The Sustainable University

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Clark University, Worcester, MA U.S.A.
Final Report

Chris Adams, Scott Archibald, Liz Bullock, Andrew Cummings, Sam Dorsey-Gordon, Randa Duffy, Carrie Fischer, Nick Gregory-Bernstein, Leah Henoch, Chelsea Hyatt, Amber Huffstickler, Margot Labadorf, Amanda Lee, Drew Jackson, Julie Muszalski, Jeffrey Rock, Kaitlyn Sephton, Alex Swenson, Lukas Parkin, Jonathan Penney

Faculty Advisor: Jennie C. Stephens
Assistant Professor of Environmental Science and Policy (ES&P), Department of International Development, Community, and Environment (IDCE)

Staff Advisor: David Schmidt, Campus Sustainability Coordinator

Back row from left to right: Jennie C. Stephens, Andrew Jackson, Jeffrey Rock, Scott Archibald, Andrew Cummings, Lukas Parkin, Sam Dorsey-Gordon, Jonathan Penney, Chris Adams
Middle row: Chelsea Hyatt, Carrie Fischer, Kaitlyn Sephton, Julie Muszalski. Randa Duffy, Margot Labadorf, Amanda Lee
Seated in front: Liz Bullock, Amber Huffstickler, Nick Gregory-Bernstein, Alex Swenson, Leah Henoch
(not in picture, David Schmidt, Campus Sustainability Coordinator, an integral participant)

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Introduction

By Jennie C. Stephens
Assistant Professor of Environmental Science and Policy (ES&P), Department of International Development, Community, and Environment (IDCE)

This report is the culmination of efforts of 20 undergraduate students at Clark University who were enrolled in an innovative course in the fall 2006 semester entitled "The Sustainable University" (EN 103). This course explored, both in theory and in practice, the opportunities and obstacles associated with "challenging convention and changing the world" to enhance environmental sustainability with a focus on institutions of higher education. The course attracted a diverse set of students including five first-year students, nine sophomores, one junior, and five seniors with majors including environmental science, global environmental studies, geography, economics, psychology, and international development and social change. The design of the course built upon the fall 2005 semester when the course was taught for the first time by my colleague Professor Rob Goble, another faculty member in the Environmental Science and Policy program.

Throughout the semester, the students in this class have been reading, writing, and thinking about the challenges of environmental sustainability and the role of the university in promoting sustainable practices in society. We have read quite extensively the work of David Orr and others who have expanded on the notion that institutes of higher education have great potential to be models for society on environmental responsibility, and that education at a university occurs not just in classrooms but throughout the campus community and space. The university's policies and community priorities, as well as the buildings and campus operations, all play a role in the education of students. We have also been reading about the psychology of fostering sustainable behavior, in addition to considering the complex science associated with many of the most pressing environmental challenges currently facing society.

Complementing the theoretical explorations of sustainability, we took several local field-trips around the Clark campus to learn about existing programs and efforts in and around the Clark community. These field-trips included visits to Clark's recycling center and the Clark co-generation power plant, as well as a tour of several of the local urban gardens within walking distance of the Clark campus. We also had several guest visitors to the class including several representatives from the Regional Environmental Council (REC), Casey Burns and Peggy Middaugh, and an architect and engineer involved in the LEED certification process for the new dorm being built on campus. Other visitors to the class included two students who were involved in last year's "Sustainable University" course, Laura Merner and Lily Acunzo, as well as Professor Rob Goble and ES&P graduate student Stephanie Parent. In addition three students from Worcester Polytechnic Institute (WPI) came to one of our class sessions and shared with us their efforts toward instituting an environmental policy at this neighboring institution. In addition Dave Schmidt, the Sustainability Coordinator at Clark was integrally involved in the class. Dave came to most of the class sessions, provided valuable advice and perspective to the students as they developed their projects, and he also made himself available and provided a variety of information and data to the class. Additionally, input from and connections with all the members of the Sustainability Task Force and the Physical Plant Staff were critical to the success of the student's projects, so thanks to all of these people who have contributed to and engaged with students from this class.

Within the first month of the semester, students divided up into groups to research and develop a specific initiative or potential project related to sustainability here at Clark University. The projects described in this report are the result of the students' research and group actions. These group projects were diverse in topic and scope. Two groups chose to focus on energy; one

group spent the semester examining how Clark University could support and foster a societal energy technology transition to renewable energy, while the other group focused on how to promote energy conservation and energy efficiency. The other groups included an examination of the potential for both green roofs and rain water catchment systems at Clark, research and recommendations on the purchasing and use of green cleaning products on campus, the development and implementation of a re-usable mug program in the Bistro, and the design of a "Green Guide" that will provide a single source of information to be distributed to first-year students at orientation detailing the role that individual students can have in promoting sustainability on campus.

In addition to engaging directly with the challenges associated with promoting sustainable behavior and fostering institutional and social change, these students have also been learning a lot about the challenges of working in groups. Throughout the semester we have discussed the importance of the critical 4 "Cs" of group work: Contribution, Coordination, Collaboration, and Communication. In almost all careers, working effectively with others in a group is a critical and valuable skill, so although completing group assignments and developing projects in a group is in many ways more difficult and complex than doing individual work, I think the students recognize that the experiences that they had working as a team in this course will help them as they move forward with their professional development.

Working with these students has been a pleasure throughout the semester. These students have worked hard and accomplished a lot as they have struggled with the challenges of promoting environmental sustainability at the individual, institutional, and societal level. This final report provides details on each of the group projects completed this semester, but several of these initiatives will continue to be developed and implemented by these students and others on campus beyond this semester, so for up-to-date information about any of these initiatives please get in touch with me, any of the students, or Dave Schmidt, Clark's Sustainability Coordinator.

Efforts Related to Renewable Energy at Clark University

By Nick Gregory-Bernstein, Margo Labadorf, Julie Muszalski
Jeff Rock, and Kaitlyn Sephton

Introduction

The purpose of this paper is to review several current and future options for the promotion of renewable energy at Clark University. This report will be useful to other members of the Clark community interested in renewable energy, including future members of Sustainable University classes. This semester, our group of five students worked on bringing renewable energy to campus. This mission has three main parts, including: encouraging Clark students to sign up for Renewable Energy Credits (RECs), researching the option of having the annual Spree Day concert run on clean energy, and looking into the possibility of a renewable energy installment on our campus.

Although the group has made considerable progress throughout the semester, it is only just the beginning of the process required to bring renewable energy to campus. Much of our time was spent researching, reading articles and case studies, and meeting with various professors, faculty, and staff on campus to discuss our ideas and receive input and advice. The following report is separated into sections, including background information, our progress throughout the course of the semester, and suggestions for the future.

Contents:

1) Introduction to Renewable Energy

Climate change is one of the greatest risks to security, health, and the environment today and is a result of green house gas emissions all over the planet (Philips and Putman, 2006). According to a recent report on the rising temperature in the northeast, "If the use of fossil fuels…remains unchanged, the temperature [in Boston] could top 90 degrees [Fahrenheit] more than 60 days a year by the end of the century" (Daley, 2006). The adverse effects of climate change are unmistakable, from an increase in storms and extreme weather events to floods and droughts, rising sea level, alterations in hydrologic systems and changes in ecosystems. These occurrences are not only dangerous, but they also impact agriculture, food production, and may also be linked to an increase in asthma and the spread of the West Nile Virus. As a result, global health and prosperity are also greatly effected (Philips and Putman, 2006). In order to prevent future environmental damage, it is necessary to greatly reduce our energy consumption and to utilize alternative sources of energy. Society's current energy system relies predominantly on the burning of fossil fuels, including coal, oil, and gas. When fossil fuels are burned for energy production carbon dioxide (CO_2), the most influential

greenhouse gas contributing to human-induced climate change, is emitted to the atmosphere. Shifting society's energy technology toward renewable energy and away from fossil-fuel reliant energy, therefore, is a critical and essential part of all climate change mitigation plans.

Renewable energy, also known as "clean" or "green" energy, is obtained from inexhaustible sources. Options include solar, wind, water, geothermal, and biomass energy. Towering windmills and solar panels with photovoltaic cells may be very expensive to build and install, but the technology is continually improving and the paybacks are significant. As stated in the foreword of the book *The Business Case for Renewable Energy,* "Renewable energy will be an energy source as long as Earth's ecosystems continue" (Philips and Putman, 2006). Alternative energy sources are not only better for the environment, but they are infinite as well.

Colleges and universities can support renewable energy by purchasing renewable energy credits, or establishing a renewable energy project on campus. Renewable energy credits (RECs) are credits purchased to benefit renewable energy projects in a given area. One REC represents one megawatt hour of energy generated and/or sold from a renewable energy facility. The funds received for RECs are allocated to renewable energy funds and research, making sources such as wind power a viable energy option for the future.

There are many tangible benefits of renewable energy for universities. The energy source is reliable, in that it will not run out. In the same sense, there is protection from volatile oil prices. By incorporating renewable energy, universities have the ability to earn LEED points, as well as credits from state implementation plans (Philips and Putman, 2006). The effects are seen on a large scale as well, as the greenhouse gas emissions and the ecological impact is reduced.

Intangible benefits for universities using renewable energy are also important. Universities essentially have great leadership and social responsibility. As former New Jersey Governor Thomas Kean said, "If our colleges and universities don't take the lead in moving us towards a sustainable world, then who will?"(Philips and Putman, 2006). It has been found that not only does campus devotion to the environment and renewable energy appeal to prospective students, it often gains great support from alumni, current students, staff and faculty. Additionally, renewable energy provides educational value and generates positive publicity, and community relations and partnerships with environmental advocacy groups.

On an average day, over 100 square miles of rainforest is cut down and over 15 million tons of carbon dioxide is added to the atmosphere, and the numbers are increasing (Orr, 1994). A recent study found that the amount of phytoplankton, the base of the marine food web, has been decreasing by about 200 million tons per year as the temperature of the oceans increase. It is predicted that this change will affect species throughout the food chain in what is seen as "yet another recent scientific study with real-time data showing that the much-predicted harmful effects of global warming are, in some cases, already here"(Borenstein, 2006).

Considering climate change and its impact on the planet, it is clear that there is a need for an energy transition. Higher education has always played a big role in instituting change and challenging convention, and its involvement in the issue of renewable energy is vital. "Universities, dedicated as they are to education and research, are ideally

positioned to lead the way in addressing global warming" (Clean Air-Cool Planet, 2006). David Orr proposes that, "the worth of education must now be measured against the standards of decency and human survival—the issues now looming so large before us in the twenty-first century" (Orr, 1994). For these very strong reasons, Clark should join the necessary energy transition by supporting renewable energy.

2) Renewable Energy Case Studies

Many schools have focused their efforts on conserving energy through florescent lighting and other energy reducing methods. Some schools have begun to use the money that they save from conservation for renewable energy projects that further benefit their schools. The University of Pennsylvania is one school that has done this. They initiated a massive campaign to conserve energy. Every day they would turn off all of the lights in their classrooms between 3:00 and 3:30pm, when daylight was sufficient to light the rooms. They powered down their computer monitors when they were not in use and they exchanged inefficient incandescent light bulbs for more efficient lighting in residence halls. The money they saved on these projects has allowed the university to use the money on renewable energy (Putman and Philips, 2006).

Students across the country have organized referendums to create student fees that enable universities to purchase renewable energy. Some referendums have advocated raising fees while others have advocated using money from the current fees the university has in place. In the year 2000, the University of Colorado at Boulder became the first university to have such a referendum. The university fees were raised $1 dollar/semester and they were raised $2 more dollars/semester in 2003 so that three student buildings could be run completely on renewable energy (Putman and Philips, 2006).

Carleton College

Carleton College is the first college in America to develop power from a utility grade wind turbine. In 2002, Carlton and Northfield ReNew created a taskforce to explore the feasibility of a wind turbine. They chose an area and tested the winds to determine the potential size of the turbine. With support from the community, students continued the wind turbine project. After a year of development, a 1.65 Megawatt utility grade wind turbine was created. The wind turbine produces 40% of Carleton's energy needs, supporting a student population of 1,764 undergraduates. It successfully reduces the amount of Carbon Dioxide emitted into the atmosphere by 4,318.1 tons (EAC, 2006).

Connecticut College

Connecticut College has proposed the use of student fees to purchase Renewable Energy Credits from an organization called Sterling Planet. The proposal stipulates that credits would be purchased to cover half of the total energy consumption. Additional money gathered from the fees will be used for future projects, and a wind power turbine is a possible future project under consideration (Cárdenas, 2006).

Harvard University

Harvard University has created a renewable energy fund to aid their efforts to become the nation's top university purchaser of renewable energy. The fund will be a three-year $100,000/year fund that is planned to move Harvard from number two to number one on the university sustainability list. A Renewable Energy Advisory Group has been created to advise the university on how to best allocate these funds. Harvard's

main objective is to increase sustainability and reduce greenhouse gas output (Sharp, 2005).

Harvard will also establish a Green Building Loan fund to increase the sustainability of the university. The fund will be used to help renovations and construction of buildings that keep sustainability and energy conservation in mind. Harvard has announced that they will buy renewable energy credits for ten years to support one of the wind power turbines in the town of Hull, Massachusetts. This ten-year agreement is considered to be the longest agreement of its kind (Harvard U Gazette, 2005).

Harvard has made significant accomplishments towards increasing the sustainability of their campus by promoting renewable energy use. Within the Kennedy School of Government, all students agreed to pay $5 each in order to purchase enough Renewable Energy Credits to offset the total energy consumption of the school in 2004. In 2004, Quincy House, one of the undergraduate residential houses, ran exclusively on wind power for a week. The funds used in this project were raised through equal contributions from Quincy residents (1/3), the House masters (1/3), and the Undergraduate Council (1/3). In the fall of 2005, a student-initiated project in the Harvard Business School installed a 192 panel photovoltaic display above Shad Hall. This display prevents the emission of 75,000 lbs. of CO_2 per year into the atmosphere. Harvard Real Estate Services agreed to a two-year deal to buy Renewable Energy Credits to offset the electricity usage of the graduate student housing on One Western Avenue. In the spring of 2005, Harvard's Divinity School decided to purchase renewable energy credits to offset 100% of their energy consumption. Five buildings associated with the Medical School are purchasing energy credits to offset 25% of their energy usage. The Harvard School of Public Health has purchased wind energy certificates to offset 50% of the electricity of all the buildings on their main campus. Also, 25 of Harvard's fleet of vans are now run on biodiesel fuel (HGCI, 2006). By analyzing these all-encompassing efforts, it is clear that Harvard is dedicated to sustainability.

Duke University

Duke University's Fuqua School of Business purchases enough Renewable Energy Credits to cover 100% of their energy usage. This undertaking is independent from the university, representing a first for business schools in the country. This began as a student-based initiative and it gained enough momentum to be carried out by the Fuqua School of Business (Brinn 2006). They purchase their energy credits through Sterling Planet, a company that works with schools and businesses that wish to offset their energy usage with the procurement of Renewable Energy Credits (Putman and Phillips, 2006).

3) The Renewable Energy Credits (REC) Initiative at Clark University

During the 2005-2006 academic year, a group of students began a 'Choose Renewable Energy' initiative to make it possible for students at Clark University to buy renewable energy. During housing sign-ups last spring, students were presented with the choice of offsetting the effects of their energy consumption at Clark by supporting clean energy options (CSI, 2005). This cost added an additional $30 to the student bill. This fall there was another opportunity for students to sign up for RECs, allowing first-year students and other students to purchase the credits.

The culmination of the 'Choose Renewable Energy' initiative occurred on Campus Sustainability Day, October 25 2006. On this day, campuses nation-wide celebrated sustainability within higher education. The central event of the day was the passing of a check for $10,320 from Clark University to the Massachusetts Energy Consumers Alliance to support the New England Wind Fund. This was the result of the REC sign-up that matched students' energy consumption on campus to support the production of renewable energy. In addition to the money raised for the development of wind power, the Massachusetts Technology Collaborative double matched Clark's contribution and awarded one grant to the City of Worcester and another to the state for clean energy projects (Clark, 2006). If this $30 donation became a mandatory fee, Clark would raise approximately $62,070 a year from the undergraduate population.

Future of the REC Program

Although the REC sign-up was a great grassroots effort on behalf of students at Clark, and provided a starting point for the encouragement of clean energy on our campus, there is a need for a new approach in the future. As it stands now, the sign-up period for RECs has been closed since the check was handed over on Campus Sustainability Day. Raising over $10,000 was a major accomplishment, however, but a more efficient process could be developed.

Last spring, the sign-up option was not open to incoming students or students that did not participate in the housing lottery. Other students missed the opportunity to sign up due to lack of publicity or understanding of the initiative. Some staff and faculty also expressed interest in partaking in the program in the future. These are issues that could be taken into consideration to increase participation in the program.

While there is sufficient justification for institutionalizing the purchase of RECs, there are also some reservations within the administration. Raising the price of student fees, even if only by $30, is unappealing to many. In order to fairly evaluate whether this is a desirable option, the idea would have to be approved by Student Government and should be voted on by the student body. Another problem with making the purchase of renewable energy mandatory is that it minimizes student involvement and the educational value of such an initiative. As it stands now, students who wish to participate can be educated about the importance and benefits of the program, and can choose whether or not to support it. On the other hand, the process of gathering signatures and going through all the bills from this academic year created a lot of extra work for staff, and did not raise as much money or awareness as it potentially could have.

By analyzing "Yale's 6-Step Program" towards sustainability, Clark University seems to be doing very well (M'Gonigle and Starke, 2006). The administration continues to "engage the ongoing grassroots efforts of students, staff and faculty" (the program's 2nd step) through support of the REC initiative, Campus Sustainability Day and the Sustainable University class. The Sustainability Task Force, comprised of a broad range of members from across the campus community, was recently created to help decision-making efforts concerning sustainability, and there are plans to generate a method of measuring sustainability at Clark. These are steps 3 and 6 in Yale's program. Other important steps that Clark needs to consider are to "create an institutional strategy and vision" and "institutionalize results"(M'Gonigle and Starke, 2006). According to this, it is most effective to decide the importance of renewable energy within the campus and move ahead to institutionalize current energy efforts. Perhaps the best balance between

institutionalizing efforts and student involvement would be a visible check-off option on the bill for students, with a small explanation of the program.

4) Renewable Energy Options for Spree Day

Spree Day is an annual event held each spring at Clark University, that engages the entire student population. Rich in tradition, this fun-filled day is usually a surprise to students, and classes are cancelled for the day. Students gather on the green to enjoy food and activities, as well as a concert. To further promote Clark's interest in sustainability, the concert at Spree Day provides an opportunity to incorporate energy consciousness in student life.

The concept of renewable energy concerts is becoming increasingly popular. On a large-scale, bands including Guster, Dave Matthews Band, Barenaked Ladies, and Alanis Morissette have joined the non-profit organization entitled, REVERB, to demonstrate their commitment to clean energy choices (REVERB, 2006). Members of REVERB attempt to raise awareness by reaching out to their fans. For example, Dave Matthews Band has encouraged renewable energy by choosing to offset their emissions from their past 15 years of touring (REVERB, 2006). At each venue, the band sets up an "eco-village" including alternative energy displays, as well as information about non-profit agencies and environmentally friendly products (REVERB, 2006). Additionally, to reduce their ecological impact, the tour buses are filled with bio-diesel fuel, the concerts are powered with renewable energy, and recycling programs are set up at the various venues (REVERB, 2006).

Large, popular bands like Dave Matthews Band have utilized NativeEnergy, a Native American owned environmental group that funds renewable projects (NativeEnergy, 2006). NativeEnergy explains that a 40-show concert with four or five trucks and two or three buses is equivalent to about 500 tons of carbon. 250 tons is compiled at the venue for energy use, 200 tons from travel, and 50 tons from accommodations (Legaspi, 2006). In the grand scheme of things, these figures are equivalent to the emissions produced by 83 cars in one year, heating 125 average homes annually, or the electricity used by 62 average homes annually (Legaspi, 2006). Due to the incredible ecological footprint produced by just one tour, it is no wonder that musical artists are beginning to change their behavior.

This is precisely what we hope to accomplish on a smaller scale, at Spree Day next spring. There are two main options to provide the renewable energy for the concert. Sunweaver, an environmental company from Vermont, holds Traveling Solar Shows to raise awareness about solar energy as a renewable resource (Sunweaver, 2006). The company has mobile solar systems that visit a site and provide the power for speakers and musicians for a concert, as well as a solar juice bar (Sunweaver, 2006). Several other schools have demonstrated interest in renewable energy efforts and have utilized Sunweaver, including the University of New Hampshire, Bowdoin College, Keene State College, Hampshire College.

Sunweaver provided the information that small or medium sized concerts require about 20 kWh of electricity. This is not a large amount of energy, in comparison to the entire campus usage on Spree Day last year (April 17, 2005), which was 31,191 total kWh. Last year, Spree Day actually consumed less energy than the average day in April,

32,895 kWh. This is not surprising, as most campus buildings are not open, and students convene on the green throughout the day.

It depends on the length of the concert, but Sunweaver typically charges between $800 and $1,000 for their Traveling Solar Show. Weather is not an issue, as the solar energy is stored in batteries and can be used indoors as well. While this is a considerable cost, the Sunweaver Traveling Solar Show has many benefits. The visible solar panel displays would provide an educational component for students. There is also an element of appeal, as the solar panels and juice bar are physical entities that are visible to students.

Another option for Spree Day is to purchase wind credits from Mass Energy Consumers Alliance and the New England Wind Fund. This is a similar process to the renewable energy credit option offered to students as a housing option. After consulting with an employee at Mass Energy, it was calculated that the wind credits required to offset the 20 kWh required for the concert would only cost about $1. Mass Energy would therefore require the minimum donation of $25. This would offset 500 kWh, which is equivalent to 551 lbs of carbon. While it would not cover energy usage for the entire day campus-wide, it would probably cover all the outdoor events at Spree Day.

As part of the group's future steps with this project, it is necessary and worthwhile to present both options to the Spree Day Committee for careful consideration. There is a clear difference in price between the two options, so the Spree Day budget will obviously be a factor. It is planned that the members of this group will attempt to become members of the Spree Day Committee upon its formation early next semester, or at least present these ideas to the Committee. It would also be useful to continue researching energy usage on campus, and figure out ways to relate energy use with daily use for students. This would be useful in the future in terms of communicating the need for energy savings, with both opportunities and targets. Further research, and hopefully the results of Spree Day could therefore be presented at Academic Spree Day next spring.

In conclusion, Spree Day provides a forum to communicate the need for alternative energy to all students on campus. Spree Day is a traditional event, and is paid attention to in the community. A renewable energy concert or demonstration would certainly gain attention, and provide an opportunity for Clark to receive positive publicity. Essentially, it is possible to unite a fun-filled day while being environmentally conscious.

5) Renewable Technology Review

There are several different ways of producing renewable energy that could be applied to a college campus. These include solar, water, wind, biomass and geothermal. Of these renewables, biomass and water are the more specialized forms of energy creation, requiring a location in close proximity to a large stream or river or a crop of plants, such as Switchgrass, that can be converted into biofuel (Biofuel, 2006). Therefore, we were able to narrow down the renewable technologies that could be implemented at Clark unobtrusively to solar, wind and geothermal. With respect to geothermal, after some research we found that the engineers and architects responsible for the design of the new residence hall had examined the feasibility of a geothermal installation, which would use the heat stored in the earth to heat or cool the interior of the building (Geothermal, 2006). They came to the conclusion that the cost far outweighed the benefits of installing

a geothermal system and thus it was also removed from our list, which left us with solar and wind as options. In respect to an urban college campus, the beauty of solar power lies in the fact that it can relatively easily be applied to any existing roof surface, provided it receives a sufficient amount of sunlight to create the maximum amount of power. A wind turbine, on the other hand, would require a large plot of land to be devoted to its tower and support system and would also require a sufficient amount of wind to make the project cost effective. In addition, solar panels do not detract from the aesthetics of a building, whereas a large turbine is not something that everyone wants to see when they look out their window.

Electricity generated from solar power is created through the use of photovoltaic panels or arrays (in addition to electricity generation, the energy from the sun can also be harnessed directly through passive solar design and solar heating – the direct heating of air and water from the sun). Since the introduction of photovoltaics, the prices have been steadily falling at a rate of roughly 4% annually (Putman & Philips, 2006). Every year we come closer to be able to implement solar power all around the world, at a cost equal to or less than that of conventional power generation. However, the latest obstacle in relation to solar power has been a shortage of silicon which is the most commonly used semiconductor in photovoltaic panels today (Solar Cells, 2006). This had led to a great deal of research on the effects of using thinner silicon semiconductors or even alternate materials that are more cost effective. In addition to the actual panels, the more common form of solar installation, grid-tied, requires an inverter to convert the direct current that is produced by the photovoltaic panels to alternating current used by all household appliances.

The other aspect of photovoltaic technology that plays an important role in its feasibility is its lifespan. Lifespan can vary greatly depending on the manufacturing technology employed, the amount of sunlight being converted into electricity, and the quality of the other components used in the system, cabling, inverter, and the charge controller. Many brands of photovoltaic panels are warranted by the manufacturer for at least 25 years (Kyocera, 2006). However, the other components of a photovoltaic system, even the mounting brackets, may only be warranted for 5 years, a timeframe that makes it nearly impossible to recuperate the installation costs before parts of the unit go out of warranty, which could mean further investment in repairs. As the technology improves, it will only become more efficient and more reliable. Although Europe is far ahead of the United States, as far as moving towards renewable energy production and a more sustainable way of life, the US currently has 2 of the 12 largest solar power plants in the world, well on our way to joining the likes of Germany, which holds the spots for 9 of the other power plants on the aforementioned list.

6) Cost-Benefit Analysis of a Permanent Renewable Energy Project on Clark's Campus

One of the major obstacles to the installation of renewable energy on college campuses is the cost. Renewable energy has high up-front costs, but long-term benefits that can eventually balance the initial investment. In addition, renewable energy sources are improving constantly, having increased efficiency and longer lifetimes.

The benefits of renewable energy are not limited to monetary amounts; there is an inherent positive externality associated with the installation and publicity of these

sources that cannot be measured with numbers. It is one of the responsibilities of colleges and universities to be models and educate their students and the surrounding public on ways to utilize sustainable energy in our world of growing environmental concern.

In theory, a permanent renewable energy source should be justifiable for purely ethical reasons. However, economics clearly play a large role in the feasibility of renewable installation. In the following section, the financial possibilities for funding a renewable installation will be presented to aid future proposals regarding installation of renewable energy sources on Clark's campus.

Potential Renewable Energy Technologies

There are a variety of possible renewable energy sources available on the market. These sources include solar photovoltaics (solar panels), biomass, wind power, landfill gas, municipal solid waste, and hydropower. Of these sources, those most commonly used on college campuses are solar, wind and biomass because of their availability and minimal environmental impact. The costs of these sources range from 3.8-7.0 cents per kilowatt-hour for wind power, to 3.8-7.0 cents per kWh for biomass, to anywhere from 29-64 cents per kWh for solar. Though most expensive, solar is the most common form of renewable energy because it can be easily expanded from a small initial installation. For this reason, and because Clark does not have a budget to fund a large renewable project up-front, this analysis will focus on funding for a solar PV project.

Potential for Solar at Clark

The main initial difficulties in selecting a solar PV system are deciding where it should be located and how much power should be generated. Renewable sources will have the greatest impact when installed on buildings that are already energy efficient. For this reason, on Clark's campus, those buildings most likely to benefit from solar panels would be the LEED certified structures. These buildings include the Lasry Bio-Science Center, the Dolan Fieldhouse and the new Residence Hall, which will soon be assessed for LEED compliance. To analyze cost effectiveness, the calculations in Table 1 are based on a theoretical 12kW system installed on the roof of the Lasry Bio-Science building.

The Lasry Building uses an estimated 80,000 kW per month (Clark Co-gen Data, 2006). According to data from the 2005-2006 school-year, campus-wide, Clark's energy purchase to generation ratio was one to five. In other words, for every kilowatt of energy Clark purchased, we produced five (see Table 1). So, technically of those 80,000 kW of energy used per month in the Lasry Building, 16,000 of them were purchased directly. That 16,000 kW per month translates to 22 kW per hour. A 12 kW solar PV system produces 12 kW of energy per hour, or 54% of the 22 kW of purchased energy used in the Lasry Building.

A 12 kW solar PV system will save an estimated $1,728.46 per year, or $144.03 per month. This estimation was made by PVWATTS, a source using location-based data to calculate the amount of energy and cost associated with solar PV systems of various sizes. The pre-programmed data for Worcester (including solar angles and DC to AC Derate Factor) supplies data for monthly and yearly savings.

An estimated cost for installation of solar PV panels is $5,500.00 per kW (Putman, 36). Using this estimate, a 12 kW system will cost $66,000. With no state or federal aid, the system will pay for itself in 38 years (see Table 1). Current solar panel technology lasts

approximately 20 years, so it is unlikely that an investment would be made without some financial aid.

Financial Incentives to Offset Costs

Fortunately, this aid is not hard to come by. Massachusetts offers grants and rebates as financial incentives for renewable projects. The 2005 Energy Policy Act initiated a 30 percent federal solar tax credit applying to "the investment balance remaining after any state (or utility) incentive." (Putman & Philips, 2006). This Act may expire on December 31, 2007, and hence must be acted upon in the near future. Massachusetts is also listed in the top nine states for the amount of available solar subsidies and supplies $383 million in public benefit funds for renewable energy. Also, many states have a stand-by charge; this charge acts as insurance that in the event of a renewable generator failure, the electric company will supply electricity. Massachusetts has exempt clean on-site generators from stand-by rates, creating even greater incentive to install such systems.

Lists of financial aid opportunities for each state in the U.S. can be found online (DSIRE, 2006). Renewable aid is often specifically defined for certain consumers or types of generators, and finding appropriate funding is an involved process that must be carefully approached. Estimations about energy and costs of systems can be found at the U.S. Department of Energy's website for the National Center for Photovoltaics (DoE, 2006). This site offers valuable information for researching and executing renewable projects. It also provides information on new Photovoltaic research and development, and can help ensure that the most advanced, reliable equipment is used.

Although renewable energy is a very important and a noble endeavor, it is expensive. Cost-benefit analysis is important in deciding how much aid is needed to make a project possible. It is likely in most cases that the costs will outweigh the benefits in the short run if one institution with limited funding is attempting the project. Yet, while financing a project may seem difficult, there are many available resources that can contribute. Hopefully, the day will come in which Clark is seriously researching those options to prepare for a renewable project on campus. A renewable energy installation on campus would provide educational value that will facilitate both the social and technical change that must occur for the coming energy technology transition.

Table 1 –Estimate of Power Potential for a PV System at Clark

Energy production potential of solar panels

Physical Plant estimates that the Bio-Science building uses a monthly average of 80,000 kW. Therefore,

$$80{,}000\frac{kW}{month} * \frac{1month}{30days} * \frac{1day}{24hours} \approx 111\frac{kW}{hour}$$

Installing 12 kW solar PV panels on the roof yields:

$$\frac{12kW}{111kW} \approx \frac{1}{9}$$

Approximately 11% of the total energy used in the Lasry Center building could be generated by the PV panels.

For 2004-2005, according to Physical Plant data, Clark bought 166,274 kWh of energy per month on average. Clark generated an average of 806,602 kWh for a total of 972,876 kWh average overall monthly energy use. Using these values, Clark purchased:

$$\frac{166{,}274}{806{,}602} \approx \frac{1}{5}$$

of its total energy for the year. So, it can be estimated that:

$$80{,}000 * \frac{1}{5} = 16{,}000kWh$$

of the energy used for one month in the new Bio-Science building was purchased directly. With 12 kW panels, it can be estimated that:

$$16{,}000\frac{kW}{month} * \frac{1month}{30days} * \frac{1day}{24hours} \approx 22\frac{kW}{hour}$$

and hence,

$$\frac{12kW}{22kW} \approx 0.54 = 54\%$$

If a 12 kW solar PV panel system were installed on the Lasry building, 54% of the energy currently purchased could be produced.

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Exploration of the Implementation of Green Roofs and Rainwater Catchment Systems at Clark University

by Lukas Parkin, Andrew Cummings, Chris Adams, Scott Archibald, Drew Jackson

Executive Summary:

In the Fall 2006 Semester, a group of students taking the class entitled The Sustainable University tried to find ways for Clark to reduce surface runoff. One of the more effective methods found was the installation of green roofs. Not only do green roofs reduce runoff, they also reduce atmospheric carbon dioxide (CO_2) concentrations by providing an additional carbon sink (plants) and by reducing emissions of CO_2 through the additional layer of insulation that reduces heating and cooling bills, reduce the "heat island effect," and create new habitat for birds and insects (Sklodowska). Green roof installation also increases awareness of sustainability within the student body as well as in the surrounding community.

Another effective method found to reduce surface runoff is the installation of a water catchment system on buildings at Clark University. Not only would a water catchment system reduce runoff, it would also collect water that could be used for a number of tasks, such as irrigation, reducing Clark's water usage. Such an installation would increase awareness of sustainability within the student body as well as in the surrounding community.

Additionally, green roofs and water catchment systems may make Clark more attractive to potential students interested in sustainability.

Introduction:

This project has evolved from a group effort involving five students enrolled in the course titled "The Sustainable University" at Clark University in the Fall 2006 semester. This course is designed to increase awareness about the importance of having a sustainable campus and learning how to make our world more sustainable. To help the movement towards these objectives, students in our class were to research potential sustainability initiatives that could be implemented around the Clark University campus.

<u>Green Roofs</u>

One initiative that our group thought would help Clark become a more sustainable living area was to have green roofs installed on one or more buildings on the Clark University campus. We have been using this semester to research and present information to different parties about the idea. Green roofs are essentially plants placed on the top of a building that reduce heating and cooling energy use, run-off water, and carbon dioxide (CO_2) emissions. This semester we have studied many aspects of green roofs and have discovered their importance and their many benefits. Many places in the United States, including many colleges, and many places across the world have green roofs that provide multiple benefits with many different types of green roofs. The variety of roofs is vast and our group has been doing extensive research helping to locate and suggest the type of roof that would be most appropriate at Clark University.

<u>Rainwater Catchment System</u>

A rainwater catchment system is designed to trap and retain water that runs off the

roof of a building. After capturing some of the water it can then be used for irrigation and cleaning purposes. Using the water that would otherwise be runoff would save Clark money on irrigation. Rainwater catchments are extremely useful. This is displayed in the amount of catchments that can be found across the county in addition to around the world. It is not uncommon to see a college or university that has an extensive rainwater catchment system. As with green roofs, our group has been doing extensive research helping to locate and suggest the best way to proceed with implementing a rainwater catchment system.

Background:

What is a Green Roof?

Green roofs began years ago in northern Europe on many rooftops to help with insulation needs. Europeans were the first to implement this process by applying moss and various self-sustaining plants on top of their roofs when they discovered its benefits. Modern green roofs consist of a thin layer of plants placed on top of the roof in soil varying from two inches to one foot. A green roof consists of the plants on top, a layer of soil, a drainage basin, insulation, a membrane, and the roofing structure in that order. The membrane sometimes has a root repellant to prevent any roots from penetrating the structure. There are two differences in the type of green roofs that can be installed: intensive and extensive. Intensive roofs require a minimum of one-foot soil depth and are more complex. They can accommodate trees as well as different shrubs, and regular access to the roof is encouraged, but regular maintenance is required. The extra load on the building per square foot can be 80 to 150 pounds and requires a complex irrigation and drainage system. Extensive green roofs are used for buildings that cannot withstand much more added weight, requiring a soil depth of only 1 to 5 inches. The vegetation is mostly ground cover and grasses and adds only about 12 to 50 pounds per square foot. These types of roofs are not designed for public access, and they require annual maintenance and the irrigation and drainage systems are simple (Green Roofs 101).

Benefits of Green Roofs

In the summer months, green roofs reduce the need for air conditioning, and in winter the roof reduces the heat demand making it a financial benefit. On a hot summer day a regular roof can be up to seventy degrees warmer than a green roof. The rooftop temperature is reduced by shading the surface from the suns radiation, insulating and absorbing moisture. Along with this, a green roof can reduce the urban heat island effect. This is a process that occurs in cities and is not related to global warming. It occurs in built up cities that don't have a lot of vegetation to absorb the heat and causes the warmth to be held in the city. When this is reduced, a reduction of smog incidents in major cities can also occur. An additional benefit is that green roofs protects the roof itself from the elements and prolongs the life of the green roof (Temple University).

Prolonging the membrane life of a roof is another role that green roofs provide. By the shading it provides, it protects the suns UV rays from blistering into the roofs membrane. On roofs that are accessible to the public, green roofs prevent people from walking its bare surface and acts as a permanent barrier. Green roofs also have a filter cloth below the soil to keep it from washing away, but also to separate it from the rest of the roof. A vital part of the green roof system is the drainage of rainwater. It directs the water towards the drains to prevent the plants from rotting and damaging the roof

membrane and to keep the structure from drooping because of the added water weight. Not only does it drain the water, but delays the time it proceeds to the drains. During a major storm the peak storm water combined with sewage can cause overflows, by delaying the drainage time a city can benefit from this. In a typical rainstorm, a green roof will reduce runoff by about 28% (Gerrits). The soil of the green roof also makes the run off water from the roof clean by filtering out pollutants from the rainwater and storing them in the soil. They also help the environment on a dry day as well by absorbing carbon dioxide and other pollutants. Many major cities such as Chicago and Atlanta have already implemented green roofs on top of their capital buildings and these cities have been gaining from the many benefits green roofs (Tennessean.com).

Along with these benefits, green roofs can also sustain habitats in an urban area for wildlife such as songbirds and butterflies. Green roofs replace the land taken up by a building that was once not there and therefore provides some additional habitat to promote biological diversity. Cities have become barren cement covered landscapes and green roofs make the city appealing to the eye when able to be viewed. The texture, sound and movement of the plants improve the overall health and well being of the citizens around it. Green roofs are becoming a widely acknowledged product and the benefits gained from it in an urban area are beginning to be noticed throughout North America (Temple University).

What is a Rainwater Catchment System?

Rainwater catchment systems are a way of collecting and storing rainwater for everyday uses along with improving the quality of groundwater. Water from rooftops is collected and stored in tanks for future use. Originally rainwater catchment had been practiced in arid and semi-arid climates and provided water for drinking use and water for farming and irrigation. In some areas of the world the water collected from these catchments has either replaced the conventional need for water resources or has limited the need for it. Other areas rely on the water collected from the catchments because of the highly contaminated groundwater unsuitable for consumption. It is a very practical, simple resource in areas that have to meet the needs for large populations (An Introduction to Rainwater Harvesting).

A typical rainwater catchment system is made of three basic items including the collection area, a conveyance system and storage facilities. The collection area is usually the roof area or building. Once the rainwater is collected, a conveyance system consisting of gutters or pipes transfers the water to a cistern or storage tank. The water is then stored in the cistern or storage tank, usually made of reinforced concrete, fiberglass, or stainless steel. Storage tanks can either be built as part of a building or as a separate unit located further away from the building. Many storage tanks are covered with a screen or mesh layer. Rainwater catchment systems require very limited skills and easily operated under a minimal amount of supervision (Rainwater Harvesting from Rooftop Catchments).

Benefits of Rainwater Catchment Systems

There are various reasons why rainwater catchments can be beneficial. Because groundwater is much more vulnerable to contamination from different sources, rainwater is undeniably the safest alternative to an area that cannot afford proper water treatment. Also, the water can be used to support cattle and other animals. Household uses can be fulfilled using this water collected from the catchments. The water can be used for laundry, showers, outdoor faucets and toilets. It can even be used for drinking water

throughout a household when treated correctly, but not recommended. It is advised to have a separate pipe to collect the initial rainwater when a storm occurs. Usually when it begins to storm parts of the roof or elements such as pollutants can wash into the gutter and become stored in one of the tanks if not washed afterwards. The collected water has been and still is useful in the effort for farmers to irrigate their fields when dry spells occur (Rainwater Harvesting from Rooftop Catchments). The amount of rainwater collected can be viewed as one inch of rain on a one thousand square foot roof can yield 623 gallons of water (Rainbarrels).

In different circumstances, the stored water can be an essential reserve in cases such as natural disasters when the public water supply is unable to be accessed. It is also recommended for areas that are prone to droughts, so if one were to occur that certain area would be prepared. Rainwater that is collected is considered to be not as hard other treated water. When water is accessed through a cities' system it usually contains chlorine, lime or sodium. Rainwater also tends to have less sediment and dissolved salts than a public water system. In larger areas, if a major storm were to occur, the catchments would divert water in storage tanks. If it were to drain into the cities water system it would increase the burden water treatment facilities and drainage systems. The simplicity of building a rainwater system makes it a very feasible and inexpensive structure for local people to build (International Rainwater Catchment Systems Association /).

Project goals:

Green Roofs

The goal of this project is to explore the possibility of implementing green roof installations on the Clark University campus. The extent of this, however, is not in our hands, but more in the hands of the Clark University administration. It is our hope that eventually all of the large buildings at Clark, such as Jonas Clark and Higgins University Center will have green roofs in the future.

The first steps in the implementation of green roofs at Clark University is to spread the word about their numerous benefits and gain interest among the Clark community. A great starting website about green roofs for interested individuals is www.greenroofs.com. Clark University should consider setting up a small preliminary extensive green roof on top of one part or all of one of the buildings at Clark as a 2 to 3 year trial run. They could either do this independently with the help of students, or hire a private contractor. This small green roof trial will allow for students to closely study its ability to reduce storm water runoff and reduce energy used for heating and cooling, as well as to study the best combination of vegetation. Along with the visual provided to students and onlookers, it would benefit to set up a poster or hand out flyers so that people can read about why there are plants growing on top of a building. Once it is shown that Clark University can benefit from green roofs after the trial run, the best working model can then be expanded to other buildings on campus. In just a few years, Clark could very easily attain national recognition and praise for their green roofs, as it will be on the cutting edge of innovative sustainability design.

Rainwater Catchment Systems

As with green roofs, the goal of this project is to explore the possibilities of implementing rainwater catchment systems into the normal campus operations. This should be achieved through a gradual process similar to that suggested for green roofs,

starting with education and awareness. Two great educational websites are the International Rainwater Catchment Systems Association (International Rainwater Catchment Systems Association), and http://rainwaterharvesting.tamu.edu/. Clark University should consider setting up a small trial rainwater catchment system on a building using small collection barrel. Accompanying this can be flyers and signs explaining the details of what onlookers are seeing. After a year long trial run of tweaking various aspects of the collection system and using this collected water for irrigation and cleaning purposes, if deemed successful and worthwhile, larger rainwater catchment systems can be installed on other buildings.

Financial Considerations:

Green Roofs

One of the barriers of implementing green roofs on a college campus include the initial costs associated with the planting The typical overall cost to install and maintain green roofs on a campus building can range anywhere from $14 to $25 per square foot of roof (Sklodowska), or up to 70% more than a traditional roof (Henderson). The range in cost is due to a number of factors, such as the current structure of the roof, its waterproofing, what it is made of, its general condition, etc. Keeping this price range in mind, we have calculated the approximate overall price of installing a green roof on a few of the flat roofed buildings on campus. Figure 1 located below shows the various range of costs if green roofs were to be installed on a few campus buildings.

Building	Approx. sq. ft of rooftop	Green Roof cost at $14-$25 per sq. ft
Johnson Hall	9,165	$ 128,310 - $ 229,125
Sanford Hall	9,800	$ 137,200 - $ 245,000
Dodd Hall	4,704	$ 65,856 - $ 117,600
Higgins UC	17,730	$ 248,220 - $ 443,250

Figure 1 approximate square footage of rooftops multiplied by range of green roof cost per square foot

Because this is such a large cost to the university, it is understood that there may be great reluctance to accept this new idea. However, there is financial assistance by way of grants and donations that can be obtained. For instance, in many previous examples of green roof installation, local companies have been willing to donate a lot of the supplies that go into the construction of the green roof. A quick Internet search on federal grants involving green roofs produces numerous grant opportunities that would definitely be obtainable. For example, funding for a green roof project can be obtained through EPA's Clean Water Act Section 319 (non-point source pollution) grant program. Funding for projects can also come in the form of incentive programs created by power and sewer companies (Temple University). It also needs to be kept in mind that this roof will eventually pay for itself over time, as it will help Clark University save on cooling and heating bills. In general, a green roof will provide an additional 25% insulation in

both the summer and winter months, and heat loss due to wind can be reduced by 50% (Beggs Jr). Also, because green roofs provide the roof structure with a waterproof and UV protected layer the life expectancy of the roof can be prolonged to more than 40 years. This is much greater than the 20-25 year expectancy of a roof built out of commercial materials (Henderson). As green roofs become the industry standard, as they most certainly will, the costs will dramatically decrease to the point where they may be cheaper than normal roofs.

Rainwater Catchment Systems

The main costs involved in the installation of a rainwater catchment system come from the purchase of a cistern that would be needed to store the collected water. There are a variety of available cisterns with different storage capacities and materials. These range from the typical home use plastic 60 gallon barrel, costing $100(Rainbarrels), to the 10,000 gallon fiberglass commercial cistern costing $10,000 (Darco Incorporated). There would be a minimal cost involved with the construction of gutters that would carry rain to the cistern. This cistern, depending on its size, could either be located above ground, or underground. It can also be connected to the irrigation system for convenience, or not connected. If the cistern were to be underground, the installation cost would be much greater than if it were above ground. There are many federal grants available that could help cover the costs, such as ones available from the U.S. Geological Service (Poole). As with a green roof, a water catchment system will also eventually pay for itself, and will save money and energy on water used to irrigate the Clark University campus.

Conclusions:

This exploration has presented a variety of options, data, and sources for the eventual implementation of green roofs and water catchment systems at Clark University. This will be a jumping off point by which the administration can do some follow up research and decide whether or not to proceed with the small trial runs of each system, possibly leading up to a complete implementation in the future.

By installing a green roofs and rainwater catchment systems on part or all of one of it's buildings, Clark University would demonstrate a commitment to innovative approaches toward improving the sustainability of campus operations. Such installations would help to increase sustainability awareness at and around Clark. Additionally, it would make Clark more attractive to potential students interested in sustainability. By installing one or more green roofs and rainwater catchment systems, Clark would gain national recognition for its innovative sustainability, cementing themselves as true "challengers of convention, and changers of our world".

Case Studies:

Green Roofs:

Several schools around the country have already taken up projects similar to the ones mentioned in this report. The University of Maryland, Temple University, Pace University and Macalester College are some examples we have provided here of places with green roofs. There are many other colleges that have had them installed as well. Williams and Smith are examples of schools in Massachusetts that have green roofs proving that the New England climate is capable of supporting these projects. These schools have already begun to experience the benefits of these projects. Clark University should follow this path that has been laid down by so many other colleges and universities.

The following links offer information on various case studies:

University of Maryland- www.honorshumanities.umd.edu/MaggieC2.pdf
Temple University - www.temple.edu/env-stud/seniorsem/section3C.htm
Pace University - appserv.pace.edu/execute/page.cfm?doc_id=19560
Macalester College-
www.macalester.edu/environmentalstudies/students/projects/macalestersfirstgreenroof.pdf

Rainwater Catchment Systems

The University of Alaska at Fairbanks, Colorado State University, the University of Oregon and the University of New Hampshire are all examples of schools that have implemented rainwater catchments. These schools have already begun to experience the benefits of these projects.

The following links offer information on various case studies:
University of Alaska, Fairbanks - www.uas.alaska.edu/attac/uaf.html
Colorado State University - www.ext.colostate.edu/pubs/natres/06702.html
University of Oregon -
http://www.uoregon.edu/~casl/course/class_pdf_docs05/rainwaterharvesting.pdf
University of New Hampshire - nhep.unh.edu/resources/pdf/low_impact_storm-unh-06.pdf

Additional News Articles

Green Roofs

"Look, up in the sky, it's green "
By Lara Gerrits The Tri-City News *Dec 10 2006*

"Green roof interest rising"
12.01.06
By CAROL KINSLEY http://www.americanfarm.com/growtopstory12.01.2006b.html

"On the roof, nature takes root: *Eco-friendly style of building creates believers in Metro"*
By MICHAEL CASS *Staff Writer*
http://www.tennessean.com/apps/pbcs.dll/article?AID=/20061127/NEWS05/611270343/1001/NEWS

"Up on the roof, a green revolution: Discovery Place joins uptown buildings in installing rooftop turf"
By BRUCE HENDERSON
http://www.charlotte.com/mld/observer/news/local/16044050.htm

"THE LOU'S A LEADER IN 'GREEN' BUILDING: Even Some 'Top Tier' Cities Looking Comparatively Brown"
By Bill Beggs Jr. http://www.stlcommercemagazine.com/archives/november2006/green.html

Rainwater Catchment Systems

"Water harvests sinking in: Students: Practice could help solve much of Tucson's water needs "
BLAKE MORLOCK, Tucson Citizen
http://www.tucsoncitizen.com/daily/local/22805.php

June 03, 2003
"Prof harvesting rain to keep gardens green, reduce water use"
http://www.uoguelph.ca/mediarel/archives/002783.html

February 27, 2002
"UNM TO CREATE RAINWATER HARVESTING DEMONSTRATION PROJECTS"
http://www.unm.edu/news/Releases/February27rainwater.htm

Thursday, July 21, 2005
"Diverting rainwater to nourish your yard: Harvesting makes ecological sense, but may not cut monthly bill

much”
B. POOLE, Tucson Citizen
http://www.tucsoncitizen.com/news/local/072105a1_water_harvesting

“Rooftop Rainwater Collection Project gets Regional, National Attention
UCR engineering students’ proposal receives grants from the Metropolitan Water District of Southern California and the U.S. Environmental Protection Agency”
(January 12, 2006)
http://www.newsroom.ucr.edu/cgi-bin/display.cgi?id=1219

“Rainwater harvesting project connects campus: Lack of water inspires professor find creative solutions”
By Laurie Mellas Ramirez
http://www.unm.edu/news/04-01-22/water.htm

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http://www.honorshumanities.umd.edu/MaggieC2.pdf

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Rainwater Catchment Systems

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http://www.gdrc.org/uem/water/rainwater/introduction.html

Darco Incorporated. http://www.darcoinc.com/fiberproducts.html

International Rainwater Catchment Systems Association. http://www.eng.warwick.ac.uk/ircsa

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Rainbarrels. Dec 18 2006. http://www.composters.com/docs/rainbarrels.html

Rainwater Harvesting: How to develop a rainwater harvesting system for your landscape http://rainwaterharvesting.tamu.edu/

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University of Alaska http://www.uas.alaska.edu/attac/uaf.html

University of California Riverside http://www.newsroom.ucr.edu/cgi-bin/display.cgi?id=1219

University of Guelph. June 03 2003 Prof harvesting rain to keep gardens green, reduce water use. http://www.uoguelph.ca/mediarel/archives/002783.html

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Energy Conservation and Improving Energy Efficiency

By Sam Dorsey-Gordon, Chelsea Hyatt, Jonathan Penney,
and Alex Swenson

As a group our main goal throughout the semester has been to promote energy conserving behaviors throughout the Clark community. We have worked towards achieving this goal through outreach to the students and help from the university itself. If our group and the university together show an initiative for an energy conscious campus, the students are bound to follow.

Energy conservation is the minimizing of energy usage in order to lessen the environmental damage associated with energy generation. One of the most serious environmental implications of energy generation is the emissions of CO_2, which is the dominant greenhouse gas causing significant climate change. Carbon dioxide is also associated with increasing averages of global temperatures and an increase of extreme weather events such as destructive storms.

Overall our group hopes to promote energy conservation throughout Clark University's community in three ways: (1) improving power management of computers, and (2) raising student awareness about ways to conserve energy, and (3) promoting more efficient use of energy in lighting.

1. Computer Power Down

Our original goals included getting students and faculty to power-down their computers at night and also provide information to the community regarding other energy conserving behaviors. Computers continue to draw power while there are left on over night even if they are not being used.

As of November of 2005, there are an estimated 1,500 student computers (25% desktops, 75% laptops) and 1,200 computers (80% desktops, 20%laptops) for staff and faculty. Faculty computers use 242,842 KWH (Kilowatts per hour) during business hours (Monday-Friday 9AM-5PM) a year and the cost of this for Clark University is almost $36,000. During non-business hours these computers use 259,379 KWH to power, costing over $38,000. Powering the students' computers draws on 414,656 HWH annually, estimating over $61,000.

It is estimated that 80% of students, staff, and faculty do not practice power management. Furthermore, 80% of all of the faculty computers are desktops, which is a factor, because desktop computers use anywhere from 2-4 times more KWH. During business hours, faculty are not at their computers because of classes, meetings, and other activities 58% of the time. (David Schmidt)

Typical computers can draw anywhere from 80-120 watts per hour. Turning off computers when they are not being used, therefore, save a significant amount of energy that would otherwise be consumed by the unattended computer. Over the past five years, Clark University has spent an average of $1.6 million on energy. Anywhere from 20% to more than 50% of the power is purchased from a provider. The rest is generated by Clark as a product of the burning of fossil fuels. The burning of these fuels emits carbon dioxide and other harmful greenhouse gases into the atmosphere. These greenhouse gases, when emitted into the atmosphere, cause climate change consisting of increased

temperatures, adjustments in ocean currents, and melting ice caps. However, there are many indirect effects such as rising sea levels. Clark University could help slow down this process of global warming by taking the steps to conserve the energy used by the computers.

Our groups initial plan was an attempt to convince the ITS department at Clark to shut down their computers in the computer labs at night to conserve energy. Initially, our group contacted Sara Cleaves at the University of New Hampshire, who did a study on the amount of money and energy saved by shutting down the computer labs for a week. This information we received and realized that Clark could also benefit from such a power down. We found that Clark never shuts down the computers in the labs and the computers were consuming energy throughout the night and day, even when not in use. This is a blatant waste of energy and as a group we decided they should be contacted and notified of this fact. Upon emailing Justin Brooks, manager of desktop support services, we were promptly written back with the information regarding why they continue to leave the computers on throughout the night. Mr. Brooks pointed out that the computers' power must be on at all times of the night so they can update and repair the computers so our networks stay safe and clean. In addition, Mr. Brooks stated that they are looking into a more energy conscious way of maintaining a secure network, but the implementation would take a substantial amount of instruction and a total revamp of the network. This acted as a roadblock for our group and we decided to pursue the Clark students to provide a more energy conscious attitude towards computer usage.

When researching the original idea of the power-down, our group discovered many websites that schools offer to show the students how they can save energy with the computers in the room. These green computing guides were found on such pages from schools like the University of Michigan, University of Colorado, and Bowdoin College. These sites offered a template for one we can use at Clark and we decided to create a site for our school to host on our page to promote the green computing habits. The site is completed and ITS has been contacted about the possibility of hosting the site. However, we have yet to hear back from them.

2. Outreach Activities to Raise Awareness about Energy Conservation

When we first thought of our ideas for what we wanted to do over the semester, we wanted student outreach to be a large part of our focus. We came up with many different ideas, including posters and verbal/written pledges from students to conserve energy. One of our early challenges was in figuring out how to make the students listen and comply. An already established group on campus, Masspirg, already does many of the things we wanted to try. Worse than that, many students feel that Masspirg is an unnecessary group at Clark. Our goal was to expand from their programs without having the students feel that we were associated with them. Instead of forcing our ideals on people and pressuring them to practice energy saving habits, we focused on showing the students the impact of wasteful behaviors. This idea was well received and coincided with the upcoming Campus Sustainability Day.

On Wednesday October 25th, 2006, Clark University set aside some time of the day for the school to focus on Campus Sustainability Day. This special event was held in Tilton Hall during the peak lunch hours where Massachusetts Energy Consumer Alliance collected money from Clark to give to New England Wind Farm. Other events included

many different groups hosting tables, presenting different projects dealing with Clark's sustainability efforts. Of the many tables was the Energy Conservation group. Tabling at this event was our original plan to start reaching out to the community, reminding them that conserving energy is a great behavior that everyone should be aware of. Using an idea from Doug McKenzie-Mohr and William Smith's book 'Fostering Sustainable Behavior', we decided it would be best to show examples and impact to get people to pay attention. To clarify our message, we showed, using watt meters, how much energy a television, a computer, and a cell phone charger consume. The computer (on ac power) and the cell phone charger showed a staggering 120 kWh. This is important to show people because people often leave both plugged in all the time and they are not aware that both chargers draw power even if they are not in use. The TV alone was 60 kWh and this was also important to show people, because many students who have TVs leave them running when no one is watching them. The outcome of our efforts was that people, who passed by, were impressed and astonished at how much the watt meters displayed. Some, who were unaware of the information, pledged to start unplugging their cell phone chargers during the day; a step we were looking for people to move towards.

After Campus Sustainability day, we focused our student outreach inwards. We developed an idea to convince students to switch their light bulbs they used in their personal lamps from incandescent to fluorescent, a much more energy efficient bulb. From this, we extended this idea to a proposal to Clark, explaining why they should buy compact fluorescent bulbs and give them to first year students.

3. Improving Energy Efficiency of Light Bulbs

In addition to the computer power-down we hope to have the school assist in the purchase of florescent light bulbs in bulk which they could distribute free of charge to students in on-campus housing for use in personal lamps. By replacing the incandescent light bulbs individuals generally use in their personal lamps, we could conserve energy which would save the school money. The school would save close to thirty dollars over the life of each bulb replaced. These savings will out-weigh the initial costs of purchasing the bulbs, especially because compact fluorescent bulbs last ten times longer than standard incandescent bulbs, and therefore would not need to be replaced as often. In a proposal we will display the financial and environmental benefits of changing and the cost benefits of doing so. Other schools like Simmons College in Boston, Massachusetts have offered an exchange of an incandescent bulb for an energy saving florescent one which is similar to what our group would propose Clark to do. Clark would save energy and thus save money with the transition from incandescent to florescent light bulbs. At this year's Campus Sustainability Day, we got our first chance to talk directly with the students about the impacts of energy consumption and we were able to give them some energy saving tips. We hope this was the first step of many to get the students of Clark to save energy by turning off computers at night, using compact fluorescent bulbs, and other conservation techniques.

Our original plan was to convince Clark University to purchase compact fluorescent light bulbs (CFL's) and distribute them to students living in on-campus housing for use in their personal lamps. CFL bulbs use less energy than incandescent bulbs (an incandescent bulb uses 75 watts whereas a CFL bulb that emits the same amount of light only uses 20 watts). CFL bulbs also last ten times longer than

incandescent bulbs and over their lifetime will same thirty dollars on the energy bill per bulb. As our project progressed we realized that it would only be cost efficient for Clark to distribute the CFL bulbs to incoming first year students for a few reasons. A CFL bulb's lifetime is about 3 years, so if a student received a bulb as a first year the bulb would most likely last through their junior year, which would be sufficient because many students live off campus their senior year. Also if every year students received a new CFL bulb they wouldn't have a use for it because the CFL bulb they received the previous year would still work. Our final proposal statement is that we propose that Clark University buy compact fluorescent bulbs in bulk and distribute them free of charge to first year students to use in the personal lamps they bring from home because compact fluorescent bulbs (CFL's) use less energy than incandescent bulbs and this switch would save the university money.

In writing our proposal we gathered information about the environmental benefits of CFL bulbs. We looked at how making the switch and distributing CFL's free of charge to the first year students would save Clark University money. We also looked to see if there would be any negative aspects to making the switch; we couldn't find any. We compiled all of these different aspects into a written proposal with the sources to our statements included and the result was our final proposal.

Reflection

Over the course of the semester, we had our highs and our lows. We struggled with keeping focused at times and we were delighted when we saw substantial progress being made. One of the marks that the energy conservation group has left on Clark is a fresh view on energy consumption and its impact. We impressed some of the leading figures at Clark and we have their support to continue making responsible change. One of our major setbacks was when ITS forced us to change our attention. But there was also a smaller, but equally important, setback in our lack of experience in affecting change. We struggled to grasp what it was that we were trying to accomplish. Overall, it was nice to finish with a positive impact (our light bulb proposal) as well as revisit our original project (working with ITS to educate people how they can save energy).

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Proposal for the Purchase of Fluorescent Light Bulbs

Global Warming is an issue that involves everyone on Earth, including us here at Clark University. Greenhouse gases in the atmosphere, which include water vapor, carbon dioxide, nitrous oxide, sulfur hexafluoride, hydrofluorocarbons (HFC), perfluorocarbons (PFC), and chlorofluorocarbons (CFC), absorb infrared rays and contain heat in the atmosphere like a blanket (EPA, 2005). This becomes a problem when increasing greenhouse gasses are causing the atmosphere to warm up by two degrees Celsius every decade. Over time these changes can lead to notable adjustment of seasons, rising sea levels, and a change in water availability and agriculture. Here at Clark University we are setting an example to demonstrate how society can minimize human impact on climate change. Energy generation is dominated by burning fossil fuels which adds CO_2, the largest greenhouse gas, to the atmosphere. We suggest that the University start by reducing energy consumption, and therefore lowering the amount of energy that needs to be generated, which will slow down the rate of global warming.

We propose that Clark University buy compact fluorescent bulbs in bulk and distribute them free of charge to first year students to use in the personal lamps they bring from home because compact fluorescent bulbs (CFL's) use less energy than incandescent bulbs and this switch would save the university money. We estimate that on average each student brings one personal lamp to school with them, and therefore, each student would have use for one light bulb. If Clark University provided every first year student with one CFL they would save on average $15,518 per class over the three years the bulbs last. (Money saved over life of the bulb x # of first-year students – initial cost of bulbs, $30 x 560 - $1,282 = $15,518). (Calculations are shown on page three.) This is because each bulb saves about $30 of energy bill cost over its lifetime, about three years. (Yes, CFL's last about ten times longer than standard incandescent bulbs.) The standard CFL uses 20 watts where as a standard incandescent bulb would use 75 watts. If the college gave these bulbs to first year students free of charge they would still be saving money because the cost of the energy saved over the three years of the bulbs life outweighs the initial cost of purchasing the bulbs. With a savings of $15,518 per class this energy conservation appears to hold only benefits for Clark University.

Each CFL bulb contains a small amount of mercury which is completely contained and harmless, unless the bulb is broken, such as in improper disposal, therefore, CFL's need to be disposed of properly. However, this isn't a change or need for any concern because normal bulbs require the same special disposal. This need for proper disposal shouldn't discourage Clark from switching to CFL bulbs because standard incandescent bulbs require the same disposal as well. On a day to day basis CFL's are safer than standard incandescent bulbs. CFL bulbs don't emit heat. There is no chance of burns as there is with hot incandescent bulbs. CFL's are cool to the touch yet they emit the same amount of light and have the same tone as incandescent bulbs. Students will have no reason not to switch their bulbs because CFL's and normal incandescent bulbs look the same. Also, if Clark University buys CFL's in bulk and distributes them for free, students will be more likely to make the switch. This is because in stores CFL's are more expensive than incandescent bulbs. CFL's cost on average $4, versus incandescent bulbs that cost on average $.75. Because the students aren't paying the energy bills and most likely don't have lots of spare cash, they won't likely want to spend the extra money on a bulb when there is no direct benefit for them in doing so. If

Clark gives students CFL bulbs we are not only encouraging energy efficiency and doing our part in preventing global warming, but we are also saving the university money that can be put to other uses.

If Clark makes the switch to CFL's we will play an important role in preventing global warming. In its lifetime, each CFL can save 450 lbs of greenhouse emissions. Let's do the math. If every first year at Clark University used CFL bulbs than in three years each class would save 252,000 lbs of greenhouse emissions. (This is 450 lbs of greenhouse gas saved by each CFL over it's lifetime x 560 first-year students who will be using the CFL bulbs). 90 power plants could be shut down if every American used CFL's instead of incandescent bulbs. At Clark University pride ourselves on "Challenging Convention, Changing Our World". Here at Clark we need to set an example for others and change our world by reducing human impact on climate change, and we suggest the university begin with compact fluorescent light bulbs.

Calculations:

($ Saved per Bulb x # First year Students) – (Cost of CFL bulb x # First Year Students) = $ Saved per Class
(30 x 560) – (2.29 x 560) =
16,800 – 15,518 = **$11,064**
$11,064 will be saved over the lifetime of the bulbs with every incoming class that receives the CFL bulbs.

*note: at http://electrical.hardwarestore.com/learning/save-money-with-compact-fluorescent-bulbs.aspx the prices for bulbs without a bulk discount were lower than at other online stores that gave an in-bulk discount.

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Green Cleaning Products

By Randa Duffy and Leah Henoch

Outline

Introduction

Cleaning products are a more pervasive problem for human health and the environment than one might think. The toxic chemicals associated with traditional cleaning products present a serious health risk to the environment, custodial staff, and all persons who use facilities that are cleaned using conventional methods. As part of The Sustainable University curriculum, our team sought a commitment from Clark University's Physical Plant to purchase environmentally friendly, also known as environmentally preferable or "green," cleaning products for all cleaning purposes at Clark University. Our research left us pleasantly surprised by how much Clark is already doing in this area, and the following report is a summation of our findings, and a series of recommendations for where we can go from here.

Rationale and Background Information

Cleaning chemicals and environmental damage

Of the more than 70,000 chemicals being used today, it is estimated that fewer than 2% have been thoroughly tested for their effects on human and aquatic life (Harvard 2006). Cleaning products are responsible for approximately 8% of non-vehicular emissions of Volatile Organic Compounds (VOCs), which can trigger respiratory problems such as asthma, contribute to smog formation, and inhibit plant growth (Green Seal 2006). A U.S. Environmental Protection Agency (U.S. EPA) study of six communities nationwide found that indoor levels of VOCs are up to 10 times higher than outdoor levels (EPA 2000a). Cleaning products are also washed down the drain and find

their way into drinking water, lakes, and streams, adversely affecting plant and animal life and further threatening public health (EPA 2003). Chemicals in cleaning products contribute to the toxic waste stream when they are used and more so when they are disposed of. Chemicals such as alkyphenol ethoxylates which are found in conventional cleaning products are endocrine disruptors that are slow to biodegrade and have shown up in the endocrine systems of fish, birds, and mammals. Other chemicals such as phosphorus contribute to nutrient loading and eutrophication, which causes algal blooms in water bodies, which in turn kills aquatic life (Harvard 2006).

Cleaning chemicals and human health

Another EPA study found that poor indoor air quality is one of the top five environmental health risks, and is primarily caused by indoor cleaning products. Studies have shown that levels of indoor air pollution can be two to five times higher than outdoor levels and more than 100 times higher after some cleaning activities (EPA 2000b). The unnecessarily high levels of VOCs, excessive fragrances, allergens, and asthmagens can all adversely affect indoor air quality. Considering that the average person spends about 90% of their day indoors, maintaining a decent indoor air quality is incredibly significant. A Pittsburg study found that implementation of new indoor air quality programs, equipment and supplies decreased airborne dust inside the building by 52%, and decreased volatile organic chemical (VOC) concentrations by 49%, while bacteria decreased by 40% and fungi colony-forming units deceased by 61% (Clarke 2006).

Contaminants can have serious adverse effects on the health of building occupants and janitors. One out of every three cleaning chemicals used to clean school buildings in the United States is known to cause human health or other environmental problems (NewDream 2006). Short term health problems caused by exposure to hazardous cleaning products range from eye, nose, throat, and skin irritation, burns and coughing to fatigue, dizziness, headaches, chest pain, vomiting, cramps, and diarrhea. Long-term effects may include asthma and other respiratory ailments, liver and kidney failure, birth defects and other reproductive disorders, brain damage, and even cancer (Culver 2002). The chemicals most frequently involved in poisonings reported to the U.S. Poison Control are cleaning products (EPA 2003).

Financial analysis of cleaning chemicals

A study of worker's compensation data for Washington state showed that six out of every 100 janitors in Santa Clara County are injured on the job as a result of the health affects of traditional cleaning products. The average reported injury costs companies $725 in lost time and medical expenses. Using safer cleaning products, in addition to better ventilation and cleaning, could improve worker productivity by between 0.5 percent and 5 percent, an annual productivity gain of $30 billion to $150 billion (NewDream 2006). Savings could reflect not only the fact that some green cleaners are less expensive than conventional cleaners, but also new opportunities for bulk purchasing, reduced worker compensation claims, reduced liabilities, and increased worker productivity. Additionally, safer cleaners have been shown to match or exceed their traditional counterparts when it comes to performance. Green Seal certified products, for example, are required to pass stringent performance standards in addition to strict environmental and human health criteria (Commonwealth 2003). Many schools and

other institutions have actually experienced significant cost savings by switching from traditional cleaners to green cleaners.

Building a better institution

In an academic institution, healthier environments mean better learning. Improving student health increases academic performance. **S**tudies indicate that green cleaning programs resulting in successful indoor air quality programs lead to an increase in productivity and higher test scores overall. According to expert Dr. Michael A. Berry, PhD, "there is a direct connection between healthy school environments; behaviors and attitudes of students, parents, and educators; and academic achievement." Factors relating these concepts include the results that, when a green-cleaning program is implemented: The appearance of the school is inviting. The school strives for student-friendly conditions throughout the building. The school is designed to reduce stress. The school is clean and sanitary. The risk of an adverse health effect is very small (OneSource 2006).

As the recognition of the dangers of toxic chemicals grows the benefit to reassessing the cleaning products used at work and at home also increases. Clark is faced with a tremendous opportunity. Over fifteen hundred students live in a facility cleaned by physical plant. This means that the department has a good deal of purchasing power and influence over business. By buying cleaner cleaning products, we can safeguard the health of both the students and the local water system, and send a financial message to companies that the demand for green products is increasing. In David Orr's, *Earth in Mind, On Education, Environment and the Human Prospect* he asks the question, "What do we want our buildings to say about us? What will they say about our ecological prospects?" (114). What kind of cleaning products we clean our buildings with speaks volumes about our commitment to sustainability, health and creating a safer environment for those using the building. Though one may not be aware of the cleaning products used in a building they are living or working it, they will be affected by the products used.

Continuing our LEED commitment

Clark University currently has three LEED (Leadership in Energy and Environmental Design) buildings on-campus: the Lasry-Bioscience building, the Dolan field house and the newly built dorm. LEED is "the nationally accepted benchmark for the design, construction and operation of high performance green buildings…LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality" (usgbc.org). LEED provides benchmarks and documentation for charting the environmental sustainability over a building's lifetime. LEED credits can be received for green cleaning programs for renovations of existing buildings. Projects can receive 9 points for green cleaning programs. In LEED buildings green cleaning products must be used, so in the three buildings on campus all green cleaning products are used. Clark prides itself on it's commitment to sustainability and it is clearly moving in the direction of LEED certified buildings. So, it makes sense for all of our on-campus building and houses to use green cleaning products, why do we only make that commitment in our LEED certified buildings?

Research Process

Meeting with Paul Bottis-11/10/06'

The main stakeholders at Clark in terms of making decisions related to green cleaning products are Paul Bottis, the head of Physical Plant and Gregg Janda, the head of Custodial Services. Every Clark student and faculty/staff member is affected by the use of green cleaning products in the academic buildings and students that live on-campus are affected by the use of green cleaning products in their living space. We met with Paul Bottis to find out what type of cleaning products Clark currently uses and if they are infact green. We learned that Physical plant tries to use as many green cleaning products as possible. They will choose a green product over a non-green one if it is comparable in price and quality. He expressed that the green cleaning product market has expanded and the products are much more affordable then previously. Our group has discussed the vagueness of "green" products and what this actually means. We talked about the importance of a product being non-toxic, biodegradable and safe for the environment.

Meeting with Gregg Janda-11/06/06

At our meeting with Gregg Janda we were able to obtain specifics relating to green cleaning products used at Clark. We learned that Janda started the program out of his own volition and is continually trying new green cleaning products when they become available on the market. Currently, three main cleaning products are used in the on-campus houses and residential halls. These include: a disinfectant, glass cleaner and an all purpose cleaner. In the residential halls only the glass cleaner is green but in the on-campus houses the all-purpose cleaner is also green. Currently there is no green disinfectant on the market. The reason why the all purpose cleaner is not green in the residential halls is because of a dispensing system Janda set up that does not use the same type of cleaner, but he plans on changing this in the next sixth months so the all-purpose cleaner in residential halls will be green. He is interested in using green cleaning products to ensure the safety of his staff, the students at faculty at Clark. He says, "I go as green as I can" and he is always looking for new green products. Right now he is looking into a liquid form of ice melt that is green, biodegradable trash bags and a citrus floor cleaner. He stressed that the industry is "going green" so there are always new products available that are at similar prices to "non-green" products.

Status of Green Cleaning Products at Clark

What we learned from Gregg Janda is that the Green Cleaning Program at Clark University is currently run within Physical Plant, primarily by Gregg himself. Gregg receives recommendations for products in addition to conducting his own research, and chooses products that meet the Green Seal certification standard.

Green Seal is a non-profit (501(c)(3) third-party certification program which **"**works with manufacturers, industry sectors, purchasing groups, and governments at all levels to "green" the production and purchasing chain." The process of product and service evaluation begins with material extraction, continues with manufacturing and use assessment, and ends with recycling and disposal of waste. Products only become Green Seal certified after rigorous testing and evaluation, including on-site plant visits. The primary function of the program is to develop standards for specific product categories

and certify the products and services that meet them. A list of certified brands is updated weekly (GreenSeal 2006).

Green Seal Standards

The organization operates under the international guidelines for environmental labeling programs, ISO 14020 (labeling principles) and 14024 (procedures and principles for third-party certifiers), set by the International Organization for Standardization. These guidelines were set by dozens of countries working throughout the 1990s to develop standards for sustainable environmental management. Once a standard has been established, Green Seal accepts and evaluates applications for certification. If the product meets the Green Seal standard, it will be awarded the Green Seal logo, which may then be used on the product, on packaging, in advertising, promotional materials, catalogs, and in product descriptions. Once certified, products are subject to annual monitoring to ensure that the product offered for sale continues to meet the Green Seal standard. Non-compliance may result in termination of the manufacturer's privilege to carry the Green Seal on its product. The standards are product-specific. For University purposes, most products would have to qualify under the "Green Seal Environmental Standard for General-Purpose, Bathroom, Glass, and Carpet Cleaners Used for Industrial and Institutional Purposes," which is included in the Appendix of this report.

The standards include sections regarding levels of allowable chemicals and compounds for products, including a list of prohibited ingredients and considerations of human health, photochemical smog, tropospheric ozone production, indoor air quality, toxicity to aquatic life, and aquatic biodegradability. In addition to environmental standards, products are tested to ensure efficacy in performance. The report also includes requirements for product training and labeling, recommendations for recyclable packaging and discourages animal testing (GreenSeal 2006).

Recommendations

We recommend an audit of Clark University's airborne pollutant (dust, VOC's, etc.). We also recommend an audit of Clark University's water pollutant outputs. We want to ensure Clark University's cleaning products fit above standards to the greatest achievable degree. We also recommend putting the information about the Green Seal approved cleaning products on the Clark University website in addition to recommendations of personal green cleaning products for students. Most students do not know that the products being used in their bathrooms are in fact Green Seal approved so having the information available on the website would raise awareness about Clark's current system. The Green Guide also encourages students to purchase green cleaning products.

Green Cleaning at Other Schools

Harvard University

The Green Cleaning Program at Harvard University began in September 2004 with extensive research into the status of cleaning products, and the feasibility of replacing conventional products and methods with a green program. A combined effort of Harvard Green Campus Initiative and University Operations Services' Facilities Maintenance Operations (FMO), funding for the initial research phase was provided by FMO and a private donor who was interested in the health effects of cleaning chemicals.

Their research lead the team to decide to use Green Seal certified or recommended cleaning products. Additionally, the program includes green janitorial products such as paper towels, hand dryers, toilet paper, microfiber cloths, and vacuum cleaners. Implementation involved a series of pilot projects- isolated buildings that implemented green cleaning programs to test their efficacy (Harvard 2006).

Duke University School of Nursing

In the summer of 2006, the School of Nursing at Duke University became the first building on Duke's campus to use a comprehensive program for environmentally responsible housekeeping. Direct by the Medical Center Architect Greg Warwick and using LEED certification standards for the new building, their program uses Green Seal certified cleaning chemicals in addition to microfiber mops (which use 95% less water and cleaning chemicals than traditional mops), recycled content paper products, and HEPA vacuum filters (Duke 2006).

Conclusions

This class has been an incredible learning experience. We have learned directly about working with the administration, faculty and staff of Clark in order to move in a more sustainable direction. We were initially surprised that Clark does infact use Green Seal approved cleaning products because the information is not available. We are excited that the information will be on the website to promote student awareness and also to demonstrate Clark's commitment to sustainability. At times it has been easy to get so focused in on the project and forget about the bigger picture. Green cleaning products are safer and healthier than non-green cleaning products for people and also for our environment. It is urgent that we make a commitment to environmental sustainability and this is reflected in the type of cleaning supplies we choose to use. Let's go green together!

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Implementation of a Reuse-A-Mug Program in the Bistro

By Carrie Fischer '09 and Amanda Lee '09

I. Introduction

The purpose of this proposal is to gain institutional support for environmental sustainability through the implementation of a reusable mug program. The idea of bringing a reusable mug program to Clark was inspired by efforts made at other campuses towards environmental sustainability. However, our vision diverged from the other cases in that reusable mug programs at other universities often require the production of new mugs to distribute to students. This uses more energy and resources than necessary and is therefore less sustainable. Our program will rely on alternative products that already exist and the willingness of participants to use them. It is our hope that this program will be as sustainable as possible in terms of environmental resources and pollution, energy use, and economics.

In late October 2006, Carrie and Amanda met with Paul Coute, Business Manager for Clark, and Cheryl Walker, General Manager for Bon Appetit, a few times to discuss ideas for starting a reusable mug program in the Bistro. We brainstormed ideas that were custom-fit to the Bistro's capabilities and Clark's student body. Past attempts at such a program had failed because mugs were not provided by the Bistro and students lost interest in bringing their own after a week. The program was also not publicized enough. Thus, the plan that emerged from these meetings was to have the Bistro provide student donated mugs for in-house use. This way, students would receive a monetary discount if they brought in their own mugs or used a mug from the Bistro. The availability of paper and plastic cups would not be eliminated but their use would be discouraged by the new program.

The program we propose for the Bistro is an attempt to invigorate campus wide participation in a reusable mug program. There was a consensus that old mugs are to be donated to the Bistro for in-house use. The Bistro would be responsible for the storage and sanitization of in-house mugs. From our conversation, the mug collection would be handled by us, the students, and Bon Appetit would take care of changes in the Bistro to accommodate this program. Success of this program would be monitored by the Bistro and designated students.

II. Cost-Benefit Analysis

A. Economic

Current situation:

Paper cups used/week	Weeks in a school year	Cups used per school year
900	36	32,400

Potential savings:

Reusable mugs/week	Savings from paper cups	Savings per school year
900	$0.10	$3,240

Additional costs the Bistro would have to take into consideration are new storage space for mugs, signs for publicity, and energy and water used to wash the mugs.

B. Environmental

The pulp and paper industry heavily contributes to air and water pollution throughout the paper production process. Pulping is a three step procedure which is energy-intensive and results in significant air and water pollution. For more details on this process see Appendix B.

If the Bistro were to implement a reusable mug program, the energy for washing the dishes would be the only environmental impact. The Bistro has a conveyor dish-machine which uses heat instead of chemicals to sanitize dishes and recycles the same 40 gallons of water per fill throughout the day to wash the dishes. The dishmachine is usually filled only twice daily, totaling in 80 gallons of water used per day. Thus, washing more dishes, namely mugs, would not significantly increase the amount of water used if the mugs only contributed to a few more loads per day.

We are using recycled mugs as opposed to new mugs because more production would result in more resources and energy used. The impact of ceramic mugs on the waste-stream is not as devastating as paper cups because paper cups are thrown out continuously (at a rate of 900 per week in the Bistro) while ceramic mugs are only disposed of when broken or unfit to contain hot liquids.

III. How the Program Will Work

In-house mugs will be supplied through an ongoing mug collection facilitated by students. The mugs will have to be in good condition and either eight or sixteen ounces. We are looking to collect upwards of eighty mugs in total. They will be stored in the Bistro and will be washed in the dishroom of the Café.

Students and staff will have the option of bringing their own mugs to or using an in-house mug at the Bistro in order to receive a monetary discount on their purchase of either coffee or tea. The mugs at the Bistro will be of standard size. With regard to the varying sizes of personal mugs, drink sizes will be determined based on the discretion of the Bistro staff.

A monetary discount of approximately $0.10, which is the equivalent to the cost of a paper cup, will be offered in order to encourage participation in the program. Currently, this applies only to hot coffee and tea; other drinks are served in different sized cups. However, we would like to have all drinks served at the Bistro included in our program.

IV. Implementation Timeline

Week of December 3, 2006	Mug collection campaign begins. Publicity for campaign will be done December 3rd – December 19th including posters and tabling.
Week of December 10, 2006	Widespread publicity continues for the campaign through flyers, mass e-mail, advertisements on the Clark website.
Winter Break, 2006	The Bistro will configure storage space for mugs and signs for the program.
Week of January 15, 2007	Mug collection will recommence. Proceeds will be donated to the Sustainability Fund.
January 21, 2007	Kick-off event for program will be held in the Bistro.
January 22, 2007	Reuse-A-Mug program begins. Sales of coffee and tea will be monitored as will the number of people who use a mug.
Week of January 22, 2007	Publicity for the Reuse-A-Mug program will be ongoing via tabling, flyers, and the internet.
January – May 2007	Monthly monitoring reports will be executed and collected.

V. Conclusion

Through the implementation of a successful Reuse-A-Mug program, Bon Appetit and the University will continue to fulfill its commitment to environmental sustainability. After carefully calculating the environmental and economic costs and benefits of the program, we feel it will be unique from its predecessors because it takes into account the life cycles of paper cups and their alternatives.

Programs at other schools are not sustainable because they incur the production of new mugs that are oftentimes plastic. Students at these schools also do not have the option of using in-house mugs, which makes participation more difficult. Since our program encourages more active student participation, it fosters sustainable behavior. By providing a stepping stone, the reusable mug program also encourages participants to further support other environmental causes. Thus, Bon Appetit and Clark University will take part in the nationwide movement towards environmental awareness and education through championing the Reuse-A-Mug program.

Appendix A: References and Contacts for Other University Programs

1. Carleton (Canada)
Karen Halley at

recycle@darkwing.uoregon.edu
http://www.uoregon.edu/~recycle/main.htm

Appendix B: Paper Cup Facts

- Thirty grams of wood, four grams of petroleum and water are required to produce a single paper cup (Hoffmann 15).
- Inorganic chemicals used in cup production: chlorine, sodium hydroxide, sodium chlorate, sulfuric acid, sulfur dioxide, and calcium hydroxide (Hoffmann 15).
- Overall it takes about 1.8g of non-recycled chemicals to produce a cup (Hoffmann 15).
- If six metric tons of paper were to totally biodegrade in a landfill, 2,370 kg of methane and 3,260 kg of carbon dioxide could potentially be produced (Hocking 504).
- Paper cups cannot be recycled because of the adhesive used to hold them together (Hocking 504).
- Production requires both wood and hydrocarbon extraction, so the environmental consequences associated with these industries must also be taken into consideration when identifying whether paper or a reusable option is more sustainable (Hoffmann 15).
- It takes less energy to manufacture a disposable cup than it does to manufacture a reusable cup (University of Victoria 1994).

Table 1 *- Break-even matrix. Each number shows the uses necessary before the reusable cup listed on the left, becomes equally energy efficient to the disposable cup listed on the top (University of Victoria).*

	Disposable Cup	
Reusable cup	**Paper**	**Foam**
Ceramic	39	1006
Plastic	17	450
Glass	15	393

Figure 1 *- The energy per use of each reusable cup (black lines) declines as it is used more times. The energy per use of each disposable cup (green lines) is a constant equal to the manufacturing energy, since it is used only once and is never washed. The numbers in the labels are the manufacturing energies for the different cups (University of Victoria).*

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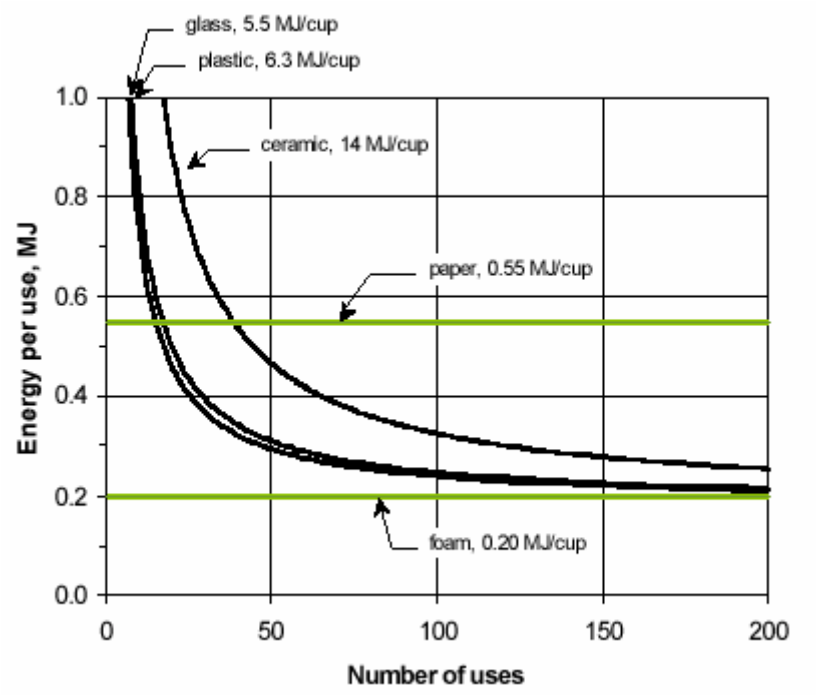

Reuse-A-Mug at Clark University

This proposal demonstrates the goals and justification of the Reuse-A-Mug program in the Bistro at Clark University. The purpose of the proposal was to convince Bon Appetit that a reusable mug program would have benefits for them in addition to promoting environmental sustainability. While this document was effective in convincing Bon Appetit that a Reuse-A-Mug program would fit into their program it does not completely explore why certain elements of the program will be effective in fostering sustainable behavior.

The success of this program relies on individual participation; however it can be difficult to gain participation. The book Fostering Sustainable Behavior suggests that there are generally three reasons why people do not take part in sustainable behavior; either they do not know about the activity, they know the behavior is beneficial but think there are barriers in promoting this activity, or there are no significant barriers but current their practices are easier continue (McKenzie-Mohr and Smith 1999). The Reuse-A-Mug program attempts to promote adoption of sustainable behavior by making the environmental benefits clear to people of the Clark University community. There will be material in the Bistro that will describe the program and its relevance to environmental sustainability. For some becoming aware of the environmental benefits will be enough justification for taking part in the program.

Unfortunately, old habits die hard as demonstrated through the failed first attempt at a reusable mug program by the Bistro where a discount was given to people who brought their own travel mug. The in-house ceramic mug will give people the option of using a reusable option over a disposable cup and removes the responsibility of bringing your own mug and washing it. Ideally this option will increase support of the Reuse-A-Mug program by removing barriers. The use of personal travel mugs is also encouraged,

however requires personal commitment to remember to bring them. The ceramic mug option is a stepping stone to raise awareness and promote commit to reusable options.

A discount will be given to people using reusable mug options. The discount acts as a personal incentive to participate in the Reuse-A-Mug program. A greater discount will be given to people who bring their own travel mug, which reflects the importance of personal behavioral changes.

Hopefully by educating, removing barriers, and promoting economic self-interest the people of the Clark community will adopt a more sustainable behavior. Ideally reusable mugs will become the dominant hot drink container in the Bistro. While this is just one way to promote environmental sustainability it is a way to promote further adoption of sustainable behavior.

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How to be Green at Clark: The Clark Green Guide

A Story of Student-Faculty-Administration Collaboration

By Liz Bullock & Amber Huffstickler

Americans represent 5% of the world's population
but consume 30% of the world's resources.

All the people in the United States make enough garbage
each day to fill 100,000 garbage trucks.

Americans throw away enough office paper each year
to create a wall 12 feet high reaching from LA to NY.

Each hour, people in the United States use two and a half million plastic bottles.

Each year Americans throw away 25,000,000,000 Styrofoam cups,
enough every year to circle the earth 436 times.
(Franklin & Marshall College, "Think Green" 2004)

Only 1% of the earth's water is suitable for drinking.
(http://www.epa.gov/safewater/kids/trivia.pdf).

Introduction

There is no end to the shocking, unavoidable statistics. The predicted business-as-usual scenario continues to instill fear in some of us, while others continue to conveniently conduct business as usual. With overwhelming amounts of environmental degradation taking place every day, what can we, as citizens, students, and a college community, do to alleviate this problem? Quite simply, education and awareness are the most promising preventative measures of combating such detrimental and destructive behavior at the community level. Given Clark's history of stewardship and concern for the community, it is only fitting that the university take a proactive stance to the protection of air, water, and land rapidly deteriorating in Worcester and throughout the United States.

Historically, the university is "one of the chief innovative forces of the society, one of the chief determinants of social opportunity… and a focus of intellectual and cultural life. Its missions take on a new urgency and importance" (M'Gonigle and Starke, 2006). Admittedly, physical installments are just a first step in the long chain of what needs to be done to promote sustainable practices: "It's one thing to put up a trophy of recycled glass and brick that relies on the sun, the wind or other renewable resources for power. It's another to build a curriculum - and to get students to look at the world differently - with green buildings as a centerpiece" (Egan, *The Greening of America's Campuses*, January 8, 2006). Because Clark has an intricate partnership with the greater Worcester community and is endowed with the academic, technological, social and financial resources necessary to lead in innovative policy, students are granted a window of opportunity in which to harness their creative fervor and academic expertise.

Awareness truly needs to be raised on campus about many problems from the most simple of issues (such as where the recycling bins are and how to use them) to the more complex (such as energy usage data). At our university, where approximately 2,100 undergraduate and 760 graduate students focus on over 30 different academic disciplines, it is hard to circulate important information in an efficient manner. In acknowledging this, it is imperative to begin such awareness when undergraduates first arrive on campus.

First-Year Clark students are exposed to countless campus organizations, academic departments, wellness resources, new faces, and college life upon arrival. Sustainability is missing in that initial exposure. Other schools have integrated sustainability into orientation for incoming students and have been met with great success. This is why we wanted to develop a green guide, containing academic programs surrounding environmental sustainability and sustainable development, student organizations committed to conservation and advocacy, and little ways individuals can contribute to sustainability on campus.

In Fall 2006, 21 students in Professor Jennie Stephen's Sustainable University class set out to change the way Clark thinks, manages, and projects sustainability throughout the institution. Several groups were formed to work on energy conservation, water management, renewable energy, and greening Clark in general. We focused on introducing incoming Clarkies to our school's commitment to environmental sustainability through a comprehensive green guide. The energy flowed; progress was made and is evident in our successful campaigns around campus. Sustainability is becoming a forefront issue at Clark, and it is all due to the cooperation of institutional bodies, faculty, staff, and students working together to make change happen.

How the Idea Developed

As students at a university known for "Challenging Convention, Changing Our World", we are used to approaching situations proactively and self-driven. Students table, demonstrate, educate, and get the community involved. How could we promote sustainability at Clark as students? We immediately began brainstorming grassroots efforts to spread awareness of the school's recycling program, to reduce solid waste on campus, to advocate for green cleaning products.

Our ideas seemed endless, and scattered. Apart from other groups in class, six of us were working as one group with nearly as many campaigns going on at one time. We realized quickly that we had to set our limits and focus our efforts, and ended up concentrating on working out the kinks in a reusable mug program, researching Clark's policy on green cleaning products, and the creation and distribution of a comprehensive green guide for incoming students during Week One '07. These ideas took a different approach at affecting change at Clark. Each sub-group worked closely with administrative departments to institutionalize the change we wanted to see, and met great success in cooperating with them.

Steps Taken

The first step we took was to meet with Dean Rebekah Freeman-Schulze, who oversees and coordinates Orientation for First-Year students. We met with her in October and discussed how to best reach new students. Clark 101 sessions in Atwood Hall are too long and boring. Training Peer Advisors on all the resources leaves our message in the hands of people who can forget (not a good idea). We decided that leaving a physical resource in the welcome package everyone gets during Week One would be a good way of exposing new students to Clark's sustainability scene.

Additionally, we decided to contact Judy Miller, who coordinates the assigned summer reading and annual theme, to put environmental sustainability on the agenda. After an initial email, she responded

> The summer reading book is selected each year by a committee consisting of faculty, one or two staff, and one student… that is convened in the late fall by the Dean of the College... The faculty as a whole are solicited for book suggestions. The committee reads three or so of them, and makes a selection based on accessibility (will students read it?), relevance to a variety of disciplines, and relevance to Clark's three signatures (Make a Difference, Learn through Inquiry, Experience Diverse Cultures). We also consider whether we might be able to attract the author or other relevant individuals to come and speak, since the theme for the year is developed from the book. (Judith Miller, October 9, 2006)

We have been researching several suitable books according to the criteria, among them **The Upside of Down** by Thomas Homer-Dixon, Paul Roberts' **The End of Oil**, and **Imperial Nature** by Michael Goldman. These will be brought up to faculty through Prof. Stephens and hopefully one will be seriously considered for the book selection.

Since the summer reading was primarily decided by faculty and an appointed committee, we decided to focus our efforts on the green guide. Once our ideas were formed and cemented, we needed to research other schools. Connecticut College and the University of Buffalo were a really good starting point. Their programs are well established, and we used their green guides as references for our own design. Connecticut College's "Green Living at Connecticut College" pamphlet inspired our design with its simple graphics, clear and direct information, and overall graphics appeal. We also investigated published resource guides from Princeton University, Franklin & Marshall College, Bates College, University of Vermont, Colby College, Clemson University, Mount Allison University and the University of Alberta. In contacting the UB Green office (part of University Facilities) Walter Simpson responded that UB's "Think Green" booklet was funded by a "$50,000 a year discretionary budget" appropriated for UB Green programs (Walter Simpson, October 9, 2006).

To fund our project, a bill of over $800, we solicited funds from academic departments and groups on campus that might have extra money. Right when funding was on the verge of being overwhelming, Doug Little, Dean of the College, agreed to fund the entire project, eliminating the extra stress of perfecting a proposal to potential sponsors. With no other steps to divert our energy away from the design of the guide, we continued to revise our guide.

We also looked into printers who employed green production practices. We understood the importance of consistency in our message; we needed a finished product that reinforced our message. Rolling Press, the company contracted to print these guides used carbon-free, recycled, non-bleached paper and a mixture of plant-based inks. This reduces toxins released during the normal printing process to both the air and regional water supply. This sort of supply chain consideration is exactly the sort of sustainable behavior that should be reinforced throughout the functioning of the university. Perhaps this guide will help to establish a relationship between an eco-friendly printer and the university.

Obstacles Faced

When working in a group, one must anticipate setbacks and obstacles to work through. Our group of six struggled through the first half of the semester with scattered interests and trouble refocusing our efforts. With so many interests and potential projects, we were quickly spread too thin and burnt out from the projects' demands. It was difficult to abandon projects because group members were very fervent about their interests, and sometimes stubbornly protected them. For instance, although we found out that Clark uses nearly all green cleaning products, Randa insisted on looking into it further, where we believed her energy would have been more appreciated in some of our other, larger projects. In retrospect, this is precisely the energy and commitment we needed to make progress at Clark.

At times, we were confused as to what the next steps were, but our main weakness pertained to punctuality and commitment to attend meetings. We struggled to find a good meeting time for all members, reducing the productivity of our meetings due to the absence of key information. It would have been beneficial to take advantage of the Chat Room on Blackboard, file exchange or email communication when we could not physically assemble, but group members quickly dismissed this idea, arguing if we could be in front of a computer, we could probably be together in the same room.

On a more positive note, our group's greatest strength was communication. We were open, receptive, and willing to listen to each other. We greatly valued each other's opinions and appreciated suggestions on how to go about executing some of our tasks. In early discussions on our "How to be Green" guide, Randa respectfully listened to our ideas and then suggested that our time and energy would be better invested in a hard copy pamphlet. Adversely, there was more discussion on the effectiveness of a pamphlet (will students *actually* look at them?) and the technicalities of raising funds, designing it, and distribution. Throughout the entire conversation and the duration of this semester's work, group members exhibited good listening skills and sensitivity to how each person would receive their suggestions.

At times, neither one of us could be positive about our project. Lulls and setbacks in our progress put a damper on our optimism. At one point near midterm crunch time, no one was willing to prioritize researching case studies or contacting people for data or outlining our final report. We fell victim to the same attitude that prevents any advancement in environmental sustainability: it doesn't pay the bills; it doesn't get us much needed "A"s in our other classes. What good will it actually do? We don't know if students will take a second look at our toils, or actually care about the environmental programs Clark offers. What we didn't do during midterm week could be easily picked

up afterwards, when we were less stressed. We were putting off the environment while other materialistic, superficial needs drew our focus.

Hot Off The Press

The new center for Bioscience is in the process of being Gold LEED (Leadership in Energy and Environmental Design) certified. It is a more efficient space, and it sets precedent for future construction projects such as the work currently being done to the new residence hall, expected to be Gold LEED Certified as well.

Clark's recycling program recycled 106.32 tons of plastic, aluminum, tin, glass and paper in 2005 (http://www.clarku.edu/offices/environment/data.cfm). It is staffed by work study students and coordinated by a Physical Plant-hired Campus Sustainability Coordinator. Recycling bins are located near each garbage bin in academic buildings as well as in residence halls.

Clark participates in a statewide renewable energy credit program called the Clean Energy Choice. Last year, students donated a total of $10,320 which was double-matched by the Massachusetts Technology Collaborative to fund a New England Wind Fund as well as local renewable energy projects in Worcester.

Clark is clearly on the edge of innovation, working at the administrative and student level to encompass sustainability in every arena of college life. However, very few students are aware of how progressive Clark is on the environmental scene. We felt it was important to both praise and acknowledge current successful programs in addition to promoting sustainable behavior not yet institutionalized.

The guide itself includes recommendations for behavior in different geographical locations visited by college students such as: in a dorm room, in the dining hall, in class, on campus and in a store. By personalizing the guide to fit a student's hectic schedule, we hoped students would find the information we've provided relevant and accessible. The guide was drafted and is currently being edited by a graphic designer to make the end product more credible and professional. Rolling Press has agreed to freeze the price estimate we were given in November until we are completely ready to begin production. The guides should be available for delivery far before the orientation packets have to be compiled (mid-August.) It was beneficial for us that this class took place during the fall semester, so we have ample time to refine our finished product. We recommend that anyone looking to update the guide in the future leave themselves a few months to contact all the necessary stakeholders and produce a refined, edited end product.

In The Future

This experimental class has taught us lessons textbooks and lectures cannot teach. We've gained valuable communication and networking skills that will help us in the future. In the final class presentation, Provost Angel and other audience members made many good suggestions, but we must take it in stride. We cannot edit the guide to include all of the suggestions we were given, nor can we make it our sole product. It must encompass the idea, the concepts, and the goals of sustainability at Clark. It was rewarding working for something with more leverage than a good grade, and we hope that students in next year's Sustainable University class will learn both from our experiences and pick up where we left off.

We have yet to see if the apathetic attitudes which sometimes appear on a college campus will get in the way of the effectiveness of the guides. A method for analyzing success of the project, such as a survey targeting First-years on the overall effectiveness of our guide, should be created and reviewed in the upcoming months. Certain indicators can be reviewed at the end of both this year and next year in an effort to compare this year's First-years with the next. Overall, this was a very positive process, and the support of many individuals and organizations on campus was very encouraging.

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