannot yet account for all office activities. Therefore, we understand that green office audit credits may not be sound indications of office practices and might be an underestimation of actual impacts; rather, this is a snap shot of the office activity. This chapter will provide details on the research experience, the methods used to gather the required information and the resulting data interpretation through pilot tests, literature review, consultation meetings, peer reviews through emails and telecommuting.

3.5.1 Literature Review

This tool is designed to assist the offices of Clark University to recognize the degree of their reliance on energy sources, waste generation and reduction, and possible solutions to address the climate change. Therefore, Clark sustainability policy and office practices were carefully reviewed. Several journal articles, reports, policy papers were accessed to understand the concept of green office, sustainability, climate change, energy intensity, efficiency and conservation, resource reduction and recycling, and behavioral analysis. Among several comparable green office tools, we have researched on comparable 47 different universities' calculator from Australia, Canada, and the United States based on size, rank, and involvement in sustainability for the development of our tool.

3.5.2 Pilot test:

A pilot program or testing the preliminary is important to test logistics and gather information prior to a larger study, in order to improve the future projects' quality and efficiency. The idea of the development green office tool remains invalid unless an accurate piloting of tool in some offices at Clark University. The objective of the pilot test, therefore, was to determine how to integrate theoretical tool in real field. The pilot test helped to identify and remove the flaws in the audit tool. It also facilitated us to understand the way to approach offices, time duration to conduct questionnaire survey. We have conducted two pilot tests.

3.5.3 Interview and review

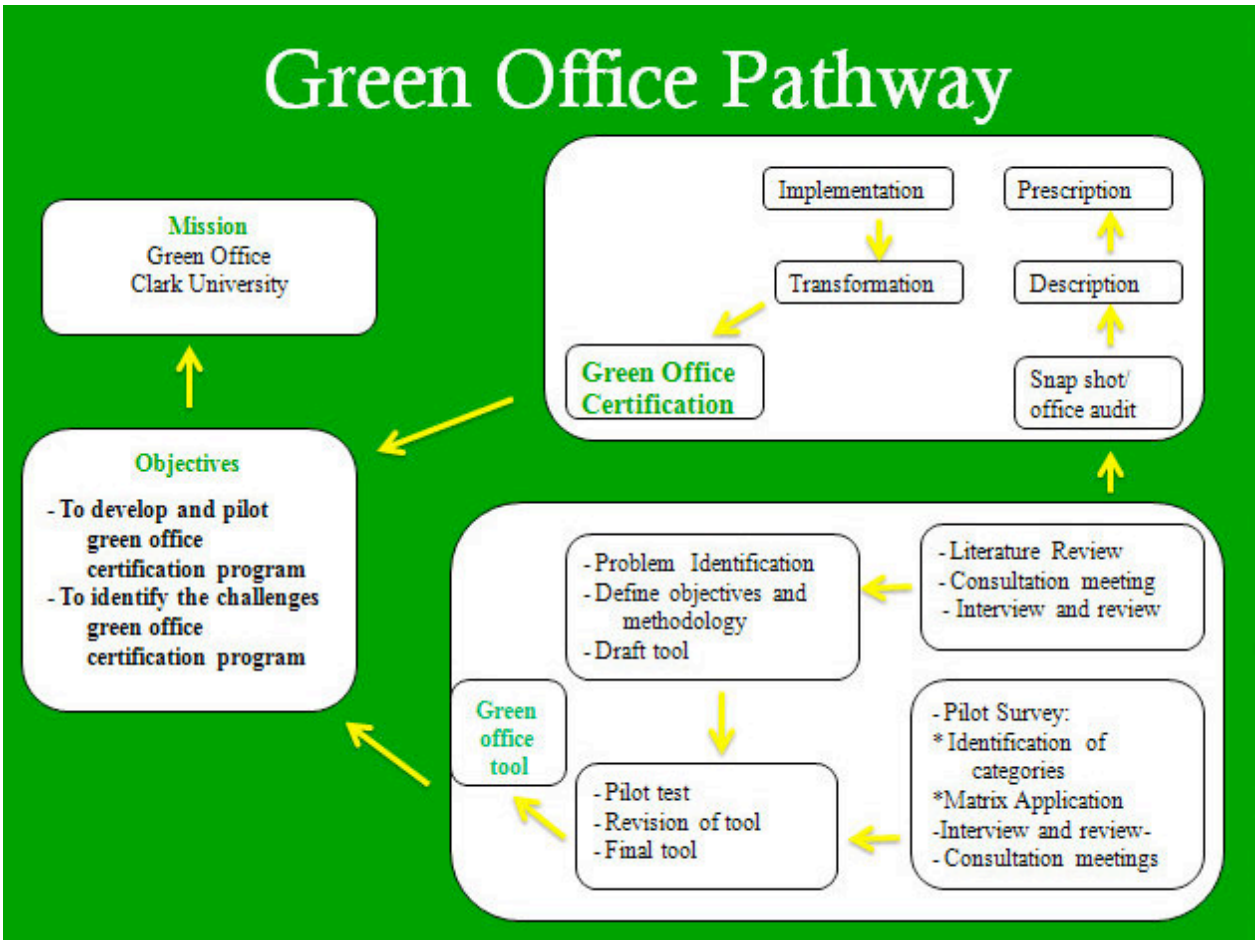
As this type tool has already been in practice at other universities, we conducted interviews to explore how offices at various universities responding to the green office approach, its benefits and weaknesses, and motivations to adopt green office tools. The interview also explored the assumption of several factors, criteria to assign credit for different options and usefulness of the green office tool weather it is the reflection of audited office or measures the real impact of the office. The selected interviewees were knowledgeable on green office issues; experienced in auditing and measuring environmentally responsible behavior; and experienced in communicating environmental issues in office scenario and public. Many of them were developer, practitioners, and experts on green audit. The review of our tool by green tool practitioners helps us to maintain the balance between questions by providing the basis to rearrange the questions of our tool. We interviewed Clark University authorities representing the physical plant and Information Technology Services (ITS) to identify energy use and management, efficiency set-up and faculty and students' responses for current energy practices.

3.6 Project Boundaries

An office is generally a room or other areas where people work, but may also denote a position within an organization with specific duties attached to it; the latter is in fact an earlier usage, offices as places originally referring to the location of one's duty. An office is

an architectural, design phenomenon, and a social phenomenon, whether it is a small office such as a bench in the corner of a small business of extremely small size through entire floors of buildings up to and including massive buildings dedicated entirely to one company. In modern terms, an office usually refers to the location where white-collar workers are employed (Wikipedia).

Figure 5: Green Office Pathway



This project built a green office audit tool, which is used to audit behavior on using energy, water, and producing waste in 53 departments and program offices, which have work stations located in different buildings in Clark Campus including Academic Advising Center, Academic Affair, and Clark One Card (The lists of offices shown in appendix).

4. Result and Discussion

4.1 Green Office Certification Tool

The prime objective of this project is to develop Green Office Certification Program in the context of Clark University. This objective was met by the methodology we applied and, seven categories were identified for green office audit tool. Based on universal practice and Clark University requirements, this Green Office Certification tool includes seven categories that are required to keep an office operation active and effective. This tool considered both LEED and STARS credit systems along with other universities practice focuses on impact as well as sustainability actions. We gave wheels' name for each category, which is described as below.

Energy Use Wheel: Among all, energy use for office activities is the most important for a couple of reasons. Energy use is the main source of greenhouse gas emissions and is the most important for all office operations. This category holds 34% of total credit out of 62. In energy use category, there are three sub categories, which include computers, electrical appliances, and lightning systems. In of computers and appliances, percentage of Energy Star out of total, energy efficiency setting and standby mode are the primary concerned area where as energy saving light bulbs, occupancy and day light sensor options, uses of natural light and switch indicator are focused area in case of light.

Convenience wheel: This category is fall under the comfort practices in terms of air conditioning, heating and related practices inside an office. We assigned the credit for Thermostat settings that follow the Clark heating policy or not that is regulated 68° or below during winter & 78° or above during summer. As air-condition related with peoples comfort and necessities for responding adverse weather, it is highly demanded and consumes huge sum of energy. However, certain practices maintain the balance between people comfort and energy use as such passive solar, using natural air circulation and practicing university heating policy. We assign nine credits for this wheel, which is 14% of the total.

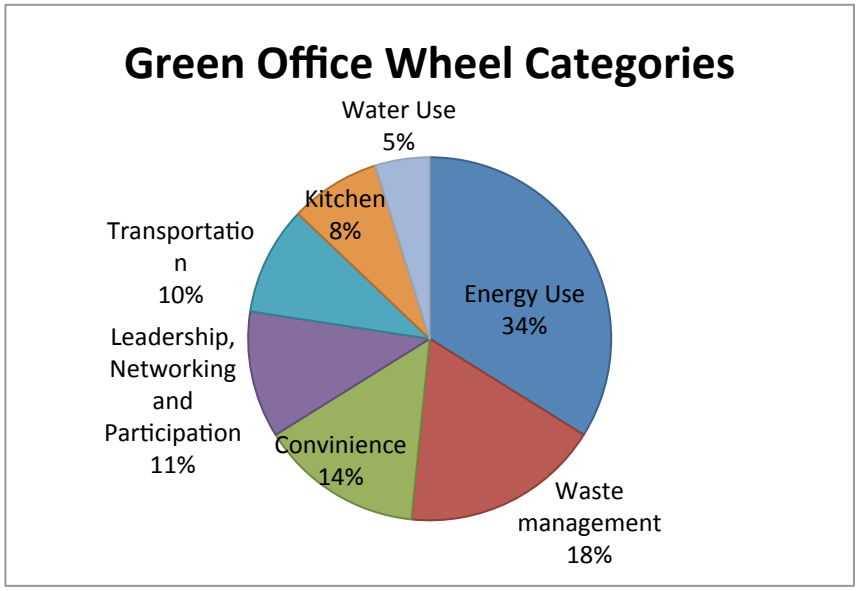
Networking, Leadership, and Participation Wheel: This category scores the engagement of office personals in Clark Sustainability programs and aware the wheel practitioner about sustainable initiatives at Clark university. From taking the responsibility of at least one tree at

Clark to attending sustainability meetings, all options are weighted equally. This holds 11% of the total with the credit score seven.

Figure 7: Green Office Wheel Categories and Credits

Green Office Wheel Categories	Possible Credits	Minimum Credit Wheel
Energy Use	21	16
Waste management	11	8
Convenience	9	7
Networking, Leadership, and Participation	7	5
Transportation	6	5
Kitchen	5	4
Water Use	3	2

Figure 8: Green Office Wheel Categories by percentages



Transportation Wheel: Though the transport sector contributes huge amount of greenhouse gas emissions, we consider only 10% of its role in our green office tool. Rather measuring emissions, we recognize the sustainable transport practice in this case, as this is not "inside office" job but still impacts office sustainability. We are not rejecting an idea of vehicle use, as this is necessity however promoting the strategies of telecommuting, videoconferencing, bike share, and mass transits.

Kitchen Wheel: Kitchen occupies 8% volume in this green office tool. Credits are assigned for shorter food miles, organic, vegetarian and fair trade products. Energy saving habits while using appliances and application of biodegradable products for dishwasher is weighted as well.

Water Use Wheel: Water footprint is reduction is achievable by practicing water saving habit. In this tool, water wheel consumes 5% volume with simple actions and applications such as dual flush toilets, leak managements, and bottle refilling stations.

5.2 Green Office Pathway

The seven green wheels assigned specific credits for each category. A green office is defined as "an office which meets at least 75% credits in all seven wheels" which means "energy use wheel" has to meet credits at least 16. And, 8, 7, 5, 5, 4, 2 in "waste management wheel", "convenience wheel", "Networking, Leadership, and Participation wheel", "Transportation Wheel", "Kitchen Wheel" and " Water Use Wheel" respectively. However, an office will be awarded a wheel separately if it meets 75% credits in that category. As such, if an office scores at least 4 in kitchen category, that office will be awarded "Kitchen Wheel" no matter other categories earn 75% credit or not.

The green office path way works when an office is audited. At first, a green office audit tool take a snap shot, identifies the possible green steps of an office, and give scores. After scoring, office will be awarded either all wheels if it earns at least 75% in all seven wheels, or a separate wheel for specific categories. Next, description and possible opportunities of improvement will be prescribed to concerned office, which will implement greening suggestions in that office. Eventually, implementation of prescribed strategies and actions in an office, allows to meet 75% credits or more and offices will be GREEN OFFICE with SEVEN GREEN WHEELS.

5.3 The challenges of Green Office Programs

As a new concept, deployment and diffusion of green office program is challenging for some reasons. Primarily, attracting offices for green office program is not easy as they are not willing to participate in new programs. Support from university administration and sustainability of staffing for economic reason is another challenge. Finally, a complete green office certification

requires investment of money. However, immediate environmental benefit and long term socio-economic benefit pay back the immediate economic investment.

5.4 Analysis of the Pilot Study

We have conducted two pilot studies to develop the green office audit tool. It is found that no office earns all wheels. “Office A” earned only water use wheel whereas “Office B” earned “waste management wheel”, “Leadership, Networking and Participation,” and “water use wheel”. In case of energy category, “Office A” earned eight credits because office supplied with motion sensors, having energy saving light bulbs, which is lacking in “Office B”. Both offices have a chance to increase their credits at by three points, simply by putting switch indicator, using desk lamps with LED and unplugging appliances when not in use, which do not involve any cost; LED light bulbs are freely available for staff from Clark Sustainability. Further improvements require cost involvement as such switching to energy star products and technological innovations.

“Office A” would be able to earn “Waste Management Wheel” simply by practicing simple actions like sharing office supplies that can be reused and bringing print and copier cartridge to “Clark Recycle Center” which also does not involve any cost.

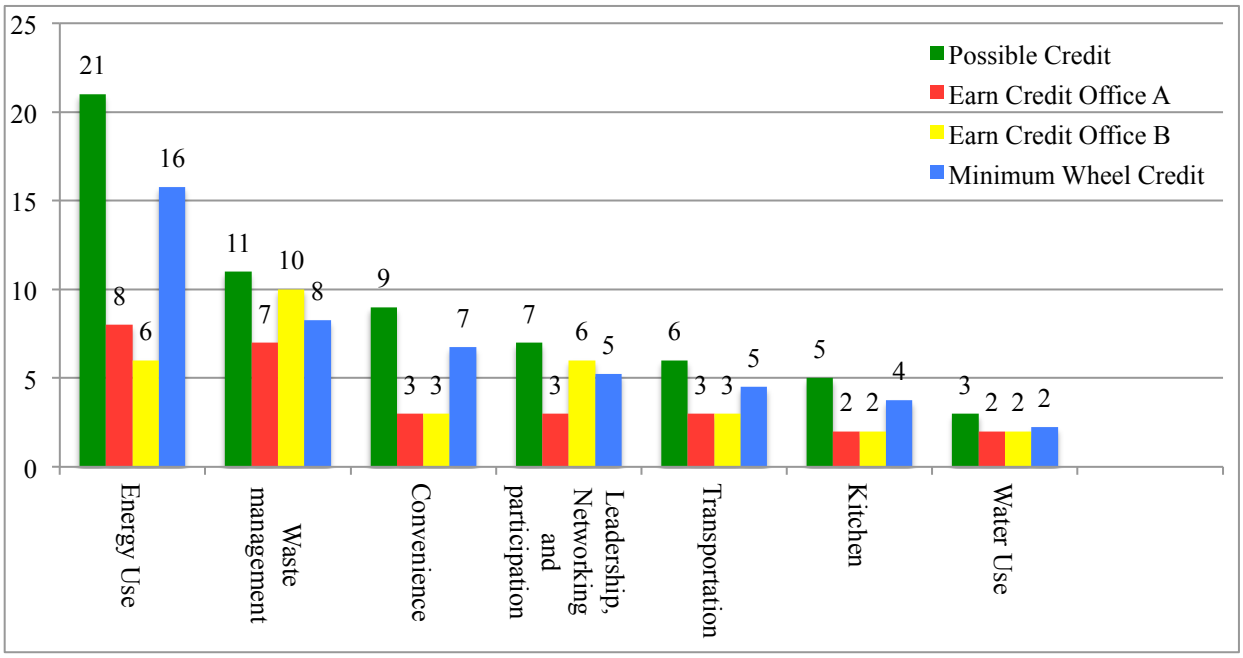
For convenience category both offices earned equal credits however, those credits do not resemble same strategies and actions performed by two offices. “Office A” supplied with heating system that can be controlled by occupants but “Office B” is not able to controlled this system and using a personal space heater. Both offices would be able to increase their credits simply by following Clark University Heating policy and using passive solar, which does not involve any new cost.

“Office B” earned “Leadership, Networking and Participation Wheel” but “Office A” failed to do so. There is a strong chance of “Office A” to earn “Leadership, Networking and Participation Wheel” by consulting authority for energy reduction and efficiency, attending annual orientations on energy and waste reduction on campus. “Office A” earned three credits in transportation categories as office employees alternate forms of transportation other than private

vehicles. On the other hand, "Office B" used telecommute, bike share, video conferencing and earned three credits.

In term of "Kitchen", neither office A nor office B got "Kitchen Wheel". Both offices would be able to earn "Kitchen Wheel," if the occupants adjusted temperature for a refrigerator and unplugged kitchen appliances when they are not in use. Both offices earned "Water Use Wheel" as they shared the bottled water refilling stations, looked for, and fixed leaks regularly.

Figure 9: Comparative study of two offices



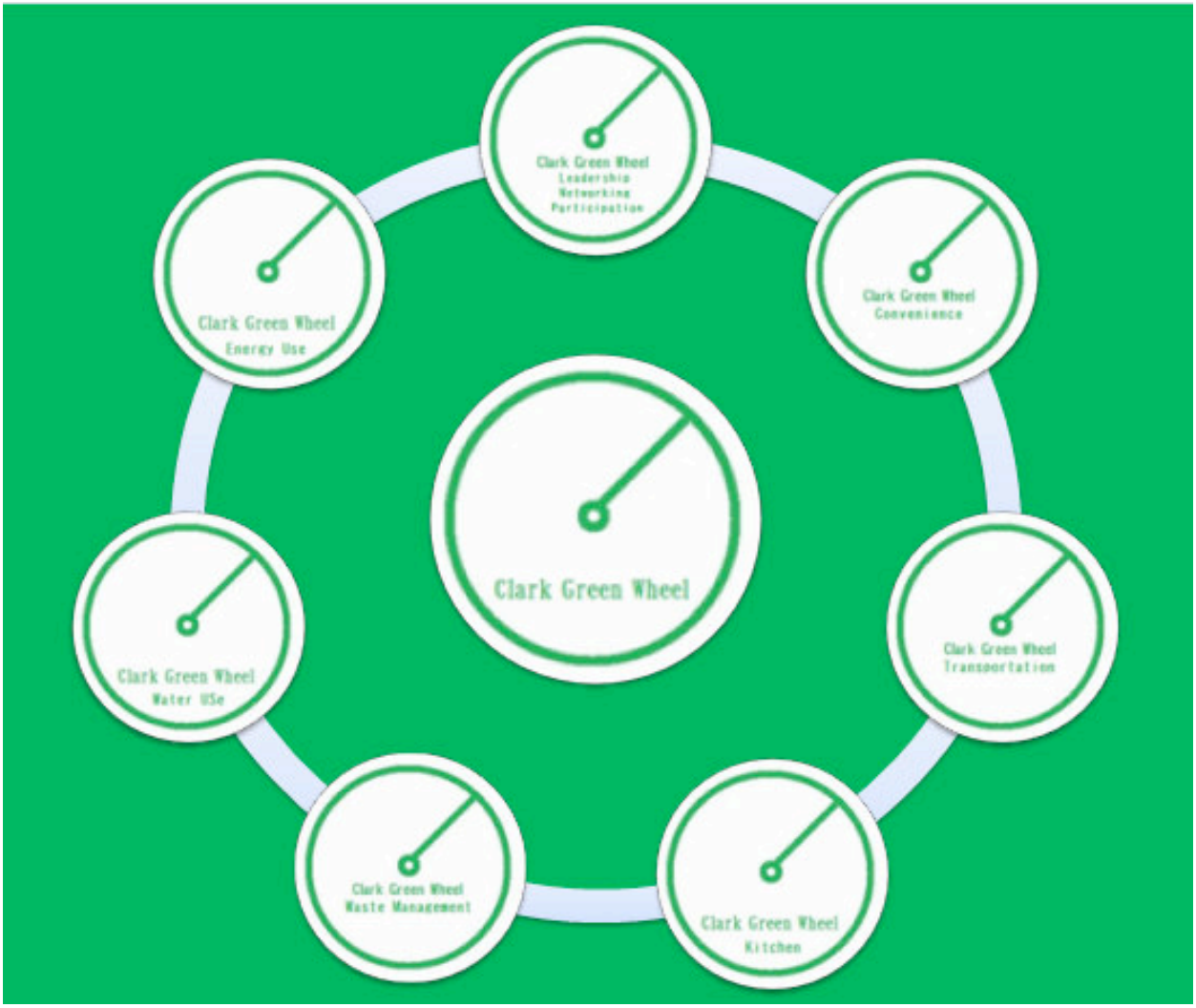
5.4 Innovations

"Green Wheel"

We have innovated seven green wheels that support sustainability at Clark University and elsewhere. This innovation is advanced over all other sustainability rating practices as such green office programs in other universities. The reason of that is other sustainability rating tools count as a whole and ignore the opportunities of green practices available on specific categories. For example, rating an office as 50% green, 70% green and so on reject the sustainability practices in specific categories. The innovation of this tool is to accept the sustainability practices in each

category as such energy use wheel, kitchen wheel, and waste management wheel. This means an office can be "green or sustainable" by either energy use wheel or water use wheel, waste management wheel, Networking, Leadership, and Participation wheel, transportation wheel, convenience wheel, and kitchen wheel.

Figure 10: Green Office Wheels



6. Recommendations

It is recommended that all office at Clark University to participate in green office certification program for environmental and economic benefits which will support Clark Climate Neutrality 2030. Further accuracy improvements of credits for each category with additional research are highly recommended.

Figure 11: Breaking university heating policy is a challenge to attend sustainability

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commercial lighting systems ".

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Appendix:

Figure 10: The Green Office Tool in Clark University

	Categories	Credit	Earned Credits		Possible credits
			Office A	Office B	
I. Energy Use					
1	Information technology	25 - 49% = 1, 50 - 74% = 2, > 75% = 3	0	0	3
1.1	Computers (desktops/laptops)				
	Total computers				
	Energy star computers				
1.2	When computers are not in use it will remain		2	2	3
1.2.1	On	0			
1.2.2	Sleep/ready	1			
1.2.3	Off	2			
1.2.4	Unplugged	3			
1.3	We follow Clark University Recommended Power Plan.	Yes = 1	1	1	1
		No = 0			
2	Appliances: printers, photo copier, and multi function copiers				
2.1	Appliances: printers, photo copier, and multi function copiers	25 - 49% = 1, 50 - 74% = 2, > 75% = 3	1	1	3
2.11	Total appliances				
2.12	Energy star appliances				
2.2	When appliances are not in use, it will remain.		1	1	3
2.2.1	On	0			
2.2.2	Sleep/ready	1			
2.2.3	off	2			
2.2.4	Unplugged	3			
3	Lights	25 - 49% = 1, 50 - 74% = 2, > 75% = 3	1	0	3
3.11	Total light bulbs				
3.12	Number of energy saving/energy star light bulbs				
3.2	We have switch reminder.	Yes = 1	0	0	1
		No = 0			
3.3	We use desk lamps with LED, when overhead light is not required.	Yes = 1	0	0	1
		No = 0			
3.4	We use natural light.	Yes = 1	1	1	1
		No = 0			
3.5	We use motion sensors.	Yes = 1	1	0	1
		No = 0			
3.6	We use daylight Sensors.	Yes = 1	0	0	1
		No = 0			
	Total		8	6	21

	II. Convenience				
1.1	We follow Thermostat settings are regulated 68° or below in winter& 78° or above in summer, according Clark heating policy	Yes = 5 No = 0	0	0	5
2.1	We use personal space heaters.	Yes = 0 No = 1	1	0	1
3.1	We clean warm-air registers, baseboard heaters, and radiators as needed; make sure they are not blocked by furniture, carpeting, or drapes.	Yes = 1 No = 0	1	1	1
4.1	During winter, keep the draperies and shades on south-facing windows open during the day to allow the sunlight to enter office and closed windows tightly at night to reduce the chill.	Yes = 1 No = 0	1	1	1
4.2	We use passive cooling methods such as opening window during cooler hours and installing curtain or shade, or using fan instead of air conditioning to reduce air conditioning loads.	Yes = 1 No = 0	0	1	1
	Total		3	3	9
	III. Waste Management				
1	We use white paper for office purposes, which have recycled content at least 30%.	Yes = 1 No = 0	1	1	1
2	We have recycle bins.	Yes = 1 No = 0	1	1	1
3	We print in both sides of page.	Yes = 1 No = 0	1	1	1
4	We consider paper margin.	Yes = 1 No = 0	0	0	1
5	We prefer to email document unless necessary to print.	Yes = 1 No = 0	1	1	1
6	We consider the Thrift Store for purchasing and sharing our office supplies.	Yes = 1 No = 0	0	1	1
7	We bring print and copier cartridge to Clark Recycle Center.	Yes = 1 No = 0	0	1	1
8	We have areas designated for sharing office supplies that can be reused.	Yes = 1 No = 0	0	1	1
9	We use reusable cups, dishes, mugs, utensils in the kitchen.	Yes = 1 No = 0	1	1	1
10	We use reusable bags instead of plastic bags	Yes = 1 No = 0	1	1	1
11	We use reusable inter-office envelopes.	Yes = 1 No = 0	1	1	1
	Total		7	10	11

	IV. Transportation				
1	We do use bike share when possible.	Yes = 1 No = 0	0	1	1
2.2	Employees, who use, alternate forms of transportation: cyclists, walkers, and public transportation.	25 - 49% = 1, 50 - 74% = 2, > 75% = 3	3	0	3
3	We telecommute for staff at least once a month.	Yes = 1 No = 0	0	1	1
4	We use videoconferencing and conference calls instead of travel, when possible.	Yes = 1 No = 0	0	1	1
	Total		3	3	6
	V. Leadership, Networking and Participation				
1	Our office attends sustainability meeting in regular basis, such as eco-carnival, difficult dialogues.	Yes = 1 No = 0	1	1	1
2	Our office is engaged with Clark sustainable initiatives.	Yes = 1 No = 0	1	1	1
3	We consult authority for energy reduction and efficiency.	Yes = 1 No = 0	0	1	1
4	Employees aware about Clark climate action plan.	Yes = 1 No = 0	1	1	1
5	We take care of at least one tree of Clark.	Yes = 1 No = 0	0	1	1
6	Annually orientation on energy and waste reduction with occupants	Yes = 1 No = 0	0	1	1
7	We display arrangement of sustainable and greening tips recommended by Clark sustainability team.	Yes = 1 No = 0	0	0	1
	Total		3	6	7
	VI. Kitchen				
1	Refrigerators are energy star.	Yes = 1 No = 0	0	0	1
2	We use naturally derived/ biodegradable/ environment friendly soap is being used to wash reusable dishware.	Yes = 1 No = 0	1	1	1
3	We prefer shorter food miles, organic and vegetarian and fair trade options.	Yes = 1 No = 0	1	1	1
4	We adjust temperatures for refrigerator around 37°-40°F for the fresh food compartment and 5°F for the freezer section.	Yes = 1 No = 0	0	0	1
5	All kitchen appliances are unplugged such as a coffee maker, toaster, and microwave when not in use or the office is closed.	Yes = 1 No = 0	0	0	1
	Total		2	2	5

	Water Use				
1	Our office use Dual-Flush Toilets.	Yes = 1 No = 0	0	0	1
3	We look for and fix leaks regularly.	Yes = 1 No = 0	1	1	1
4	We share our bottle water refilling station.	Yes = 1 No = 0	1	1	1
	Total		2	2	3
	All Total		28	32	62

Figure 11: Office Directory in Clark Campus

Administrative Office	Phone numbers
Academic Advancement	508-421-3722
Academic Advising Center	508-793-7468
Academic Affairs	508-793-7673
Accounting (Business and Financial Services)	508-793-7564
Admissions (Undergraduate)	508-793-7431
Alphagraphics	508-793-8853
Alumni Affairs	508-793-7166
American Language and Culture Institute (ALCI)	(508) 793-7794
Bookstore	FREE 508-792-5330
Business and Financial Services	508-793-7564
Campus Safety	508-793-7575
Career Services	508-793-7258
Center for Excellence in Teaching and Learning	508-793-7386
Center for Technology, Environment, and Development	508-751-4622
Clark Anti-Violence Education	508-793-7790
Clark Fund	508-793-7331
Clark OneCard	508-793-7109
College of Professional and Continuing Education	508-793-7217
Community Engagement and Volunteering	508-421-3704
Counseling Services	508-793-7678
Dean of Students	508-793-7423
Dean of the College	508-793-7671
Disability Services	(508) 793-7468
Environmental Health and Safety	508-793-7280
Event Planning	508-793-7471
Financial Assistance	508-793-7478

Goddard Library	508-793-7461
Graduate School of Management	508-793-7543
Health Service	508-793-7467
Human Resources	508-793-7294
Idrisi Project	508-793-7526
Information Technology Services	508-793-7745
Intercultural Affairs	508-793-7362
Mail Services	508-793-7304
Map Library	508-793-7322
Media & Classroom Services	508-793-7724
Mosakowski Institute for Public Enterprise	508-421-3872
Physical Plant	508-793-7566
Planning and Finance	508-793-7443
President's Office	508-793-7320
Recycling (see also Sustainable Clark)	(508) 793-7601
Registrar	508-793-7426
Residential Life & Housing	508-793-7453
Small Business Development Center	508-793-7615
Sponsored Programs and Research	508-793-7765
Student Leadership & Programming	508-793-7549
Study Abroad Program	508-793-7363
Sustainable Clark	508-793-7601
Telecommunications	508-793-7381
University Advancement	508-793-7200
University Marketing and Communications	508-793-7441
University Police	508-793-7575
Writing Center	508-793-7405

Sustainable Commuting Report

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Fall 2012
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12-17-12

Abstract

Transportation alone accounts for over a quarter of all greenhouse gas emissions in the United States. Our goal for this project was to attempt to make transportation at Clark University more sustainable. Our group aimed to make transportation at Clark more sustainable through the Clark Escort Service, free programs such as NuRide, and creating green parking passes. We created a survey to assess student knowledge on sustainable commuting and we used some of these results to form a marketing idea to promote NuRide on campus. We created a cost benefit analysis on green vehicles to be presented to the Clark Escort Service, and we had meetings with administration regarding green parking spaces. Our results indicated that most students were knowledgeable about sustainable commuting but did not know about free resources such as NuRide. Most stated that they would be willing to join since NuRide provides incentives for people who commute sustainably. Our cost benefit analysis identified that plug in hybrid vehicles would be much more cost effective for the school and the Clark Escort Service. Finally, throughout our meetings with administration we discovered that green parking spaces were not a viable option at this time. We still recommend the university look into the idea more thoroughly. With these findings and our recommendations, we believe changes can be made that will ultimately help Clark achieve its goal of carbon neutrality by 2030

Figures for Sustainable Commuting

Introduction

Inefficiencies in transportation can result in higher carbon emissions, greater usage of fossil fuels and oil source depletion, financial instability, and environmental imbalance. Rising levels of CO2 emissions pose many long term effects such as increased average temperature, more severe weather, and changes to our global and local climate. Although the average temperature of the earth rose 0.8 degrees Celsius, one-third of the ice in the Arctic is gone, the oceans are 30 percent more acidic, and the atmosphere over the oceans is 5% wetter, setting stage for devastating floods (McKibben, 2012). If this is what happens when the temperature increased 1 degree Celsius, imagine the adverse change that will take place when the earth is 2 degrees warmer, which is the recognized limit during the Copenhagen climate conference (McKibben 2012).

In the year 2010, 27% of the United States greenhouse gas emissions were caused by transportation. Transportation also accounts for the greatest end use source of greenhouse gases. From 1990-2010 greenhouse gas emissions from transportation accounted for 45% of the net increase in greenhouse gas emissions (EPA 2012). These increased emissions can be traced back to Americans desires to have bigger faster cars, such as SUV's and big trucks which have lower mpg ratings. As of 2010 our average vehicle fuel efficiency was 22.5 miles per gallon, a slight increase over our 2009 value. In 1980 our average vehicle fuel efficiency was at 20 miles per gallon and slowly declined from there until around 2005 when fuel efficiency once again started to increase (Evarts 2010). From 1990 to 2010 the number of registered vehicles in the US has increased by over 50 million. (BTS 2012)

Through their own climate action plans universities have identified transportation as a major problem contributor to greenhouse gas emissions. In Clark's Climate Action Plan it was identified that 27% of all greenhouse gas emissions occur from transportation. This number is in line with the national average of 27%. This number could be significantly higher for schools such as community colleges because almost all of their students are commuters. Transportation presents a problem specifically in the university setting because of the fact that students and faculty are spread out over a large area. Landscape development in the United States has allowed people to live far away from their workplace and commute easily every single day. This presents a problem for universities and other workplaces trying to lower their carbon footprint because they cannot limit where their staff lives. Universities are presented with the unique

situation where some of their population lives directly on campus while some live off campus. Combine this with faculty and staff who live off campus, the majority of the total people who are involved with the university live away from the campus. Universities also have a problem area in transporting students while on campus. Some universities opt for a shuttle or escort system, some universities opt for public transportation cards, while others provide no services requiring students to find their own means of transportation. The use of public transportation provides students with transportation that is more environmentally friendly than using their own vehicle. Shuttle or escort services are other options that are a little less environmentally friendly due to idling times and not being able to transport large amounts of people at one time. Universities are well positioned to tackle the issue of sustainable transportation because universities are the center of a large amount of research they have a motivated student base, and they have access to many resources.

Clark University has a large student population that lives either on campus or walking distance from campus. Some students that live off campus within walking distance still prefer to drive to campus. Faculty and staff tend to live farther away from campus resulting in longer travel times and increased greenhouse gas emissions. While it is not directly known or made public where faculty and staff live we can hypothesize possible reasons for not living closer to Clark. Faculty may live farther away due to family concerns, other work obligations, the idea of living closer to a metropolis (Boston), or the lack of amenities in Worcester. These however cannot be confirmed because we are uncertain how many faculty members actually drive a substantial difference into work. Most local students that live off campus stay within the local area nearby the university. This makes ease of access to the school quite easy and usually would not require driving to school under normal circumstances. The Clark community surrounds the school for a few blocks on each side of the school which appears to be where the majority of the students would live. It is also important to consider commuter students who travel from large distances to attend the school. Their driving habits will be much more difficult to change because of the need to drive to school and the options for public transportation or carpooling may not be available.

Institutions are at the center of the sustainable commuting transition and are setting the standard for other aspects of society to follow. Between research being done and action already taking place colleges and universities are showing the rest of the world that change can be made.

Universities have taken steps by offering carpooling services, free public transportation, and using green alternatives in their own fleet of vehicles. These minor changes are setting the path for major changes to come at the university scale and even on a larger scale. Clark has utilized resources and partnered with NuRide to offer its students rewards for sustainable commuting. It also offers the Escort Service as a safety precaution but it also is a more sustainable way of commuting rather than having every single person drive. However, with all that's being done there is room for improvement. NuRide is not a well known entity on campus among students or staff. The Escort Service, while useful to students, can be much improved in regards to being environmentally friendly.

This project is intended to help Clark University meet its climate action goals by reducing emissions due to transportation through developing and implementing a program that focuses on promoting student action and bringing awareness to Clark administration. A central part of this project will be to further advance the NuRide program on campus. We will accomplish this by conducting a study of student knowledge on green commuting through a survey then we will use the results to promote the NuRide initiative with active campaigning on campus. Additionally, in an attempt to reduce campus use of gasoline, the team will do a cost and benefit analysis for biodiesel versus gasoline powered vans for the Clark University Safety Escort service. Our final goal is to address the issue of green parking options on campus.

Background:

Transportation is not only increasing in the US but in developing nations across the world as well. Due to new availability and ease of owning a private car in China, for example, the number of cars has risen 27.5% from 2010 to 2011 pushing the world's car population above one billion. (Tencer 2011) Seeing the effects of transportation on greenhouse gases and the substantial increase of

Figure 1

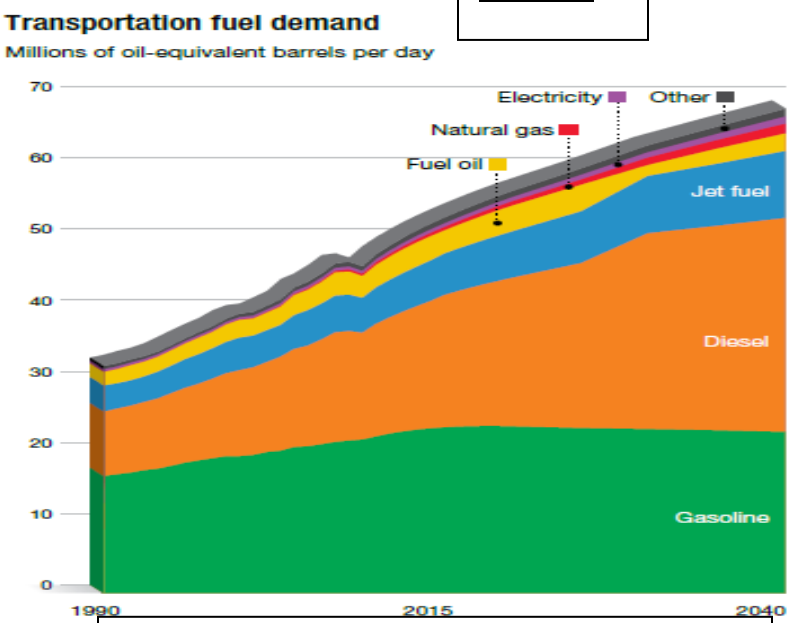

Figure 1 depicts all types of transportation fuel demand in the coming years. http://energyforumonline.com/5638/transportation-fuel-demand-type-1990-2040/

transportation in recent years it is evident that this is a problem that needs to be addressed at a global and local level. In the transportation fuel demand chart we see the different types of fuels used for transportation and we are able to see what types of fuel are used the greatest. As can be seen in the chart, diesel and gasoline are the two biggest fuel sources. It's important to note that in future years diesel is expected to overtake gasoline as the major source for transportation fuel demand. Also, due to increasing technological innovations we can expect more cars to be powered by electricity or biodiesel

Institutions nationwide have already taken action with regards to transportation on their campus. The University of Colorado at Boulder is one of the leaders in transportation efficiency. Currently over 22,000 of their 30,000 students travel to campus by some means other than personal automobile. The students at UC Boulder also tax themselves each semester, as part of their tuition, to have use of the city of Boulder's public transportation system. (Hignite 2010) Elon University currently offers a program in which the university charges $25 per semester for students to use bikes owned by the university. Other major universities such as the University of Arizona, University of California San Francisco, and the University of Indiana all sponsor carpool programs which lower the cost of parking permits. Universities can take actions such as these incentives for parking and public transportation, but there are other opportunities such as converting the fleet of vehicles used by the university to electric based or biodiesel. They can also promote or create programs such as NuRide.

Actions like these promote awareness for the need of environmental stewardship while taking measurable steps in reducing transportation emissions. Incentive programs such as NuRide are few and far between on campuses throughout the United States. While most universities offer incentives to commute in and eco-friendly way during specific times of the year, usually sometime around Earth Day, these incentives are not present year round. Most university incentives are also not geared to companies who are based off campus, making NuRide a unique incentive program.

As a university, Clark has the opportunity to educate and promote systems of transportation that have positive, sustainable influences on society, the environment, and economy. Clark University prides itself on having students challenge convention and change the world. As a university at the forefront of the environmental change we believe that Clark has the opportunity and the resources to be a model for other universities in regards to sustainable

commuting. Clark's Climate Action Plan outlines the need and desire for the school to become carbon neutral by the year 2030. Statistics from our universities Climate Action Plan show that our schools commuting, fleet usage, and air travel accounts for 27% of all of our greenhouse gas emissions. According to the Sustainable Commuting research paper as a part of last year's Sustainable University class almost 93% of all faculty and staff drive to campus by themselves. (CAP 2009)

Clark provides students with an escort service from 4pm to 4 am which transports students within a set area around campus. There are 4 vans that run continuously throughout the night and transport students whenever needed. Our commuter students pay a fee of $40 dollars to park on school parking lots from 7 am until 10 pm. However there is abundant free street parking available. Current overnight parking prices on campus range from $110 to $350. We have 2 electric charging stations on campus currently of which one is used by a Clark faculty member. However, Clark currently has no incentives for employees or students to promote a more efficient way of commuting.

Clark University has 3300 students and around 200 full time faculty members. While no specific data is available to see how many of these campus members actually commute to Clark, we do know that of all commuters 92% drive to Clark by themselves in their own vehicle. (CAP 2009) Clark is located in an area called Main South, which is a very diverse urban setting in Worcester, MA. Our location provides us with part of the limitations of reducing overall commuter numbers. Since Clark is located in an urban setting there is some crime that happens in the surrounding areas of the university. While the campus itself is quite safe, students and staff seem to prefer driving to campus rather than walking due to the crime in the area. This can drastically enlarge the number of commuters within a mile range of the school. The sustainable commuting survey that was conducted last year aimed to see how many students and faculty drove, and what types of vehicles they drove so the group could get a better grasp on the amount of emissions produced by commuting.

NuRide is a program that Clark students and faculty can easily utilize in their daily life. NuRide is a national program that has partnered with MassDOT, which gives participants points based on their efforts to reduce carbon footprint through transportation. These points once accumulated can then be exchanged for rewards through certain companies. As stated before one of the perceived limitations of NuRide is the crime in the area deterring people from walking

or biking to Clark. This is a barrier which ultimately we cannot change. Another limitation for NuRide is the fact that you must log on and enter your distance traveled every time you travel by walking, biking, or public transportation. This can prove to be a bit tedious for some people, but NuRide has now set up a program which automatically adds on distance if you walk the same route every day. For students it would be extremely easy to add your walking route to Clark and identify this as a route you take every week day. Once this is done NuRide will automatically add this to your totals every weekday.

We also aim to investigate the feasibility of having biodiesel or electric cars for the Clark Escort Service by conducting a cost benefit analysis for three different types of vehicles. The biggest problem for this part of the project is the lack of diesel or hybrid minivans in the United States. There are currently none available for purchase in the US, but you can purchase them from overseas and have them shipped to the US. Green parking spaces would be placed in locations around campus near buildings to create an incentive for owning and driving a green car. The only anticipated problems with this would be possible backlash from commuters about preference given to certain car drivers. By utilizing and capitalizing on all three of these commuting aspects, Clark University can become a leader in sustainable commuting.

We believe that Clark can utilize its student population and create a vibrant sustainable commuting initiative. With the implementation and promotion of NuRide on campus students will have excellent resources to sustainably commute and they will also be rewarded for doing so. In the future we hope the Clark Escort service utilizes more sustainable commuting options when they become available, and our cost benefit analysis will guide them in making those decisions. Finally, we hope to further promote sustainable commuting on campus by creating green parking spaces on campus for vehicles that fall under certain guidelines. All of these aspects of commuting will eventually lead Clark to be a leader in sustainable commuting.

Process

Our project aims to develop and implement a program that focuses on promoting student action and making commuting at Clark more sustainable. A central part of this project is to further advance the implementation of the NuRide program on campus. Our objectives in accomplishing the main goals are to identify student knowledge about green commuting at Clark, to establish an awareness campaign for NuRIDE, to create green parking passes or green parking

spaces so commuters who own green cars can utilize this service, and to identify the cost benefit analysis for biodiesel versus gasoline powered vans in the attempt to convince UP to consider buying diesel powered vans.

Our project and study is limited to the Clark community, we are focusing mostly on the graduate and undergraduate student and faculty population. Within the population, all genders, ethnicities, and ages are accepted as study participants and as beneficiaries of the project. All of our data collection as well as promotion is done within the Clark Campus or with social media connected to the Clark community. The project commenced with brainstorming ideas at the beginning of Fall Semester 2012 and implementation of ideas began soon after. The specific conceptual, temporal, and spatial boundaries are outlined in the tasks that followed with our objectives.

Assessing awareness and interest

Without knowing what the student and faculty knowledge on sustainable commuting and NuRide consists of and how much importance they give to it, conducting a project or promotion tactic could be misled. As a method of gaining context for our project, we conducted a survey. Using the results of the survey we aimed to deduce the popularity of NuRide and whether there is an interest in such a service; thus, we would know whether NuRide has the potential of gaining large interest on campus. There are ethical considerations with conducting survey such as confidentiality being hampered. However, with blanket approval from the IRB for the entire class, we were able to draft survey questions and distribute them fairly quickly after getting feedback from Professor McCauley. See Figure 2 for survey questions:

Figure 2

1. What is sustainable commuting and how can it be achieved? Answer with 1-2 sentences

2. On a scale of 1-10, rate how important, in your opinion, is fuel conservation? 1 being the least and 10 being the most.

3. What is the maximum distance you would walk to a place?

4. Do you know what NuRIDE is? Do you use it?

5. NuRIDE is an initiative towards green transportation. By walking, telecommuting, carpooling, taking the train, subway, or bus, you get rewards! They help you with

carpooling as well. NuRIDE exists on the Clark Campus and local businesses like Acoustic Java take part in it as well. By using the program you could get free coffee! Now that you've learnt a little bit about NuRIDE. Would you use the program?

6. If NuRIDE were to collaborate with other local businesses around campus or services on campus, what services would you prefer and suggest?

Figure 2 contains all of the questions that were present in our survey

Through the first question, we can know whether an average Clark student or faculty is aware of the aspects of sustainable commuting that are easily feasible like carpooling and walking. We can then learn what needs to be promoted and popularized on campus. Results of the second question help us determine where the focus needs to lie in promoting sustainable commuting. If the community does not give enough importance to the matter, we need to work on creating an environment that encourages the community to think otherwise. By asking the maximum distance one would walk, through the third question, we can determine student and faculty interest in following through with sustainable behavior. We then went on to ask about NuRide. Questions 4 and 5 help us infer what standing the initiative has on campus and whether promoting it will necessarily attract the community to the program. The last question serves as an aid to get an idea on the types of services that we should approach to join NuRide.

The survey was open for responses for a total of 15 days (10/24/12-11/9/12). It was open to Clark community members only. The survey was created on Survey Monkey and posted on a Facebook page, made public for people registered as Clark University Students in order to ensure that our data did not stray from the target population. The group promoted the page by linking it to their Facebook Statuses, in different group pages on campus, and on pages of friends. We also printed the survey out and handed them to different professors. When we realized that even though people joined the page on Facebook rapidly, we were not getting many responses on the survey. Therefore, we printed copies to hand out in the Academic Commons. A total of 50 students and faculty members of different ages, genders, ethnicities, and social groups answered the anonymous survey distributed by our group.

For the questions that ask for comments, answers will be categorized by similarities. It will be treated qualitatively rather than quantitatively. Disparities are hard to avoid with these questions. However, a general analysis can be made. For the questions that ask for rankings and

numbers the average of those numbers will be taken for analysis. The specific data analysis methods are defined in the results section.

Promotion of NuRIDE

One of our goals was to increase the awareness on campus about sustainable transportation through the NuRIDE rewards program. We felt like NuRIDE would be a great way to achieve this because they gave students a way to track how many times they walk while rewarding them with points that they can use towards rewards. In addition, their progress could be converted into other units, such as emissions prevented, which provide a unique look at savings other than monetary values.

Our first step was to find someone who works with NuRIDE. Through the Sustainable University class, we were directed to Dujuan Chowning, a worksite outreach coordinator for massRIDES. MassRIDES is a program under the Massachusetts department of transportation that focuses solely on promoting and providing information about sustainable travel options, such as NuRIDE. After setting up a conference call with him, we found out that he works with promoting NuRIDE and has done promotion with other colleges around the area. We later met in person, where we obtained flyers, pens, cards, and other small promotional items. In addition, Mr. Chowning said he could provide us with NuRIDE data specific to Clark University.

Once we obtained all the necessary items, we decided to go through with promoting NuRIDE throughout campus. One of the first actions was to participate in the sustainable carnival that was held in Bullock Hall. There, we encouraged other students to join the program, while promoting the different types of rewards. In addition to the carnival, we have also done some tabling at the University Commons.

After some promotion, we contacted Dujuan Chowning in hopes of getting some data specific to Clark (This is on-going. The data we will receive will be analyzed and shown in the results. We hope to get some data relating to how many people have signed up for NuRIDE this semester and other numbers such as money saved, and CO_2 saved).

Green parking passes

For our second objective, our goal was to explore the possibility of implementing green parking passes on campus. The main goal of these parking passes is to provide students and

faculty who drive cars with a certain gas mileage or carpool with discounted parking passes. As stated above in the background section, programs similar to these Green parking passes have been implemented at other schools such as The Community College of Baltimore County and Austin Community College. By implementing these programs, we hope to raise awareness on campus about sustainable commuting as well as encouraging people to commute to campus in a more sustainable way.

To get started on this objective, our first goal was to find out how the parking system works on campus as well as the rates. We decided to set up a meeting with Jack Foley, the vice president of government and community affairs at Clark University. From this meeting, we discovered that parking passes here for commuters were very cheap (starting at $40 a semester) and that discounted parking passes would not be feasible. The low price would not provide enough capital for Clark to maintain all the parking lots. In addition, since the price was already so low, the discount would not be enough to encourage people to either carpool or drive more fuel-efficient cars.

With this in mind, we decided to shift our focus else ware. Instead of focusing of green parking passes, we decided to focus more on green parking spaces, which would set aside priority parking spaces in preferred locations, similar to carpool parking spaces. By implementing more green parking spaces, we hope to increase awareness on campus about sustainable transportation as well as encouraging carpooling by limiting the amount of parking spaces near buildings.

With this goal in mind, we met with Jack Foley again to discuss the feasibility of this idea. We met with Jack Foley on Tuesday, December 4th, and discussed with him the idea of parking passes. We also discussed with him promoting NuRide further on campus and other sustainability initiatives which will be discussed in the results section.

Cost benefit analysis

For our third objective our goal was to provide administration with the information they needed evaluate the feasibility of buying "green vehicles" as a part of the Clark Escort service. We believe that green vehicles would benefit Clark Escort in two different ways. First, greenhouse gas emissions would be greatly reduced. By looking at hybrids, electric vehicles, and biodiesel vehicles you can substantially cut your emissions while still getting the basic needs

out of the vehicles for Escort. Secondly, even though the costs up front will be more expensive we believed that in the long run the costs would balance out and become essentially equal. Our group believed that if this was the case then it would make economic sense to invest in these types of vehicles because you are spending equal amounts of money but reducing your greenhouse gas emissions. These vehicles would be used solely for the Clark Escort Services which operates throughout Clark's campus and the surrounding areas every night during the school year. When we started this project the Escort Service was planning on buying a new van to use immediately, which, along with our desire to promote sustainable commuting, is why we decided to create the cost benefit analysis.

To first begin with our cost benefit analysis we needed to decide on what vehicles would be involved. We decided to use the most fuel efficient van currently available on the current market (Mazda 5), a Toyota Prius plug in hybrid, and a foreign diesel van (Chrysler Lancia Voyager). We needed to choose a foreign diesel van to use with biodiesel because no diesel vans are currently produced or sold in the United States. We took the basic unit price for each and calculated out the final cost with an 8% tax rate. We were given information by the escort service that says the vans run at about 4,000 miles a month. With the given vehicle miles per gallon ratings we were able to calculate the amount of fuel needed per month. We then computed the average cost per year for fuel based on the current gas price at the time of $3.59 per gallon. For biodiesel we took the national average biodiesel cost ($4.20) since there was no local information on costs of biofuel. (U.S. Dept of Energy 2012) We also decided to keep the price of gas steady throughout the entire 5 years because gas price fluctuation is too difficult to predict. From our interviews with administration we were told that Clark has a company that they would purchase their biodiesel from, but they were unsure of the price they would be charged. We extended these fuel costs for five years and then added up all of the fuel costs and initial costs to get our final 5 year cost for each vehicle. Another consideration we had to take into account was the fact that with the purchase of most hybrids or electric vehicles you get some sort of government rebate. This rebate only applied to our Toyota Prius plug in hybrid. We used five years as a vehicle age limit because Clark Escort told us that the vehicles average about 5 years before they have to replace them. We assumed that all vehicle costs and repairs were to be equal among the three vehicles.

We also calculated the amount of carbon dioxide that each car would produce over its five year life span by multiplying the number of gallons consumer per month, nine months (months the escort is in service), five years, and the value of carbon dioxide emissions in a gallon of gas (19.64 lbs). We then converted this into tons by dividing by 2000. This gave us the overall emissions in tons which is a more recognizable metric with carbon dioxide emissions.

Results

Assessing awareness and interest

The first question asked, "What is sustainable commuting and how can it be achieved"? Most of the responses assessed that sustainable commuting involved the use of carpooling and public transportation and its association with reducing one's carbon footprint, air pollution and overall impact on the environment. Some mentioned the use of "green transportation" but did not specify the meaning of "greener". Other answers mentioned the minimization of our use of fossil fuels, the improvement of greener technology, and an increase in education and awareness on sustainable transportation. Our assessment of the results here showed us that most people understand that carpooling, use of public transportation, biking, and walking are ways to be sustainable and that sustainability includes some type of reduction of our negative impact on the environment. There was little demonstration of deeper understanding, but in our own interpretations we concluded that most people have a general grasp of the concept and see sustainable commuting in positive light.

The second question asked survey respondents to rate the importance of fuel conservation on a scale of 1-10 and to explain their decisions. The calculated average of importance ranked at 8.13. The average was calculated by adding all the numbers and dividing them by the number of responses. The resulting number (8.13) showed that most people view fuel conservation, saving fuel by walking, biking, or taking public transportation as highly important. About 17/50 respondents ranked it of utmost importance while 1/50 respondents ranked it of least importance. Only 3/50 respondents ranked importance below 5. These numbers led us to conclude that most people find the issue of fuel conservation one of high or growing concern and very few people think that it is not yet of immediate importance. Many people pointed at climate change, oil drilling, carbon emissions, pollution and resource exploitation as reasons for ranking it of such

high importance. Some were concerned with oil as a root of conflict and political issues. An outlier response was explained by the fact that it wasn't of individual importance.

Figure 3 displays our findings, showing the percentage of responses on the importance of fuel conservation from 1(least important) to 10 (most important). The third question simply asked the maximum distance people would be willing to walk to any destination. The results show that nearly half of the respondents are willing to walk about 2 miles to any destination. Nobody was unwilling to walk any distance. Figure 4 shows the results of this question.

Figure 3

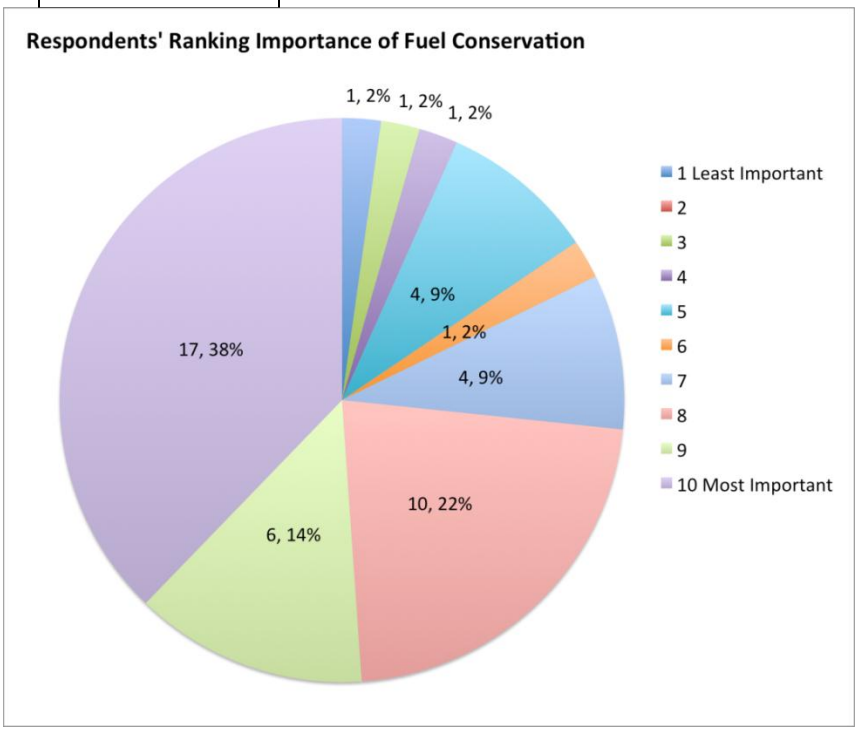

Figure 3 depicts survey answers ranking the importance of fuel conservation. The majority of students view fuel conservation as important.

Figure 4

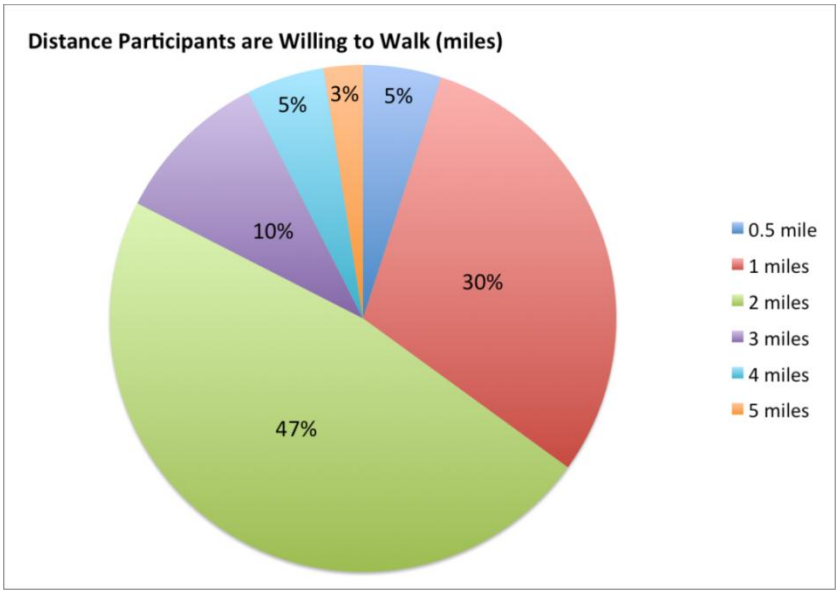

Figure 4 represents answers from our survey question asking how far participants would be willing to walk. The majority said they were willing to walk 2 miles

The fourth question asked if respondents knew NuRide and if they used NuRide. Eight out of 50 respondents knew what NuRide was, but out of those 8, only 3 use it or have used it. The fifth question continued to explain NuRide and asked if respondents were interested in using the program. Four said they wouldn't, 11 were on the fence, and the rest said yes. Most of the people who were unsure were hesitant about how committed they would be with logging their traveling records every day. Others wanted the benefit of better rewards to locations they could easily access.

The very last question asked respondents about the kind of services or local businesses they wanted to see involved with the NuRide program. There was incredible variety in the answers given. The top ten from most to least mentioned included supermarkets (Big Y/Price Chopper/Shaw's), Yo Way, Jazzman's, CVS, Blackstone Valley Shops, Annie's, Uncle Sam's, the Bistro, the Clark Thrift Store, and the bookstore. A few of the options are already associated with NuRide. However, these responses led us to conclude that publicizing those businesses with NuRide and working with NuRide to add more localized businesses will increase usage of NuRide by making it more appealing to Clark students. Building up on the incentives of NuRide was a huge conclusion drawn from this survey study.

Cost benefit analysis

The next three figures highlight the data acquired towards the cost benefit analysis.

Figure 5

Car	Unit Price	Price with Taxes	Rebate	Total Cost	Vehicle MPG	Miles traveled per month	Gallons of fuel consumed
MAZDA 5	$21,420	$23,133.60	$0	$23,133.60	21	4000	190.47619
Toyota Prius Plug in	$32,000	$34,560.00	$2,500	$32,060.00	95	4000	42.1052632
Chrysler Lancia Voyager	$51,175	$55,269.00	$0	$55,269.00	22	4000	181.818182

Figure 5 represents the cost benefit analysis aspect where we analyzed unit price, taxes, rebates, total cost, vehicle mpg, miles travelede per month, and gallons of fuel consumed per month.

Figure 5 highlights some of the basic information about the cars and a initial cost analysis. As seen above the MAZDA 5 minivan was the cheapest with a total cost of $23,133 dollars including taxes. The Prius comes in at $32,060 dollars including the $2,500 dollar government rebate. The most expensive was the foreign Chrysler Lancia Voyager which sells for $55,269. This cost was a bit surprising to our group especially since we did not account for shipping costs to the United States. The Toyota Prius had a far better rated mile per gallon that the other two cars because of it having the plug in aspect. The car is able to travel up to 60 miles on one charge and then switches over to gasoline. This is the technology that gives the Prius such a high mile per gallon rating. The two minivans were fairly close, both coming in at just above 20 miles per gallon. As stated before Clark Escort provided us with the information that each van travels about 4,000 miles per month. Using the vehicles mile per gallon rating we were able to compute the amount of gallons of fuel that would be used for each vehicle during each month. The MAZDA 5 would use over 190 gallons of gasoline, the Toyota Prius Plug In would use over 42 gallons of gasoline, and the Chrysler Lancia Voyager would use over 181 gallons of biodiesel.

Figure 6

Car	fuel cost	cost year 1	year 2	year 3	year 4	year 5
MAZDA 5	$3.59	$6,154.29	$6,154.29	$6,154.29	$6,154.29	$6,154.29
Toyota Prius Plug in	$3.59	$1,360.42	$1,360.42	$1,360.42	$1,360.42	$1,360.42
Chrysler Lancia Voyager	Avg. national cost- $4.20	$6,872.40	$6,872.40	$6,872.40	$6,872.40	$6,872.40

Figure 6 represents the cost benefit analysis aspect where we analyzed fuel cost, and yearly of fuel

Figure 6 show the yearly cost for fuel among the three cars. We used the fuel cost of $3.59 which was the cost when we met with administration about the Escort Service. We then multiplied the cost of fuel by the number of gallons of fuel needed per month (which was given in Table 1) by nine months which is the amount of time Clark Escort is in service. The yearly totals are seen above. The MAZDA 5's fuel costs $6,154.29 per year, the Toyota Prius' fuel costs are a mere $1,360.42, and the Chrysler Lancia's costs are $6,872.40. As stated before we used the national average price of biodiesel from the EPA, but Clark administration has a company that would sell them biodiesel at possibly a cheaper price. We also have the capabilities on campus to make our own biodiesel but it is not known how much we could produce.

Figure 7

Total Cost by Year: negating year to year repairs	Beginning Costs	1	2	3	4	5	Carbon Dioxide Emissions Over 5 years (lbs)	CO2 emissions over 5 years (tons)
Mazda 5	$23,133	$29,287	$35,442	$41,596	$47,750	$53,904	168343	84
Toyota	$32,060	$33,420	$34,781	$36,141	$37,502	$38,862	37208	19
Chrysler	$55,269	$62,141	$69,014	$75,886	$82,759	$89,631	47945	24

Figure 5 represents the cost benefit analysis aspect where we analyzed beginning costs, costs over 5 years including fuel costs, and carbon dioxide emissions in lbs. and tons.

Figure 7 above shows the costs over 5 years of each vehicle including their initial costs. We have already discussed how we got the overall cost of each car, but in this section we add on fuel costs per year. At the end we also decided to compare the emissions of all 3 cars. After calculating out our final costs the cheapest model was in fact the Toyota Prius Plug in Hybrid. Its total costs for 5 years were about $38,862. It is important to understand that electricity costs to charge the vehicle were not used in these calculations. The second most cost effective vehicle was the MAZDA 5 which cost $53,904 over a five year period. The least cost effective in this case would be the Chrysler Lancia which had a total cost of $89,631. To get the carbon dioxide emissions over the 5 year period we multiplied the number of gallons of fuel consumed x 9 months x 5 years x the value of carbon dioxide emissions per fuel. Gasoline produces 19.6 lbs. of carbon dioxide per gallon while biodiesel produces on 5.8 lbs. per gallon. With these numbers we calculate that the MAZDA 5 produces 168,343 lbs. of carbon dioxide over the 5 years or the equivalence of 84 tons. The Toyota Prius produces only 37,208 lbs. of carbon dioxide which is equivalent to only 19 tons while the Chrysler Lancia produces 47,946 lbs. of carbon dioxide or the equivalence of 24 tons.

NuRIDE data

We received data from our NuRide representative which showed that Clark University currently has 68 students and faculty signed up for NuRide. This number is just a fraction of total students who attend Clark University which is 3,306. There are a few different figures that stood out to our group. First, one of the figures that we highlighted was that each student saved an average of seventy dollars while signed up for NuRide. This number is calculated to show fuel savings and other related savings through not traveling via car. If every Clark student signed up for this free program you could see savings of well over two hundred thousand dollars. Another interesting figure is that NuRiders from Clark have saved over one thousand individual car trips since September 2012 by walking, carpooling, or taking public transportation. Finally, by not driving individually, the current students and faculty signed up for the program have saved 5.33 tons of emissions. Again, if every Clark student signed up for NuRide and pledged to walk or carpool more you could possibly save over 250 tons of emissions.

Recommendations:

- Clark University should consider adding at least one hybrid minivan or plug in electric vehicle to its Clark Escort Service.
- Conduct a Cost Benefit Analysis for Clark Escort including a business route in their daily services. This business route would go to locations such as Price Chopper, CVS, Walgreens, and Big Y.
- Focus on NuRide and PROMOTE.
- While promoting NuRide educate students on how much money/emissions they could save by walking to campus.
- Begin discussions with staff members on campus about raising parking pass prices to try and help reduce the number of vehicles used to travel to campus which would in turn reduce the amount of cars on campus and in surrounding areas.

Conclusions

This project intended to promote a sustainable commuting mindset on the campus of Clark University. Our group aimed to understand student knowledge of sustainable commuting and gage interesting in NuRide through a survey conducted on campus. Through this survey we were able to infer that not many students knew about the program but the majority (greater than 50%) we willing to walk or bike more than 2 miles if the rewards were right. This survey allowed us to understand the mindsets of the students at Clark University and should help future groups organize their promotion efforts in a more efficient way.

Another goal of ours was to promote the NuRide program which was achieved through tabling at an event on campus and promoting with word of mouth. We believe NuRide could be a very effective resource on campus for faculty and staff in the future. Our group had planned on doing more activities associated with NuRide this semester but we ran out of time. We anticipate that different promotions or competitions around campus would really get students signed up and involved in the NuRide program.

We created a cost benefit analysis for Clark Escort which clearly shows that a plug in hybrid would be more cost effective for the university. We believe Clark should take a more active approach in making the escort service more environmentally friendly. By setting up partnerships with local dealers it could be possible that Clark create some sort of agreement to use or lease a more environmentally friendly vehicle for the escort service. Some members of administration are against certain vehicles being used for escort because they cause a safety

hazard. While we don't disagree with administration, we believe it is something that it is an issue that needs to be looked at more in depth

Finally, we aimed to get the campus to create green parking spaces on campus which was met with resistance from administration. In the future we still hope to have green parking spaces on campus, but it will take a little more persuading of administration to put them in place

Overall, we recommend that the next group who tackles the issue of sustainable commuting to attack four different issues. First, we would like to see the price of parking passes reduced since they are very cheap and at times unnecessary. Secondly, we recommend the group do a cost benefit analysis to see if it would be beneficial if the escort service created a business route. Thirdly, we would like Clark to seriously consider adding a plug in or hybrid vehicle to their escort fleet. It would only further Clark's commitment to sustainability. Finally, we would like the NuRide program to be better promoted on campus in ways that allow opportunities to educate the students while also showing them the benefits of the program. We believe that by using student motivation and activism we can accomplish these new goals and make Clark a university that is regarded for its sustainable commuting.

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EDIBLE SUSTAINABLE LANDSCAPING AT CLARK UNIVERSITY

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AN

ACTION

PROJECT RESEARCH PAPER

SUSTAINABILITY IN HIGHER EDUCATION
(EN 103 / IDCE 30185)

Department of International Development, Community, and Environment

CLARK UNIVERSITY

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ABSTRACT

EDIBLE SUSTAINABLE LANDSCAPE AT CLARK UNIVERSITY

Edible sustainable landscaping is an important step toward sustainability in an urban environment. Replacing a traditional grass lawn with this type of landscaping would reduce water and maintenance requirements of an area of campus and would create habitat for animals as well as providing food for local wildlife, pollinators, and members of the community. The project sought to design a plot of edible landscaping on campus of Clark University and understanding faculty and staff attitudes and opinions toward the project. The methods used in this project included the exploration of secondary data on edible landscaping, field trip to UMass Amherst, interviews with six stakeholders, soil test analysis, plot and plants selection. The results indicated most stakeholders agreed that edible, sustainable landscaping at Clark would increase the institution's approach to sustainability, foster students' learning and encourage behavioral change through education, and collaborative partnership. Annual herbs, fruit-bearing shrubs, nutrient accumulating ground cover plants, and some trees are ideal for this type of landscaping. The soil test illustrated that the soil quality at the selected plot is low in important nutrients but lead levels are below hazardous limits so growing edible plants will not be a problem with the addition of compost. With the support of staff and faculty, one plot in Downing Street that is dominated by grass and difficult to mow was selected for this edible landscaping pilot project.

ACKNOWLEDGEMENT

Monk: Where can I enter Zen?
Master Gensha: Can you hear the babbling brook?
Monk: Yes, I can hear it.
Gensha: Then enter there.

We would like to thank Dr. Stephen McCauley, Visiting Assistant Professor of Environmental Science and Policy at the International Development, Community, and Environment (IDCE) for his professionalism, guidance and critique, which led to this work. We are also grateful to Sharon Bort, Teaching Assistant of the Sustainable University for her timely presence in class and prolific engagement in discussions.

We would also like to extend special thanks to Chip Pybas at Physical Plant for his monumental assistance in paving the way in recognizing specific locations for the establishment of the plot. Jenny Isler, Coordinator at the Office of Sustainability at Clark University for her instrumental advice in recommending specific stakeholders in generating data for analysis.

We also ascribe special thanks to all those that accepted and participated in our study, which include professors, experts and practitioners in the fields of sustainability, landscape ecology and environmental science.

FIGURES AND TABLES

CHAPTER 1: INTRODUCTION

"To the dull mind nature is leaden.
To the illuminated mind the whole world burns and sparkles with light."
–Ralph Waldo Emerson

Landscape ecology and design on college campuses can play an unprecedented role in ensuring energy balance, aesthetic attractions and cultivating ecological values in both urban and rural areas. The cultivation of parasitic grasses on the landscape discourages biodiversity within the ecosystem and with limited or no edible fruit trees grown, animals are left at the margins of these landscapes creating dysfunctional systems. The desire to attract students by cultivating grasses, high maintenance trees and herbs in developing an ideal landscape outweighs sustainable practices to protect the environment. Research has shown that the conventional landscape system is highly expensive and labor intensive (Fichtner, 2011; O'Brien, Phillips, Bossenberry, Hay, & Kerton, 2001).

The proposed project is a collaborative project between undergraduate and graduate students of the Sustainability and Higher Education course, the Sustainable Clark office, and the Physical Plant department at Clark University. The overall objective is to design a plot of edible, sustainable landscaping on campus based on the principles of sustainable permaculture. Students of the Sustainability and Higher Education course at Clark would use the designed plot to create and promote awareness of edible, sustainable landscaping and local food production.

Clark University maintains a unique standing within the Colleges of Worcester Consortium, characterized by its unyielding dedication to promoting environmental sustainability, not only within the institution itself, but also throughout the surrounding community. With the Clark Sustainability Collaborative (CSC) ranking as the largest student organization on campus, it is evident that students at Clark are truly invested in sustainable actions and behavioral change. Initiatives set forth by various clubs within the collaborative cover green-inspired projects ranging from a student run campus-recycling center, to composting workshops and cafeteria reforms, to bottled water banning

campaigns. In the midst of all this, Clark students manage to reach out to the surrounding Worcester community and create strong alliances and partnerships with individuals and organizations throughout the city (J. Isler, pers. comm.). This deeply rooted sustainable culture at Clark provides a context for the edible landscaping project developed by our team.

Many universities all over the country are beginning to incorporate gardens into their campuses, and institutional support of locally grown food is on the rise (ClarkU, 2011). Despite Clark's small size, urban location, and limited access to agricultural resources, the university is constantly working to improve food sustainability on campus. This fall the Herban Gardeners, Clark's campus gardening group, shared their harvest with the community by hosting a free supper prepared using food they grew sustainably on campus. Last spring Susan Foster, Chair of the Department of Biology, developed a class dedicated to planting trees at Clark, after a severe storm caused high tree mortality on campus. The class launched an ongoing project driven by student-led landscape design, conservation biology, and campus sustainability.

It is a fundamental and unprecedented problem when the most common green land cover (grass monoculture) is highly unsustainable. The ubiquity of turf grass landscaping means that the disproportionate demands of grass compared to alternative groundcovers are often overlooked in keeping with the status quo. It is both unfortunate and uncharacteristic of Clark University to continue to cover its limited campus space with the conventional monoculture system of lawn grass, as most of the landscaping on campus needs intensive maintenance and artificial watering. The Edible Landscaping team seeks to mitigate this problem by designing and implementing a permaculture system on campus that will improve soil conditions, encourage community engagement, promote biodiversity, and serve as a model for alternative and effective ways of utilizing space within the urban environment.

Current obstacles to comprehensive sustainable landscaping are primarily a lack of knowledge base for this type of design. Initial funding is also often a barrier despite long-

term cost effectiveness of reduced maintenance, water use, and food production in these landscapes. This paper and the actual garden plot on campus are intended to increase knowledge and capacity towards alternative approaches to landscaping among Clark students, faculty, staff and the community at large. We also hope to make landscaping with permaculture designs more inclusive for groups and individuals at Clark and elsewhere to support and inspire similar projects on campus and in the community.

We will establish a plot of edible landscaping on campus during the implementation stages of the proposed action project, which will be used as a model to showcase edible, sustainable landscaping as an alternative to the current turf grass monoculture system. In the light of sustainable development, the project is important to Clark University particularly and the Worcester community in general because it will encourage, enhance and promote sustainable food production, improves water use, reduce labor, and increase biodiversity while at the same time contributing towards the attraction of the campus. In addition, the availability of edible landscaping on campus is a means to increase public awareness about sustainability. By looking at the signboards at the plot showing information about the selected plants, people will understand more about the importance of edible landscaping in sustainable development.

Informal interviews with experts in the field of sustainable landscaping, sustainable development and the university authorities are necessary part of the project during the process of data collection. Data generated through informal interviews will help inform the design and implementation of the project and the development of the plot. Information synthesized would also significantly point to appropriate measures during the process of site and plant selection and the overall structural formation of the plot. Additionally, field trips to other campuses within Massachusetts where similar projects are currently been conducted would facilitate the process of engaging specific stakeholders associated with those projects in order to learn about what has been done with regards to edible, sustainable landscaping within the context of urban college and university campuses.

CHAPTER 2: BACKGROUND OF THE STUDY

"It were happy if we studied nature more in natural things,
and acted according to nature, whose rules are few, plain, and most reasonable."
–William Penn

2.1. Land Use in Urban Environment

Land use is an important consideration for a rapidly growing, rapidly urbanizing population. Though urban areas make up only about 3% of total land area, there is a large body of evidence that shows "urban land uses effect profound changes in all environmental components and that humans are the main drivers of change" (Kowarik, 2011). These changes occur at the local and regional levels as habitat fragmentation, changes to water systems, and alteration of the nutrient and microbe balance of soil that can cause areas to become nutrient poor and easily desiccated without continuous maintenance. Degradation of soil is an especially poignant issue in urban settings where soil is treated as a substrate for grass and is not managed with concern for long-term sustainability (Johnsen, 2005). This soil quickly becomes unable to support the plant, microbe, and fungal life that define a healthy ecosystem and is not suitable even for turf grass without artificial fertilizers, which further contribute to ecological problems. Recently, efforts by mostly small independent groups worldwide have been responsible for changing ideas of urban land use.

Plants are adapted to the conditions in the environment where they naturally occur. Their light, water, and nutrient requirements match the availability of those resources in their niche. The grass that is typically requires more water than the climate in central Massachusetts provides whereas most native species are adapted to regional rainfall (Clark, 2002). Kjelgren et al (2000) report that lawn irrigation accounts for most of outdoor water use and that temperate-climate woody species typically use less water than turf grass. Lawn monocultures require inputs of water and toxic chemicals, which are harmful to biodiversity and healthy ecosystems (Ramalho & Hobbs, 2012; Roger, et al., 2000).

The monoculture mentality extends beyond the backyard and into our farm system. A complete dissociation with our system of food production has led to disrespect for the

land as a source of life and a centralization of food production that is both unsustainable and harmful to the health of consumers and the ecosystem (Ramalho & Hobbs, 2012; Roger, et al., 2000). Industrial agriculture systems have degraded large areas of previously fertile land, introduced synthetic fertilizers and pesticides into the environment, and created vast monocultures susceptible to insect and disease outbreaks (Horrigan, S., & Walker, 2002; Ramalho & Hobbs, 2012). The only sustainable solution to these problems with food production is more intelligent farming practices: creating ecosystems that give the desired output without degrading the soil and requiring artificial nutrient input, using plants with water demands concurrent with the local climate, and directing succession instead of replanting monoculture each year. From a local perspective, this means designing landscapes that give back instead of taking and promoting natural ecosystem function through plant selection (Clark, 2002; Kowarik, 2011).

2.2. Looking Ahead for Urban Sustainability

Some cities, commercial entities, and educational institutions are taking steps to reverse this trend of land degradation while at the same time increasing the habitat, food, and recreational value of their green spaces. We are focusing on the role of college campuses on increasing urban sustainability so a lot of our research looks at how campuses are changing their land use patterns.

2.3. Permaculture

Permaculture is a term coined in the mid-70s by Bill Mollison and David Holmgren and is defined in a book by the latter as "consciously designed landscapes which mimic the patterns and relationships found in nature, while yielding an abundance of food, fiber, and energy for provision of local needs" (Holmgren 2012). Permaculture is a form of land use that provides for the needs of present inhabitants without sacrificing the prosperity of their descendants. They advise that permaculture designs should take into consideration several factors, goals and processes that will affect and be affected by the design including: land

and nature stewardship, the building process, tools and technology available, education and culture generated, health and spiritual well-being of those interacting with and maintaining the plot, finances and economics, and land tenure and community governance. Although the word is recent, permaculture has roots in millennia-old gardening practices still used by societies, especially in the Amazon region and tropical Asia, that some consider primitive. These societies, like the Karen peoples of northern Thailand, combine gardening edible and medicinal plants with consideration of systems ecology and land stewardship. Dave Jacke and Eric Toensmeier outline permaculture as careful design of a plot of land to minimize competition and combine complementary plants along with directed succession producing high, diverse yields with maximum self-maintenance and ecological health at minimum cost (Jacke & Toensmeier, 2002). Complementary planting means planting species that are known to have functional interconnections together in the garden. A common example is the use of creeping ground cover plants like clover or strawberries to prevent evaporation around the base of taller plants. Some plants like basil, called aromatic pest "confusers," deter pests of many common garden plants, protecting them without the need for pesticides. Herbicide use is eliminated by filling all ecological niches with useful plants, which excludes weeds that could take advantage of unfilled niches. Permaculture is a technique for producing food that can be used on a small scale by individuals or families to improve their food security and by institutions to have a positive impact on their environment and provide food and other necessities.

2.4. Xeriscaping

Xeriscaping refers to the design of landscapes, which require little or no water input in addition to normal rainfall. Carefully designed landscapes can reduce the need for watering and prevent waste of treated city water. There are several ways to decrease water requirements by designing landscapes with plants other than grass. The grass used in most landscaping applications is not adapted to survive in the climate of central Massachusetts. Instead it requires water addition. Using ground covers native to this region like native

grasses, clover, moss or other ground-cover plants would prevent the need for additional watering. The mat-like nature of grass requires watering across the whole surface of the landscape and this usually means sprinkler systems. Sprinkler systems are very inefficient because a lot of the water is lost due to runoff and evaporation and the sprinklers have to water the entire area uniformly, resulting in overwatering of some areas. Landscapes designed with shrubs and trees can use a more efficient form of watering (if watering is necessary): drip irrigation. This targets the roots of plants instead of watering the entire area. A truly xeric landscape will require no watering in addition to normal rainfall and is very sustainable in this way. Xeriscaping in the central Massachusetts area, a region with relatively high annual rainfall, is certainly not difficult to plan and implement.

2.5. Current Sustainable Landscaping Projects

Many colleges and universities have started implementing low-maintenance, native, and edible landscaping into their campus environment. Oregon State University has recently been looking at edible landscape plants in the context of new landscape design (OSU, 2006). University of New Hampshire Durham has developed an extensive plan to restore their traditional campus-style landscape to its agrarian roots by carefully selecting native, hardy, and edible plants and reducing the amount of space given to asphalt and expansive lawns. Their goals are to create habitat, reduce no-yield maintenance and restore a healthy topsoil ecosystem. Georgia Institute of Technology also has an extensive master plan that, when completed, will greatly reduce runoff while creating habitat for local species and contributing to a corridor for other animal species. They will do this by removing large grass lawns that promote runoff of rainwater and also by increasing the canopy cover of the campus by planting more trees and planting the areas around the trees with a wide diversity of other plant species. One example of large-scale implementation of the permaculture design is the multiple permaculture gardens recently created by students at University of Massachusetts Amherst (Clark, 2002).

CHAPTER 3: METHODS AND DATA ANALYSIS

"Speak to the earth, and it shall teach thee." –Job 12:8

In this chapter, we discuss the methods use in the implementation of our plan and the processes conducted in data collection and analysis. We started by defining the targeted population for the generation of data and the selection criteria in the process of identifying viable and potential sites for the establishment of the edible, sustainable landscape plot.

3.1. Targeted Population

For the purpose of generating prolific data in exploring the possibility of establishing edible landscape on campus, we decided to conduct interviews with practitioners, experts, staff and faculty at Clark University as well as practitioners at the University of Massachusetts at Amherst. The sample size for those we interviewed is composed of seven (7) individuals.

3.2. Data Collection

In order to gather the necessary data, we explored secondary data on edible, sustainable landscaping and gathered information of what has been documented in the literature, conducted field trips to assist us in the formulation and design of a plot and conduct interviews with practitioners, staff, faculty and experts to be able to triangulate the results to make decisive judgment on plot design and implementation plan.

3.2.1. Secondary data collection

In order to determine the overall benefits, challenges, and the importance of edible landscaping in terms of sustainable development, we analyzed published research papers related to edible and permaculture landscaping. Moreover, to design a plot, we review books and published papers regarding plant selection, water consumption, soil types, and possible design structures.

3.2.2. Field trip

In order to examine in detail a working permaculture landscape and have more experiences regarding designing the plot, the field trips to the University of Massachusetts at Amherst was conducted. In University of Massachusetts, the similar project about edible landscaping has been implemented successfully for three years. The data collected from the trip help to provide the group insights about plant selection, aesthetic concerns, structure of the edible garden and how to get students and staff more involve in the project.

3.2.3. Site Selection Criteria

In order to determine the optimal site for edible landscaping on campus, we consulted Physical Plant and other staff on campus. After consulting them and based on interview responses, we developed four criteria that guided our decision in the process of site selection. The criteria include whether or not the proposed site was difficult to mow and maintain, site is completely covered with grass, is being irrigated by a sprinkler system, and lastly, that the plot was highly visible to students, staff, faculty and community members to serve awareness and educational purposes. Based on these criteria, we chose the plot that is situated in front of George F. Kneller Athletic Center.

The selected site will be highly visible to people walking through campus. As a result, this may lead to an increase in public awareness about doing sustainable projects on campus. Additionally, the plot has a steep topography and is dominated by grass and it is difficult for the Physical Plant to maintain. Currently, the plot is irrigated by a sprinkler system on campus. Having a plot of edible garden at this site would contribute to addressing the demand on Physical Plant of having a low-maintenance area but still ensure the harmony related to landscaping on campus. The selection of this plot would increase aesthetic value and quality of the old Downing Street area that has just been reconstructed.

3.2.4. Interviews

For the purpose of understating attitudes and opinions of implementing edible landscaping project on campus, face-to-face interviews were conducted from November to December 2013 by used of an interview guide (Appendix A). Seven experts in the field of

sustainable development, landscaping and authorities of Clark University were selected for the interviews. Fifteen questions divided into two themes, which are education and plot design are included in the questionnaire. Almost all questions are open-ended questions, so this allows respondents to express all their ideas and concerns about the project. Each interview was conducted within 30-45 minutes. All interviews were recorded to avoid missing information while interviewing.

3.3. Data analysis

We used the grounded theory to analyzed interview responses from stakeholders. The theory was developed by Glaser and Strauss and its main focus is to generate theories or themes regarding social phenomena: that is, to develop higher level understanding that is "grounded" in, or derived from, a systematic analysis of qualitative data (Carlsen & Glenton, 2011; Lingard, Albert, & Levinson, 2008). Grounded theory is appropriate when the study of social interactions or experiences aims to explain a process, not to test or verify an existing theory. Grounded theory can also be effectively used in gathering sensitive data in participatory action projects (Carlsen & Glenton, 2011). In most instances, researchers approach the question with interdisciplinary interests, background "postulations and an understanding of the literature in the domain, but they neither develop nor test hypotheses" (Lingard, et al., 2008). Rather, they allow the data to generate the theory as we analyze by developing codes, collapsing codes to create categories and emerging categories to develop the theory or themes. In essence, the grounded theory is the complete opposite of quantitative data analysis.

We used Atlas.ti Version 7.0. Atlas.ti is a computer-based program used mostly, but not exclusively, in qualitative research data analysis. The program allows users to compile, create codes and associate codes with quotes and quotations in primary documents. Atlas.ti also organizes data and assists locate codes and annotate findings in primary documents. It allows researchers to weigh and evaluate their importance and relevance to visualize the complex relationships that exist between codes, categories and themes.

CHAPTER 4: RESULT AND DISCUSSION

"The violets in the mountains have broken the rocks."
–Tennessee Williams

4.1. Introduction

In this section, we present the results of our action project as part of the course Sustainability and Higher Education. The section is composed of presentation of qualitative results from semi-structure interviews with professors, staff and experts at Clark University and field trips at University of Massachusetts-Amherst. The results are divided into two broader domains. The first domain is the primary research results, which include salient codes, categories and themes that were generated from interviews and field notes as well as specific direct quotations associated with each broader themes significant to our research. The second domain is consists of the action project, which contains the sketched map of the plot where our proposed edible landscape will be established during the spring 2013 semester.

4.2. Primary Research Findings

4.2.1 Salient Codes

During our analysis, the following codes were generated based on interviewees' responses to specific questions asked about their perceptions of edible, sustainable on campus and familiarity with initiatives that foster sustainability on campus. We used the Grounded Theory to generate codes, categories and themes as we analyzed data. We did not approach the data analysis process with set of predetermined codes, which is commonly associated with quantitative data analysis. We were more interested in how specific responses from stakeholders, experts and practitioners in the field of edible landscape and sustainability interplayed within the dataset. We developed codes that appropriately manifest the concept of our project by associating each code with specific quotations from the interviews responses. Grounded of codes indicate the relevance and

importance of codes in the dataset. The significance of the grounded of codes is that, the higher the grounded of codes indicate their relevance and importance it they relates to our research. We also used the density of codes to describe how each code is related to other codes. The higher the density of codes, the higher that code relates to other codes. The application of the grounded of codes and their densities allowed us to identified specific trends in the data. Table 1.0 shows the 9 salient codes from our list of twenty codes. We decided to select the top nine (9) salient codes to collapse into categories based on their grounded and density.

Label	Code	Grounded	Density
Education	EDU	19	10
Collaborative Partnership	CP	17	3
Sustainability	SUS	17	9
Impacts	IM	12	2
Landscape Design	LANP	10	5
Challenges	CH	7	9
Project Management	PM	7	9
Water Management	WM	6	7
Plant Selection	PS	5	7

Table 1: Salient Codes

Education, collaborative partnership and sustainability were considered as the most significant codes in the dataset based on how grounded they were amongst others codes. The stakeholders that we interviewed considered Clark University as an institution that foster cutting-edge education, which promote sustainability through collaborative partnership through a multidisciplinary approach. What this means is that projects at Clark that are designed and implemented by staff, faculty and students across various departments through collaboration and have the potency of being integrated within the curriculum to inform academic excellence, leadership and competence.

4.2.2 Categories

The next step involves collapsing similar codes into broader categories or concepts from which we formulated themes that would guide our action project. Each category relates to a specific concept that we explored. We collapsed related codes into categories based on their similarities. Codes that were similar in context to a particular aspect of our project were collapsed into the same category. Table 2.0 shows the list of categories based on how they are grounded in the dataset as well as their density with other categories. The result shows that sustainability grounded at 23% is the most salient category in the dataset. This also indicates that most interviewees considered Clark University as an institution that engages in sustainability projects and practices to reduce its ecological footprints (ClarkU, 2007, 2009).

Category	Label	Grounded	Density
Sustainability	SUS	23	5
Landscape Design	LANP	22	5
Collaborative Partnership	COP	20	5
Challenges	CH	19	5
Education	EDU	19	4
Access to Resources	ACT	10	4

Table 2: Major Categories

Landscape design was also a category that was highly considered as one of the significant results that was predominantly salient from responses of stakeholders that we interviewed. The respondents agreed that the design of the edible, sustainable landscaping project should take into account the selection of plant varieties that would not require intense human labor, irrigation and the application of chemical fertilizer. In short, the design should be self-sustaining by integrating plant cultivars that support each other.

Another category that was significant in our result is the concept of collaborative partnership in the planning, development and implementation of campus-base students-led

projects. We thought this is an important finding because Clark University has always promoted the idea of approaching a problem from an interdisciplinary perspective incorporating various ideas, concepts and skills in finding doable solutions.

Figure 1 shows the network of relationships that exist between each categories of our dataset. The relationship between each category is defined by the definition of the links between each node. The relationships indicate that there is an association between education, collaborative partnership and landscape design; whereas, sustainability is part of education and associated with collaborative partnership and landscape design. Access to resources was identified, as a major challenge and is part of landscape design and collaborative partnership. Interestingly, access to resources is a cause of challenges towards sustainability, which contradicts education. The main message of this relationship is that in order to create a sustainable edible landscape on campus, major challenges, which include access to resources, should be addressed through collaborative partnership and education.

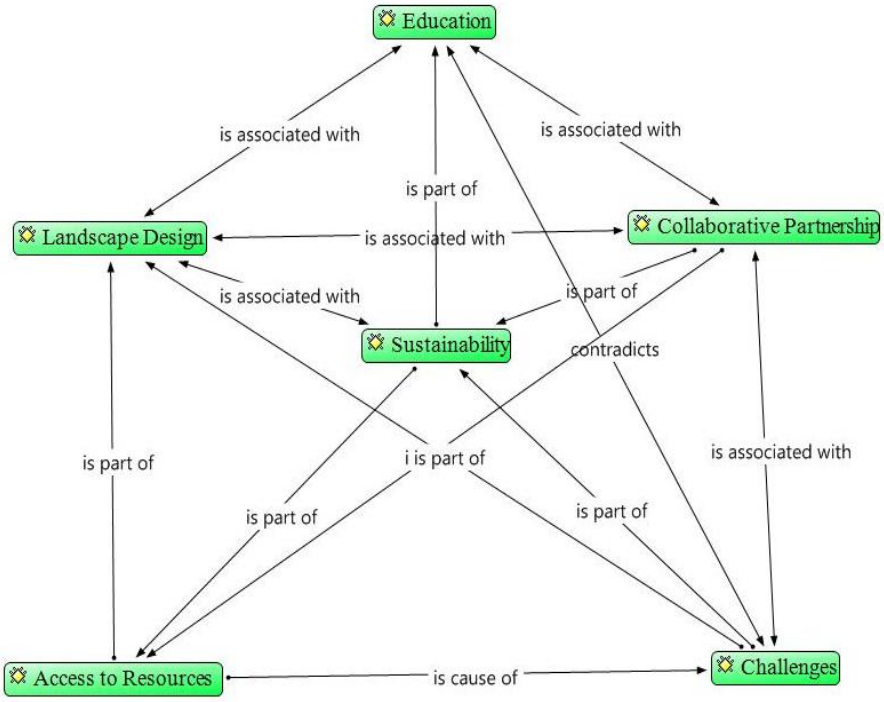

Figure 1: Relationships Networks of Categories

4.2.3 Major Themes

Finally, we also merged similar categories into much broader themes that capture the spectrum of the data our stakeholders provided. We merged categories into four broader themes to formulate the theory that guided our research, which forms the units of analyses for the primary research component of our study. Figure 2 shows the network of relationships our four major themes. The four major themes that guided our project include landscape design, education, and collaborative partnerships. The network of relationships suggests that there are two-ways associations between landscape design, education and collaborative partnership, which means that to implement effective landscape design to be implemented, education of staff, students and faculty are necessary components to establishing collaborative partner, which would provide the needed resources for project implementation. There is a negative relationship between education and challenges. This contradiction is discussed when we discussed each theme in more details later in this chapter.

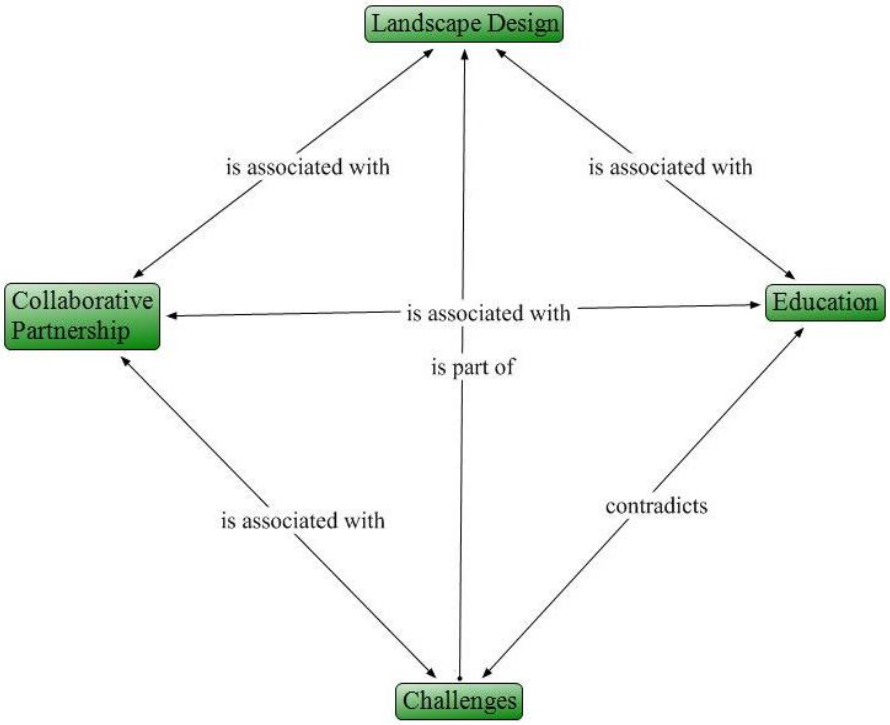

Figure 2: Relationships Networks of Themes

The following section provides snapshots of some of the direct quotations from interviewees and from field journals that relate each of the four major themes listed above.

4.2.3.1 Landscape Design

Site Identification

"Some plots should be retained as open areas for recreational activities such as plots in front of the main campus. Some plots should be replaced by edible landscaping or eco system such as a plot in the intersection between Maywood and Downing Street. The plot between the library and police station is more sustainable because it has some trees instead of grass" ***(Interview response from a professor at Clark University).***

"There are several sites on campus that could benefit from redesigning, areas near the Goddard Library elevator toward Downing Street and any plot in the new Downing Street area" ***(Interview response from a staff member at Clark).***

"Grass in front of Lasry should be replaced with more sustainable plants. Main campus – the main campus "green" is attractive but not sustainable, such a high-use area should have an example of sustainability" ***(Interview response from a professor at Clark).***

Plant Selection

"Some of the plants that can be planted in the garden can include various varieties of tomatoes, carrots, corn, possibly bok choi ("normal" foods), fruit trees, native species, Asian-Longhorn beetle non-hosts" ***(Interview response from a professor at Clark).***

"Tomato-Basic planted together - aromatic pest "confusers" like basil can be natural pest deterrents. This is especially useful with plants that have many common pests like tomatoes. Potatoes planted with marigolds (also aromatic pest

confusers). Three sisters planting – corn provides a tall stalk but requires lots of nitrogen. Beans produce usable nitrogen through nitrogen fixation and need something to climb up, in this case corn stalks. Squash vines grow along the ground and protect the soil from drying out. "Layered plantings"-Garlic (pest repellant), clover (ground cover, N fixer) or strawberries, chard and kale (grow taller than the ground-cover), fruit trees (taller than kale)" ***(Field Trip Notes at UMASS Amherst-FPWUMASS01 & 02).***

"Some great perennials: consort black currant, anise hyssop, yarrow, feverfew" ***(Field Notes UMASS-Amherst).***

Plot Design

"Hosting a design contest is a great way to raise awareness, get volunteers, and design the site. They designed their gardens with a sheet mulch substrate – compost, then cardboard, then mulch on top (wood chips)" ***(Field Notes UMASS).***

"We plant in several gardens usually using planting in different arrangements, most of them with companion or complementary plantings" ***(Field Trip Notes at UMASS Amherst-FPWUMASS001 & 02).***

"Beds can be mulched with straw (not hay). Utilize vertical space and create several microclimates by building an herb spiral" ***(Field Notes at UMASS Amherst).***

4.2.3.2 Collaborative Partnership

"The university is probably open to the idea of edible landscaping it should reduce maintenance, someone needs to commit to maintaining it, Physical Plant will probably help with installing the site, including providing wood chips, workers, tools, trucks for transportation" ***(Interview response from a staff at Clark).***

"Money, committed volunteers that have a long-term presence (not students) and the Administrative support, project performance evaluation as well as

collaborations, scale, climate or weather" ***(Interview response from a professor at Clark).***

"Marsh Institute could provide space for working. Interns working on the project could use the offices and meeting rooms. Someone in the department might be interested in doing research related to this project" ***(Interview response from a professor at Clark).***

4.2.3.3 Education

"Use within class: use as a place for doing field trip. Use as a possible internship opportunity: it depends on how big the project is, whether it is big enough for supporting internship" ***(Interview response from a professor at Clark).***

"Dining service occasionally has local food which promotes awareness of local food. I was curious about student perspective and involvement" ***(Interview response from a professor at Clark).***

"Could be useful within classes, might be a LEEP pioneer opportunity in gardening or education IDCE or geography department could use it to study urban geography. It could foster the study of connection to "place" in association with this project" ***(Interview response from a professor at Clark).***

"Sustainable landscaping is important to promote local organic food systems, improved nutrition and food systems, and societal awareness" ***(Interview response from a professor at Clark****).*

"Edible Landscape would allow Clark to be a model for the neighborhood and City" ***(Interview response from a professor at Clark).***

4.2.3.4 Challenges

"Money, committed volunteers that have a long-term presence (not students) and the Administrative support, project performance evaluation as well as

collaborations, scale, climate/weather" ***(Interview response from a professor at Clark).***

"It is challenging finding a way to communicate with students and faculty that are primarily off campus. The politics, differences in opinion following up on results, and measuring behavior change" ***(Interview response from a professor at Clark****).*

"Funding is a big challenge. Also, Clark relies on student initiative because the staff is always busy of works. Students have short time period studying, so it is difficult to maintain the participation with big project that need a long time to finish" ***(Interview response from a professor at Clark).***

"The weather is a major challenge. The availability of students to work on this project requires the support from authorities on campus" ***(Interview response from a professor at Clark)****.*

4.3. Action Project Findings

In this part of our project, we present details of what has been achieved in terms of developing a plan for an action project and the criteria used for the selection of a site on campus for the establishment of the an edible, sustainable landscaping plot. After careful analysis of the responses from major stakeholders and based on recommendations from Physical Plant on the selection of potential sites and variety of plants, we selected a plot closer to the Goddard Library and located on Downing Street for the implementation of the project edible, sustainable landscaping plot. The criteria developed and used in the selection of a plot include whether or not the potential plot was difficult to mow and maintain, a plot that was entirely covered with grass, irrigated by a sprinkling system and a plot that was highly visible to students, staff, faculty and the entire Clark community. These core criteria were used in identifying and assessing a legitimate and viable site for the establishment of the project. Figure 3 shows the selected plot that is currently been explored for the establishment of our project.

Figure 3: Plot Selected for Edible Sustainable Landscape

We are still in the planning and negotiation stages for the approval of this site. Once the site is approved and if we can receive some funding, we are planning to start the "ground breaking" ceremony during next semester to start the project. We already have positive hopes from the support of professors, staff as well as Jenny Isler and Chip from Physical Plant. Once we have the final approval and the weather starts to become warmer, we will contact the City of Worcester and other local agencies for compost. We will also contact professors who expressed interests in our project to see how best they could integrate this project in their course curriculum for students to participate. Part of this process will be a massive effort on campus to solicit students' involvement next semester through awareness campaign on social network websites such as Facebook, Twitter and LinkedIn.

During the academic semester, we conducted a field trip to edible, sustainable landscape project at the University of Massachusetts at Amherst. The purpose of the field trip was to engage with stakeholders and practitioners who similarly designed and implemented edible, sustainable landscape project at their university. Informal discussions held were part of the data collected and the results were used to inform plant selection, plot design and strategies to formulate to have students engage and create awareness. Figure 4 is a photograph of the edible, sustainable landscape project at UMaas-Amherts.

Figure 4: Edible Landscape Plot-UMass, Amherst

As part of our project, we have designed the selected plot by using Google Sketch Up. Google Sketch Up is a free an open source online platform that allows users to create plans for any structure in order to create a visual presentation of ideas and concepts. We finalized the desire plot design to be used to create in creating the edible, sustainable landscape garden on campus as visual aid to accompany our reports and subsequent project reports. We will provide a completed sketch and design of the plot to Physical Plant and the Office of Sustainability. The design was developed in consultation with professors,

staff and experts in sustainability and landscape ecology and it captures the details of a semester worth of research, planning, designing and sketching. Figure 5 shows the sketched map of the proposed plot for the implementation of our project. We also developed a list of specific plant species that we proposed to cultivate in the plot (Appendix C).

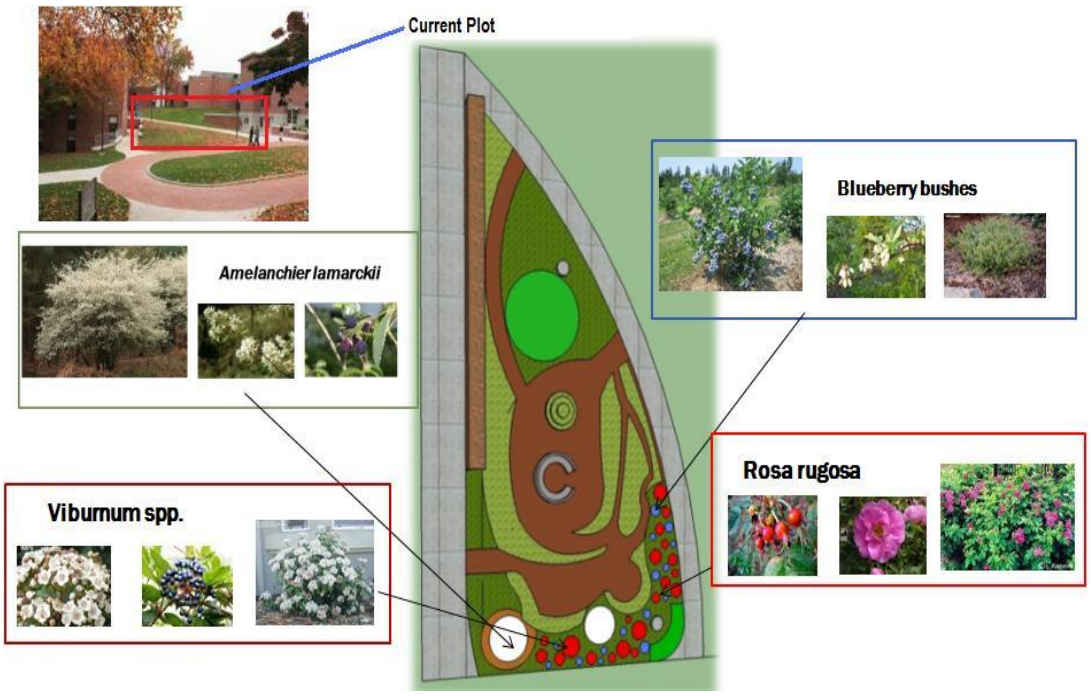

Figure 5: Sketched Plot of Edible Landscaping

In the process of selecting the site for our project, conducted a soil test analysis through the Worcester Roots Project to determine the pH of the soil and the various measurements of micronutrients that support plants growth and development and the level of lead in the soil to determine if the selected site is hazardous to humans. The results indicate that Phosphorus (P = 2ppm), Potassium (K = 102ppm), Calcium (Ca =678ppm), and Magnesium (Mg = 35ppm) where all within the normal range and that composting and mulching are recommended practices to replenish these essential nutrients. The result also illustrates that Lead (Pb = 3ppm) is below the hazardous level of 300ppm and does not have any significant effects of humans' health (Appendix D).

4.4. Discussion of Themes

4.4.1. Introduction

In this section, we discuss the results of our primary research component of our project. The discussion would be based on the four major themes presented in the previous section. It is our hope that this project will receive funding so that we can be able to put to into action our plans for creating and promoting edible, sustainable landscaping on campus. It should be noted that this project is still in its preparation stages and is subject to be modified in view of constant review of results from data collected and response from major stakeholders.

4.4.2. Landscape Design

Edible, sustainable landscaping is the process of incorporating traditional, organic form of vegetable crops, herbs, and shrubs production using sustainable strategies that support local systems by reducing our impacts on the local environment. During our interviews, field trips and personal observations, we talked and interacted to experts, professors, practitioners and staff engaged in creating and promoting edible landscaping and sustainability at Clark University and UMass Amherst. The following is a discussion of our results in order to learn how this process can be implemented at Clark to create biodiversity within the local ecosystem, reduce water use and labor cost and to serve as local food system for both humans and animals.

The results from analyzing qualitative data show that site identification, plant selection and plot design were sub-categories identified to be salient among all interviewees. A professor from Clark University who is very involve in sustainability and water used management indicated that the establishment of an edible landscape would have to be done in areas where there are enough grasses. She indicated that:

> *"Grass in front of Lasry should be replaced with more sustainable plants. Main campus – the main campus "green" is attractive but not sustainable, such a high-use area should have an example of sustainability."(An interview response from a professor at Clark University).*

Grasses depletes soil nutrients, excessive use of water, it is expensive to maintain and requires intensive labor. There are lots of places on campus that are solely planted with grasses and that system is not energy efficient. Another professor who is also very interested in our project suggested that while grasses are inefficient and cost intensive, it is would be great to retain some plots on campus that would still have grass for recreational activities:

> "*Some plots should be retained as open areas for recreational activities such as plots in front of the main campus. Some plots should be replaced by edible landscaping or eco system such as a plot in the intersection between Maywood and Downing Street. The plot between the library and police station is more sustainable because it has some trees instead of grass" (Interview response from a professor at Clark University).*

A staff member at Clark who is responsible for all physical infrastructures added that why edible landscaping seems to be a good idea, there are several sites on campus that needs to be redesigned in line with sustainable and efficient strategies, such as edible landscaping. This is what that staff member had added:

> *"There are several sites on campus that could benefit from redesigning, areas near the Goddard Library elevator toward Downing Street and any plot in the new Downing Street area" (Interview response from a staff member at Clark).*

Another aspect that came up during the interview is the selection of plant for the proposed edible, sustainable landscape plot. All of our interviewees made significant attempts to suggest potential plant cultivars that can be selected for this project considering their environmental significance, ecological values and ability to adapt to changing environmental conditions. One interviewee indicated that plants selected should include variety of vegetable crops and native species of fruit trees that would not be susceptible to pests and insects infestation. This is what that professor added:

> *"Some of the plants that can be planted in the garden can include various varieties of tomatoes, carrots, corn, possibly bok choi ("normal" foods), fruit trees, native species, Asian-Longhorn beetle non-hosts" (Interview response from a professor at Clark).*

We were also very fortunate to be able to take a field trip to the edible landscape project at the University of Massachusetts at Amherst in October. During our visit, we had the opportunity to talk with some students and staff members that actually planned and implemented similar project at that institution. They talked to us about their experiences, progresses and some of the challenges they had gone through to make their project possible. However, when we asked them about plants selection, this is what they suggested:

> *"Tomato-Basic planted together - aromatic pest "confusers" like basil can be natural pest deterrents. This is especially useful with plants that have many common pests like tomatoes. Potatoes planted with marigolds (also aromatic pest confusers). Three sisters planting – corn provides a tall stalk but requires lots of nitrogen. Beans produce usable nitrogen through nitrogen fixation and need something to climb up, in this case corn stalks. Squash vines grow along the ground and protect the soil from drying out. "Layered plantings"-Garlic (pest repellant), clover plant (ground cover or nitrogen-fixing plants), strawberries, chard and kale (grow taller than the ground-cover), and fruit trees (taller than kale)" (Field Trip Notes at UMASS Amherst).*

Plant selection is an important aspect to thoroughly consider when deciding on edible, sustainable landscaping because some plants species may actually be inviting pests and insects. Basic agricultural field practices such as crop rotation, companion cropping, intercropping and mixed cropping could be some of the best approaches to use in order to reduce plants' susceptibility to insects, pests and microorganisms in the soil.

As much as site identification and plant selection are important, the design of the actual plot to be used for edible, sustainable landscaping is equally important because the design of the plot tells the story of the garden to passerby as well as creates aesthetic attraction. We are very appreciative to our interviewees for some of the magnificent ideas proposed in soliciting the perfect design for our plot. One such suggestion came from practitioners we interviewed at UMASS-Amherst. They suggested that one way to have the students engage and own the project is to stage a "Landscape Design Contest." In this contest, students from across departments would design and defend their proposed landscape design. This is what the practitioners at UMASS-Amherst added:

"Hosting a design contest is a great way to raise awareness, get volunteers, and design the site. They designed their gardens with a sheet mulch substrate – compost, then cardboard, then mulch on top (wood chips)" (Field Notes UMASS-Amherst).

The edible landscape plots at UMass-Amherst used one of the sustainable cultivation practices mentioned earlier and that involves "companion planting." Companion planting is not a new strategy. It has been in used for thousands of years. It is commonly used among Native Americans and the concept of "Three-Sisters for Life" applies the companion planting principle. The Three-Sisters for Life is a concept that integrates the cultivation of beans, squash and maize at specific intervals, growing at different stages and providing mutual support through a symbiotic relationship of mutualism.

"We plant in several gardens usually using planting in different arrangements, most of them with companion or complementary plantings" (Field Trip Notes at UMASS Amherst).

The concept of mulching was brought up by one of the practitioners at UMass-Amherst. Mulching like companion cropping is not a new concept. The practice of mulching during sunny weather keeps the solid moisture content at satisfactory levels that plant needs, it decreases the growth of weeds and significantly reduce evaporation and when the straws decay through the mulching process, the decaying debris add nutrients back to the soil-a process that reinforces biodiversity and the local ecosystem. This is what they added:

"Beds can be mulched with straw (not hay). Utilize vertical space and create several microclimates by building an herb spiral" (Field Notes at UMASS Amherst).

4.4.3. Collaborative Partnership

Every project that needs to be implemented effectively and with adequate financial, material and human resources relies on partnerships. Projects being planned, designed and

implemented by students is no exception to this fact. Likewise, the effective planning and implementation of our project requires effective collaborative partnership.

As part of the data analysis and result, collaborative partnership was identified as one of the salient themes. Institutional policies, local laws, maintenance cost, access to financial and material resources and lack of information by students engage in action projects are some aspects that became paramount features in considering collaborative partnership. A staff member at Physical Plant at Clark had this to say on how their department is willing to collaboratively partner with us in making sure that needed materials and assistance are provided:

> *"The university is probably open to the idea of edible landscaping it should reduce maintenance, someone needs to commit to maintaining it, Physical Plant will probably help with installing the site, including providing wood chips, workers, tools, trucks for transportation" (Interview response from a staff at Clark).*

A professor at IDCE added that financial inputs, volunteers' commitment, administrative support from faculty and staff at Clark and other factors such as project performance evaluation are paramount component of the partnership process. This is what he added to the discussion on collaborative partnership:

> *"Money, committed volunteers that have a long-term presence (not students) and the Administrative support, project performance evaluation as well as collaborations, scale, climate/weather" (Interview response from a professor at Clark).*

The process of collaboration in the implementation of this project also relies on the capacities of professors who can use their influence-not with force, to encourage and mobilize students in their class to consider participating in our project. One way to approach this is to set up internship opportunities for students who would like to get involved in the project and earn course credit towards their studies at Clark or within the Consortium. Another professor associated with the Marsh Institute at Clark added that:

> *"Marsh Institute could provide space for working. Interns working on the project could use the offices and meeting rooms and someone in the department might be interested in doing research related to this project" (Interview response from a professor at Clark).*

4.4.4. Education

Education is one of our key themes. Across all of our interviewees, education was the most salient theme of all the four themes being discussed. All of our interviewees agreed that there is a continuous need to bridge the gap between research and the application of research findings. Interviewees praised Clark University's LEEP initiative as one step in bridging the disconnection between theoretical and applied knowledge. However, they also cautioned that it is not time to relax because there are yet more that needs to be done. On this note, respondents urged that there is a need to prioritize students' projects as part of academic courses to foster education and awareness of some of the initiatives on campus that others could participate in and learn from the experiences of others. An interviewee from IDCE and also a professor at Clark stated how our project if implemented would be used:

> *"Could be useful within classes, might be a LEEP pioneer opportunity in gardening or education IDCE or geography department could use it to study urban geography. It could foster the study of connection to "place" in association with this project" (Interview response from a professor at Clark).*

An interviewee and sustainability practitioner indicated that when she moved to Clark few years ago, she was impressed with how Dining Services consistently promoted local food systems. This led her to become increasingly curious about the students' perspective and how they are involved. She also praised the Dining Services because preparing locally grown food for students improves their nutrition and also tastes better. This is what she said during our interview with her early December:

> *"Dining service occasionally has local food which promotes awareness of local food. I am curious about student perspective and involvement with respect to their local food system. Sustainable landscaping is important to promote local organic food systems, improved nutrition and food systems, and societal awareness" (Interview response from a professor at Clark).*

She also added that creating a space for edible, sustainable landscaping on campus would give Clark a leading edge among other institutions as a model to imitate. This is what she said when we met her:

"The implementations of edible, sustainable landscaping will provide as the Clark University to be a model for neighborhoods and the City of Worcester" (Interview response from a professor at Clark).

4.4.5. Challenges

All our interviewees acknowledged the challenges that are associated with forming and implementing an action project involving landscaping. All the respondents indicated that these challenges could be minimized if we effectively coordinate with other institutions and departments on campus and in the City of Worcester to access key resources. In an interview with a professor at IDCE, he mentioned that some of the key challenges to most students' projects include monetary, recruiting volunteers and commitment, administrative support and supervision, project performance evaluation, the scale of the project, climate and weather related uncertainties. Most micro projects on campus are planned and implemented by students and some of those projects require funding. A professor at IDCE summed it up this way:

"Funding is a big challenge. Also, Clark relies on student initiative because the staff is always busy of works. Students have short time period studying, so it is difficult to maintain the participation with big project that need a long time to finish" (Interview response from a professor at Clark).

As a group that is passionate about this project, initiating this project during the winter is considered to be a major obstacle because we cannot at this time start any physical work until the spring semester begins when we will start to have warm weather conditions. In a follow-up question during one of our interviews, a professor narrated his frustration with these words:

"The weather is a major challenge! The availability of students to work on this and other projects require institutional support"(Interview response from a professor at Clark).

An important challenge that was highlighted in one of our interviews is that some professors and students find it increasingly problematic connecting with other professors and students who live off campus. How this relates to our project is yet to be conceptualized and contextualized, but it is worth mentioning for the purpose of

exploration in future research project. What connects with our project is how institutional politics, dynamics and opinions influence the decision-making processes. Another issue that an interviewee indicated was a challenge and compromising the effective implementation and evaluation of students' project is that there is lack of adequate mechanism in place to assess behavior change at Clark. In a follow-up question during one of our interviews, a professor summarized this point in these words:

> *"It is challenging finding a way to communicate with students and faculty that are primarily off campus. The politics, differences in opinion following up on results, and measuring behavior change" (Interview response from a professor at Clark).*

In this context, we are talking about behavior change of everyone at Clark not only students. This is a serious claim because most of the problems in the world today are caused by our inability to change certain behaviors. As much as students' behaviors need to change, the behavior of the institution that seeks to nurture "good behaviors" also needs to change. This brings us to the question of why should Clark plant grasses at the Downing Street project if they knew that grasses are unsustainable, labor intensive and too costly to maintain. This question needs to be answered and not only answered but also contextualized within the institution's behavior on some of the principles it teaches.

To conclude, we identified four major interrelated themes that are paramount to consider in the planning and implementation of edible, sustainable landscaping on campus. These themes include the development of a landscape design that is appropriate to Clark. Plants to be selected and cultivated would enhance soil nutrients, requires no human labor and very low water intake. Based on the collaborative partnership model, this project has been working closely with the Physical Plant and the Office of Sustainability to ensure that we address all pressing issues. Education is paramount to transmitting knowledge and transforming communities. Against this backdrop, we will establish a social networking webpage on Facebook during the spring semester to create awareness of edible, sustainable landscaping. Liaising with students' organizations on campus to stage a "Landscape Design Contest" will follow this.

CHAPTER 5: CONCLUSION AND RECOMMENDATION

"The world is not to be put in order, the world is order incarnate.
It is for us to put ourselves in unison with this order."
–Henry Miller

In this chapter, we conclude our project and present specific recommendations to those who seek to continue our work in an effort to continue this project. The purpose of our project is multifaceted and integrates disciplines in science, social change, and community development. The primary aim of our effort is to implement edible landscaping at Clark University to serve as a model to create behavior change, promote sustainability and reduce maintenance cost. We intend to promote and encourage sustainable food production, behavioral change and reduce labor associated with the maintenance of turf grass. Our goal to administer this permaculture system of edible, sustainable landscaping serves to enhance a healthy ecosystem on campus by increasing biodiversity and improving soil conditions. We also intend to increase public awareness and encourage community engagement through education via the conspicuous location of the plot, the use of informational signs at the location, and also through social networking websites such as Facebook and Twitter.

Against this backdrop, we conducted interviews with faculty at Clark, successful garden club directors at University of Massachusetts at Amherst, and Physical Plant at Clark University. It is important to note that the head of Physical Plant's grounds crew division suggested our current intended plot area based on his professional opinion of where human labor and overall energy would be most effectively reduced.

The arrangement of plants and the design we suggested for the plot developed through extensive research on existing literature concerning permaculture and based on personal communications with experts in the field of sustainability and landscape ecology.

Edible landscaping at Clark University serves as a model for effective and alternative ways of using limited spaces in an urban environment. Additionally, edible landscaping would increases students' awareness of food sustainability, stimulates dialogue and thought concerning the significance of local food production. This

significance is enhanced within the larger context of our current society's conventional regime, which is centered on mass food production, agricultural practices that are both harmful to the environment and human's health. The disconnection of the public's ability to access their own food sources, the cultivation practices and the industrialized processing of food products are paramount components that we addressed while proposing edible, sustainable landscaping at Clark University.

5.1. Recommendations

In this section of chapter 5 we present specific recommendations to potential students and staff who would be interested in further expanding on edible landscaping or other permaculture systems at Clark. One of the most effective actions we took in the development of our project was networking with various stakeholders and institutions. We would like to suggest that this collaborative partnership continue to provide access to resources for the implementation of this project.

The campus garden group at UMass Amherst was informative and inspirational when giving us a tour of their beautiful garden. They explained to us the way their garden was designed, which plants complemented each other, and even gave us advice on how to acquire rocks and signs for ornamentation. There are numerous colleges and universities with successful campus gardens throughout New England, and many of them are glad to share their experiences, tips, and insight with fellow campus gardeners.

Closer to home, the grounds crew division of Clark's Physical Plant office was an immensely helpful resource for us. Physical Plant is composed of people who not only are here year-round, but also witness long-term changes of the campus landscape, as they are not here temporarily like most students. They have a deep understanding of the maintenance required for our campus, and they even offered us access to resources like transportation of garden materials. Clark's Office of Sustainability is also a supportive resource, and Jenny Isler, the Campus Sustainability Coordinator, provides wisdom on the subject of gardening, as well as access to useful records.

Challenges that we encountered during the course of our project include lack of funding, and this is because we did not obtain authorization for the plot. We encourage future developers of this project to connect with the Business Manager Office and work with them to establish a proposal for authorization of landscaping on the plot. If authorization is granted, it will be a great opportunity to secure funding. Although this project doesn't need much money to take off, it is essential to have some kind of monetary support in order to procure basic materials.

Lastly, we think it is important to engage the greater community. One thing we learned from the UMass Amherst garden club is that they used friendly competition amongst students and held a garden design contest. This motivated their peers to engage themselves and resulted in an aesthetically pleasing, harmoniously organized, and highly sustainable garden design. Attracting more students through community outreach encourages people to get involved and gives them incentive to lend a hand.

APPENDICES

Appendix A. Interview Guide

Thanks for accepting our invitation to be interviewed for our current action research project entitle: **"Edible Sustainable Landscaping at Clark University."** In this informal interview, we will be asking you series of semi-structured questions relating to landscaping at Clark University and your role as a staff/faculty/employee/student in ensuring sustainability on campus. It should be noted that these questions are not meant to be exhaustive. Members of our group include Jenkins Macedo, Matt Huck, Dao Hoang and Andrea Gialtouridis. We are all current students of the Sustainability and Higher Education course that is being taught by Dr. Stephen McCauley. This interview will last for about 30 minutes during which we will be taking notes. It should be noted that we would keep your information confidential by developing a code to de-identify you and the information you provided. You are free to stop the interview at any time during the process and it should be emphasized that your participation is totally voluntary. The data that will be collected in this interview are meant for academic and awareness purposes only.

Phase 1: Ask More General Questions

1. What is your name?
2. Do you live on campus?
3. What is your current position?
4. How did you get involve with Clark University?
5. Can you please briefly describe your current job at Clark?
6. How many people work in your department?
7. What are some of the challenges you face at your current job?
8. Since you been started working at Clark, can you briefly describe some of the changes that have occur relevant to your work?
9. How has these changes impacted the university?

Phase 2: More Specific Questions

10. How are you involved in the landscape design on campus?
11. In your own words, how would you describe the current "green" landscape on campus?
12. What current plant species on campus you think are appropriate for sustainable landscape?
13. Are you familiar with the edible sustainable landscape model?
14. How do you think edible sustainable landscaping on campus would ensure sustainability?
15. What kinds of plants would be appropriate for edible sustainable landscaping on campus?
17. How would the university/your department help in ensuring that this model continues on campus?

18. What strategies would be appropriate to change the behavior of others to consider edible sustainable landscaping as oppose to the traditional landscape we see around college campuses?
19. What are some of the challenges do you foresee that relate to this proposed action project?

Phase 3: Summary Question(s)

20. In your own words, how would you describe the effectiveness of implementing edible sustainable landscaping on the campus at Clark University?
21. What do you think would be some of the cost benefits of establishing a model of edible sustainable landscaping on campus?

Appendix B: Cost Benefit Analysis

Cost	Benefit
1. Landscaping $1000-3000 2. Volunteer labor 3. Loss of turn 4. Transportation of materials (various)	a) Habitat creation b) Water savings by reduced irrigation c) Reduced maintenance requirements on physical plant d) Local food production, security and sovereignty e) Energy savings f) Aesthetic improvement g) Increased biodiversity and ecosystem services h) Increase community awareness of healthy food systems i) Harvested produce from the landscape will provide local food for students j) Decrease GHG emissions through sustainable practices

Appendix C: List of Plants Selected

Spreadsheet of plants for edible, sustainable landscaping in central MA

Common Name	Specific name	Family	Form	Habit	Light	Moisture	Soil preferences	Native region	Uses	Functions
Trees										
Amelanchier	Amelanchier spp	Rosaceae	very large shrub	multi-stemmed	full sun	mesic	slightly alkaline	ENA	edible berries	wildlife
American hazel	Corylus americana	Corylaceae	large shrub	clumping thicket	full sun	mesic	slightly alkaline	ENA	edible nuts	dyn acc, nectary
Shagbark hickory	Carya ovata	Juglandaceae	large shrub	tree	full sun to partial shade	xeric to mesic	slightly alkaline	ENA	edible nuts	dyn acc, nectary
Bushes/Shrubs										
High-bush blueberry	Vaccinium corymbosum	Ericaceae	large shrub	multi-stemmed	full sun	varies	acid	ENA	edible berries	wildlife
Creeping blueberry	Vaccinium crassifolium	Ericaceae	prostrate shrub	evergreen, clumping mat former	partial shade	mesic	acid	ENA	edible berries	wildlife, ground cover
Viburnum	Viburnum spp.	Caprifoliaceae	large shrub	multi-stemmed	full sun to partial shade	xeric to mesic	varies	ENA	edible fruit, decorative	wildlife, nectary
Rugosa rose	Rosa rugosa	Rosaceae	m shrub	running thicket	full sun	xeric to mesic	wide range	ASIA	edible fruit, decorative	wildlife
Perennial Herbs										
Yarrow	Achillea millefolium	Asteraceae	medium herb	running	full sun	xeric to mesic	wide range	ENA	medicinal	dyn acc, habitat, nectary, ground cover
Purple cone flower	Echinacea purpurea	Asteraceae	large herb	clumping	full sun to partial shade	mesic	slight alkaline	ENA	medicinal	habitat, nectary
Anise-hyssop	Agastache foeniculum	Lamiaceae	m-l herb	clumping	full sun to partial shade	mesic	slightly alkaline	WNA	medicinal	habitat, nectary
mugwort	Artemesia vulgaris	Asteraceae	medium herb	clumping	full sun to partial shade	mesic	slightly alkaline	ENA	medicinal	nectary
Sage	Salvia officinalis	Lamiaceae	small shrub	evergreen, m stem	full sun	xeric to mesic	wide range	ENA	culinary, medicinal	wildlife, nectary
Asparagus	Asparagus officinalis	Asparagaceae	large herb	clumping	full sun	mesic	alkaline	EURA	edible, medicinal	nectary
Thyme	Thymus vulgaris	Lamiaceae	perennial herb	creeping mat	full sun	xeric to mesic	alkaline	ENA	culinary, medicinal	habitat, ground cover
Comfrey	Symphytum officinale	Boraginaceae	large herb	clumping	full sun to partial shade	mesic	wide range	ENA	medicinal	dyn acc, habitat, nectary
Rosemary	Rosmarinus officinalis	Lamiaceae	s-m shrub	evergreen, m stem	full sun	xeric to mesic	wide range	ENA	culinary, medicinal	wildlife
Rhubarb	Rheum spp	Polygonaceae	large herb	clumping	full sun to partial shade	mesic	alkaline	ENA	edible, medicinal	
Sweet cicely	Myrrhis odorata	Apiaceae	medium herb	clumping	full sun to partial shade	mesic	wide range	EUR	edible, culinary, medicinal	habitat, nectary
Bee balm	Monarda spp	Lamiaceae	m-l herb	running	full sun to partial shade	xeric to mesic	wide range	ENA	culinary, medicinal	wildlife, nectary
Chives	Allium schoenoprasum	Alliaceae	s-m shrub	clumping	full sun to partial shade	mesic	alkaline	ENA	edible, culinary, medicinal	dyn acc, nectary,ground cover

Appendix D: Soil Test Results

SOIL ANALYSIS REPORT FOR HOME GARDENS 11/30/12

SOIL AND PLANT TISSUE TESTING LAB
WEST EXPERIMENT STATION
UNIVERSITY OF MASSACHUSETTS
AMHERST, MA 01003

LAB NUMBER: S121127-216
BAG NUMBER: 112882

SOIL WEIGHT: 5.73 g/5cc
CROP: VEGETABLE

WORCESTER ROOTS PROJECT
5 PLEASANT STREET FLOOR #3
WORCESTER, MA 01610

COMMENTS: INFO@WORCESTERROOTS.ORG

SAMPLE ID: DW013

RECOMMENDATIONS FOR HOME GARDENS:

SOIL PH ADJUSTMENT:
Your soil pH is in the desired range. No limestone is needed this year.

FERTILIZER:
** VEGETABLES: Apply 4-5 lbs 5-10-5 per 100 sq ft in early spring.
OR, ORGANIC FERTILIZER:
If you prefer INSTEAD to provide nutrients from organic sources, apply the following materials per 100 sq ft prior to planting:
NITROGEN AND POTASSIUM: 3-4 bushels well-rotted manure
PHOSPHORUS: 6 lbs steamed bone meal OR 16 lbs rock phosphate

** ANNUAL FLOWERS: Apply 2.0 lbs 5-10-5 per 100 sq ft in early spring.
Alternatively you may use one-half the ORGANIC recommendation given above.

** ROSE BUSHES: Apply 5 tablespoons of 5-10-5 per bush in early June and early August. None after August 15.

Avoid overfertilizing which can cause plant toxicity and can contribute to insect and disease problems.

MICRONUTRIENT		PPM	SOIL RANGE	MICRONUTRIENT		PPM	SOIL RANGE
Boron	(B)	0.1	0.1-2.0	Copper	(Cu)	0.3	0.3-8.0
Manganese	(Mn)	3.4	3 - 20	Iron	(Fe)	10.8	1.0- 40
Zinc	(Zn)	0.7	0.1- 70	Sulfur	(S)	17.0	1.0- 40

SOIL pH 6.7
BUFFER pH 6.9

NUTRIENT LEVELS:		PPM	Low Medium High Very High
Phosphorus	(P)	2	XXX
Potassium	(K)	102	XXXXXXXXXXXXXXXXXXXXXXXX
Calcium	(Ca)	678	XXXXXXXXXXXXXXXXXXXXX
Magnesium	(Mg)	35	XXXXXXXX

CATION EXCH CAP
5.6 Meq/100g

PERCENT BASE SATURATION
K= 4.8 Mg= 5.3 Ca=61.2

MICRONUTRIENT LEVELS
ALL NORMAL

EXTRACTABLE ALUMINUM: 51 ppm (Soil range: 10-250 ppm)

The lead level in this soil is low.

VISIT www.umass.edu/soiltest FOR FURTHER INFORMATION ON SOIL TESTING AT UMASS

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