An Evaluation of UNC Student Energy Use: Recommendations to Reduce the University's Carbon Emissions

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Introduction

In June 2006, the Town of Chapel Hill became the first U.S. municipality to commit to a 60% reduction in carbon dioxide emissions by 2050 through the Community Carbon Reduction (CRed) Program. Immediately following, the University of North Carolina at Chapel Hill (UNC) echoed that pledge, and, in doing so, UNC and the Town of Chapel Hill became the world's first town-gown participants to commit to a sixty percent reduction in carbon dioxide emissions. UNC demonstrated its commitment to the environment further by signing the American College and University President's Climate Commitment in January 2007. Among other things, this commitment requires UNC to set a target date and milestones to achieve climate neutrality.[1]

Much like a small town, UNC has its own population, governance, infrastructure, and vehicle fleet. According to a carbon dioxide inventory completed in 2005 by a former ENST 698 capstone team, UNC produces around 340,000 metric tons of carbon dioxide per year.[2] About 50% of the carbon dioxide emitted by UNC comes from its coal-fired, co-generation power

plant, which provides roughly one third of UNC's electricity and all of its heat. Another 47% of UNC's carbon emissions come from the generation of electricity by other power providers. With over 27,700 enrolled students, much of UNC's carbon dioxide emissions can be attributed directly or indirectly to student energy use.[3]

Carolina students are no stranger to the conveniences of modern society, and each day they are faced with hundreds of choices that involve energy consumption. From the moment the alarm clocks sounds, Carolina students, like the rest of Americans, are surrounded by electronic equipment, gasoline-powered vehicles, and climate-controlled buildings. Virtually all of the devices on the road, in the dormitory, and on campus are powered by electricity or fossil fuels and, therefore, are part of a process that emits greenhouse gases like carbon dioxide into the atmosphere.

To better understand student energy use both on and off campus, a survey was created to help discover behavior patterns associated with student energy consumption. Data from this survey was compiled and evaluated, and a suite of recommendations for reducing student energy use on campus was presented to the Vice Chancellor's Sustainability Advisory Group. The implementation of energy-saving programs and measures for students, along with other approaches like LEED-certified new buildings, will not only help UNC meet the ambitious goals of CRed and the American College and University President's Climate Commitment but can also save the university money.

Methods

The initial survey was motivated by an attempt to emulate the energy inventory for Chapel Hill on its CRed beta website. That site evaluates energy use and the resulting carbon emissions across different sectors of Chapel Hill (residential, commercial, transportation, local government, and UNC) and tries to capture community-wide carbon reduction efforts by quantifying energy-saving actions made by individuals and businesses. The capstone-led survey was initially designed to take a quantitative inventory of the average UNC student's energy use. Student energy use was to be divided into categories like lighting, heating, cooling, cleaning, transportation, and electronic devices. For example, data from questions such as "How many lights do you have in your room?" were to be used to estimate the total amount of energy a student uses in each category.

The underlying question for structuring the survey was, "How will this survey aid in making recommendations to the UNC administration with regards to student energy use?" We reasoned that statistics, such as the average energy used by students for water heating, could support energy-saving recommendations, such as installing low-flow shower heads in dorms. However, the uncertainty involved in quantifying student energy use complicated our task and compelled us to refocus the study.

The final version of the survey was designed to capture student behaviors and attitudes regarding their energy use, with emphasis on gaining information about student willingness to change energy-consuming behaviors. The questions on this survey were selected with specific recommendations in mind. For example, we hoped to find a significant number of students who set their thermostats above 70ºF in the winter and who were also willing to lower their

thermostat by one to two degrees. If this were the case, we could recommend that the university promote a thermostat degree-reduction campaign. Conversely, if very few students were willing to lower their thermostats, the survey allowed the students to write in reasons why they would be unwilling to lower their thermostats.

The reason for switching from an energy-inventory oriented survey to an attitudes-and-behavior oriented survey was that it would help us make more direct, better-supported, recommendations. It was decided that the benefits of understanding students' attitudes outweighed the cost of not having a quantitative estimate of total energy use. In particular, two questions relating to the energy inventory prompted the switch. The first was, "For what parts of their energy use should we hold students accountable?," which reached into issues of shared-use appliances and spaces, as well as the energy used to create appliances and operate them. The second question was, "How reliable is our data?" With no estimates of uncertainty on the conversion factors we would have used to infer energy use, we would not have been able to estimate the precision of our energy-use calculations.

IRB Approval

An important step in our survey-design process was obtaining approval from the University's Institutional Review Board (IRB). The IRB is a committee that evaluates and approves research involving human subjects. According to the UNC IRB website, "The primary purpose of the IRB is to protect the rights and welfare of the human subjects." Because the survey involved human subjects and constituted research, which is defined by the IRB as an "investigation contributing to general knowledge, designed in advance, and utilizing a systematic

approach," IRB approval was required. IRB approval entailed a long application process led by the principal investigator, Brian Naess, and co-investigator, Dana Haine, as well as an online training course for the entire Capstone team. This study, number 08-0377, received IRB approval by Expedited Review on March 5, 2008.

Survey Format

The survey was administered online for a number of reasons. First, survey responses were recorded automatically, rather than by manual data entry, eliminating the potential for human error during data entry. Second, online administration made statistical analysis much easier because the survey software created a corresponding spreadsheet with each row containing a respondent's answers. Third, an online survey is easier to promote, and multiple people can participate at the same time, which means our statistics would be based on a larger sample number and carry greater significance. Finally, the entire student body had access to the survey at any time during the day. Our intention was that at least one hundred students would take the survey.

Survey Bias

Perhaps one of the biggest problems with administering the survey was that the people most likely to take it were those who already cared more than most about the environment. A majority of survey respondents with environmental leanings would bias the survey results, especially in a small dataset. This problem could manifest itself in the data, for example, by indicating lower student energy use and higher willingness to change than would be true for the

whole student body. A strategy employed to address bias in the survey was to profile respondents by asking for their housing type, sex, self-described level of environmental awareness, the frequency with which they consciously save energy, and their level of concern about global warming. Analysis of these answers provided an idea of how representative our sample was of the entire UNC student population.

Another issue related to bias was students' ability to report about their own actions. One question asked students to estimate the temperature they set their thermostat to, and another asked them to report the length of their showers. In these cases and others, students may not have had a way to quantify these values in the course of taking the survey, which means that their responses depended on their estimation ability. Compounding this problem is the format of questions and answers, which may have led students to assume one value as more acceptable because it falls in the middle of the range of options. The survey questions and multiple-choice responses appear in appendix A.

Survey Assumptions

Several assumptions surrounding the survey must be recognized. The first was that a random sample of the UNC student body was obtained through the mass email. This, of course, was unlikely as discussed in the "*Survey Bias*" section and undoubtedly influenced the results. Likewise, it was assumed that the ratios of male:female and on-campus:off-campus respondents were similar to those of the entire university. This is important because the energy use behaviors of these groups differ and the results may vary depending on the ratios of these groups.

When developing the recommendations, one of the best ways to evaluate the

effectiveness of each recommendation was to estimate the potential financial and carbon-reduction benefits to the university if the recommendation was implemented. This required assuming some reasonable estimates of the cost of energy and amount of carbon dioxide emitted per energy generated, as well as deciding the likely level of student participation as indicated by the survey results. The values of $0.08 per kilowatt-hour and 1.46 pounds of carbon dioxide per kilowatt-hour were used in order to be consistent with similar calculations on the Chapel Hill Community Carbon Reduction beta website.[4] Using these values, the benefits of recommendations were estimated when possible.

Survey Testing

In the weeks between submitting the IRB application and sending the campus-wide email invitation, all members of the Capstone team tested the survey. Student volunteers were also invited via email to take the survey and report any user feedback, and capstone members reviewed the underlying test data set to ensure that data entry was proceeding as intended. Student email addresses were obtained from the Focus the Nation event in January 2008, and from Dr. Jose Rial's climate change class, as well as from student organization contacts on the studentorgs.unc.edu website.

Survey Analysis

The statistics in this report were found by analyzing the survey data spreadsheet using the SAS-developed statistical software JMP 7.0.1. Most statistics were created by counting distributions of responses among different groups, and a number of the count tables appear in

appendix B. The tables and charts were created in Microsoft Excel 2007. To infer the significance of comparisons of average values, the responses were compared with a 2-way t-test. Differences were considered significant when the p-value was less than 5%.

For the analysis of average heating and cooling temperatures, the values from respondent ID#50, 27° F and 20° F, were eliminated as outliers because domestic thermostats do not usually allow such a low setting. In the likely case that the respondent meant Celsius degrees, then they would translate to 80° F and 68° F, respectively, but those values were not included.

For questions requiring respondents to indicate their level of agreement with a particular statement, a five point Likert item was used. For example, respondents were asked to rate the frequency of actions they perform between "Never, Very Infrequently, Occasionally, Very Frequently, Always." Often, the "average" value of the responses is informative. The five-point Likert item assigns a value to each of the responses above from one to five, and from those values a weighted average can be calculated. For example, the weighted average for the recycling frequency of students on campus was 4.46, which indicates that most students recycle always or very frequently, if the distribution is normal.

Results and Recommendations

Respondent Profile

The makeup of survey respondents were compared to the UNC student body with respect to the male:female ratio, housing type, and environmental awareness. 400 students completed the online survey. Of these, 71% were female and 29% were male. 28,136 students attend UNC and 59% are women[5], therefore, this sample is somewhat representative of UNC's student body,

although it still is biased toward women. This bias may have impacted our results because many responses differed significantly between the sexes. For example, women were willing to spend $7.88 on average for a reusable beverage container, while men were only willing to spend $7.55 (t-test, p=0.02). Men estimated that they kept their thermostats on for an average of 3.4 months in the winter, while women averaged 3.7 months (t-test, p=0.01). On average, women reported their shower times as nine minutes, two minutes longer than the average for men (t-test, $p=2x10^{-6}$). These data do not support the conclusion that either men or women consume more energy than the other, but the over-representation of women may have biased our results in some cases.

Approximately 44% of UNC students live in university-affiliated housing, and 56% live off campus. Of those students who responded to the survey, 33% live in dorms or other university housing, and 67% live in off-campus houses, apartments, and Greek houses. So, our sample is biased toward the perspectives of those living off campus. Only 2% of respondents indicated that they live in Greek housing (fraternities and sororities). Currently, 9% of UNC students live in Greek housing; therefore, the survey does not adequately represent this population of students[6]. The bias toward off-campus students likely affected our results because some responses were different between on- and off-campus students. For example, students living on campus responded that they turn off the lights when they leave the room 92% of the time, while those living off-campus said they did only 84% of the time (t-test, $p=6x10^{-6}$). Meanwhile, students living off campus reported their shower times as 1.4 minutes shorter on average than students living on campus (t-test, p=0.01). As with sex, neither group was consistently more energy-conserving than the other.

.Recently there has been an increase in the attention given to environmental issues, particularly energy use. In 2008, over half of Americans claimed to have made a "green" new years resolution as an attempt to be more environmentally friendly.[7] At Colby College, students more frequently felt informed about environmental issues than the general population, with 76% of students claiming to be moderately or very aware of environmental issues.[8] More than half of Tulane University students considered themselves highly concerned about the environment.[9] With regards to energy use, the majority of students surveyed at Michigan State University answered that they frequently or sometimes make a conscious decision to conserve energy or limit their energy use.[10] Students at UNC are no exception to the general trend of environmental awareness on college campuses, with 81.1% of survey respondents rating their level of environmental awareness at a seven, eight, or nine out of a ten point scale (Figure 1).

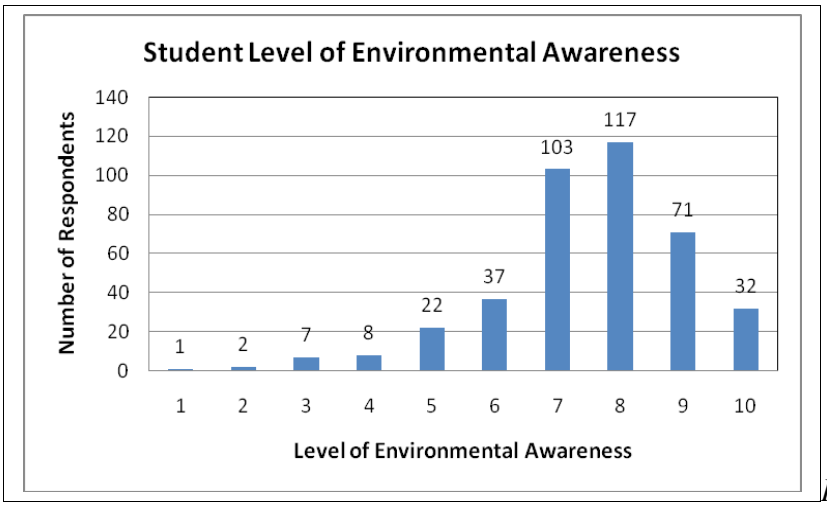

Figure 1. The self-rated level of environmental awareness of respondents.

The issue of global warming dominates the current environmental scene, with most Americans listing their concern about climate change at the top of environmental issues.[11] While climate change may top the list of environmental concerns, a survey conducted by the Pew

Research Center listed 47% of people questioned as not being concerned at all over global warming.[12] Surveys show that college students demonstrate more concern with regards to global warming. For example, a survey of Tulane students said that 15% were highly concerned with global warming in 2001 and 21% were highly concerned in 2003.[13] Comparable to attitudes at several other college campuses, students at UNC are concerned over global warming, with 58.8% of survey respondents voicing their opinion as being very concerned over global warming, as shown below in Figure 2.

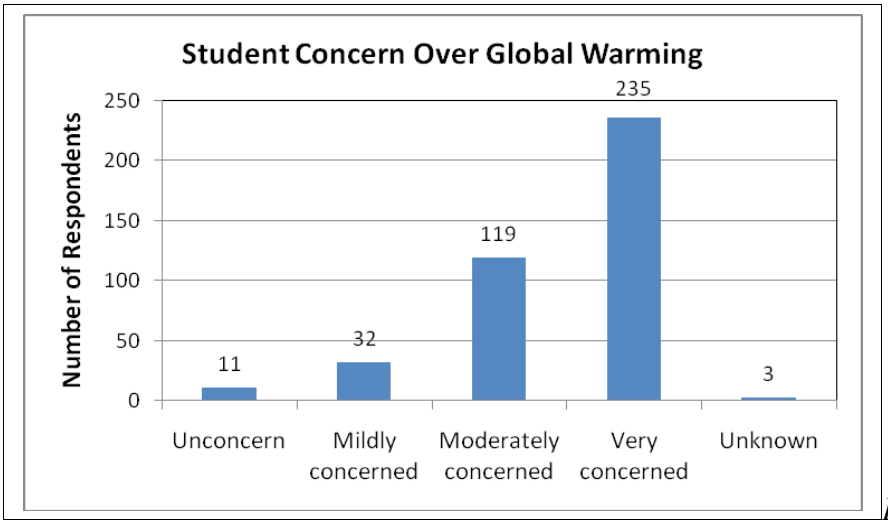

Figure 2: The concern of survey respondents over the issue of global warming.

Survey Data Not Used for Recommendations

Data from the survey that were not used to make energy-saving recommendations are summarized in this section. These data, however, could prove useful in future studies. Data specific to the items students recycled were collected, which could be used to target a recycling advertising campaign around specific items to be recycled. The survey also asked students how often they use a number of kitchen appliances. These data did not support any of the

recommendations listed below, but if one wanted to encourage or discourage the use of a particular appliance, it would help them estimate the energy savings.

While large trucks and Sport Utility Vehicles (SUVs) have become extremely popular with American drivers, UNC students tend to drive more passenger vehicles. The majority of UNC students drive cars, with 85.5% of survey respondents selecting "car" as their vehicle type. Only 10.7% of survey respondents reported that they drove a truck or SUV and 3.8% classified their vehicle as hybrid. 75.2% of survey respondents reported spending between $50 and $100 each month on fuel for their vehicle while only about 1% of survey respondents reported spending over $200 a month.

Only 91 out of the 353 respondents that owned a television had a flatscreen TV. For off campus residents, 84% had a dishwasher in their residence. For laundry, 32% of students occasionally washed with hot water, while just 9% always or very frequently used hot water.

The willingness of the survey respondents to adopt water- and energy-saving practices indicates that most are environmentally aware, as shown in Appendix B, table 24. Additionally, 62% of students always set their laptop to sleep or hibernate when not in use, while another 26% occasionally or very frequently do it.

Recommendation #1: Increase Sustainable Energy Fee and Broaden its Applications

Estimated Annual Gains: $224,000 for "Green" Programs

Several colleges and universities have incorporated environmental or sustainability fees into their semester costs for students, and the majority of fees were voted on and approved by the student body. The use of the money collected by these fees varies, but UNC-Chapel Hill, for

example, instituted a $4 fee to support the use of renewable energy on campus. The initiative was passed in 2003 with 75% of students voting in favor of the energy fee and 85% voting in favor of it in 2005. The money from the fee is managed by the Renewable Energy Special Projects Committee (RESPC), made up of five undergraduates, two graduate students and three administrators, and goes towards renewable energy projects around campus. One example of work done through this fee is the purchase of a solar array which was placed on top of Morrison Residence Hall after it underwent renovations following the 2004-2005 school year. The solar panels will heat domestic hot water for the dorm, which houses approximately 800 students. This fee in support of renewable energy is comparable to other colleges and universities. However, the money received through the fee is only applicable to projects involving renewable energy, so by increasing and diversifying the fee, UNC could direct more money to energy conservation measures and decrease its carbon emissions. In addition to the current $4/semester fee for renewable energies, 70.8% of survey respondents indicated that they would be willing to pay up to 100% more through student fees in order to boast a more environmentally friendly campus (Figure 3).[14] If the University raised the fee to $8/semester, it would bring in an additional $224,000 for renewable energy projects. Although the current student fee only addresses funding for projects dealing with renewable energies, UNC students want to see their campus become more environmentally friendly on all levels. Currently, most UNC students are trying to act on a personal level, with 77.6% of survey respondents always or very frequently making an effort to conserve energy. By raising the student sustainability fee and by expanding the environmental projects which can be funded, the image of UNC as a university that is caring and aware about modern environmental problems will be further promoted.

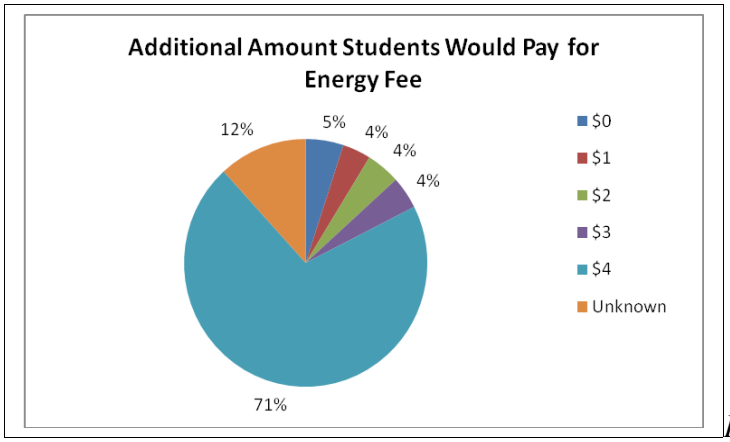

Figure 3: The additional amounts students would pay for the energy fee.

Recommendation #2: Provide Power Strips in Dorms

Estimated Annual Savings: $20,000 and 170 metric tons of carbon dioxide

Many electronic devices continue to use energy even when they are turned off. One source estimated that approximately "75% of electricity used by home electronics is consumed while off."[15] This consumption even while "off" has been termed phantom load. It was estimated that the phantom load for a TV was about $3.17 per year, while that for a microwave oven was $2.02 per year.[16] The phantom load for a laptop was estimated at $0.75 per year.[17] Individually, those costs seem trivial, but consider this – "one study estimated that the phantom load from TV's alone was equal to the output of a Chernobyl sized power plant."[17]

However, phantom loads can easily be reduced or eliminated by plugging electronics into a power strip and turning it off when not in use. The survey data showed that at least 50% of UNC students do not unplug everyday electronic devices when not in use, as displayed in Figure 4 below.

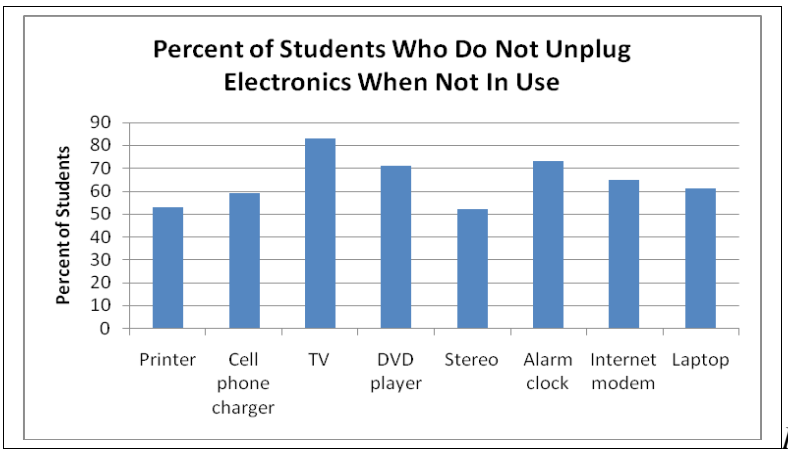

Figure 4: Percent of UNC students who do not unplug certain electronic devices when they are not in use.

These data were then divided based on housing type to view the information for students living in dormitories. Dormitories are of particular interest because the university can have an influence in motivating behavior changes among these residents. Figure 5 shows the data for respondents who live in dormitories, and it reveals the same trend as the graph above.

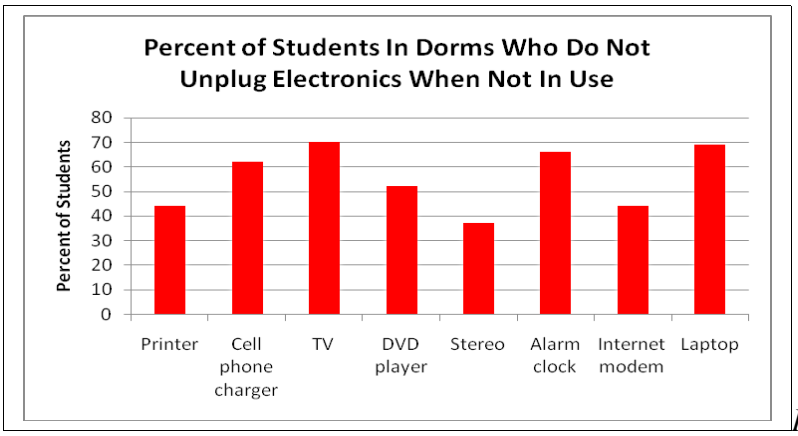

Figure 5: Percent of dorm room students who do not unplug certain electronic devices when they are not in use.

From these data, it seems that many students at UNC are unaware of phantom loads. Indeed, one of the authors of this report did not know about phantom loads prior to this study. The university should implement programs to reduce the phantom load of appliances in

dormitories. Other universities have already established such programs. For example, according to the Association for the Advancement of Sustainability in Higher Education website, both Furman University and Oberlin College have created education programs in dormitories to increase awareness about phantom loads, encouraging students to turn off electronics when they are not in use. Oberlin College also sponsors energy competitions between dormitories, with the winning dorms reducing electricity use by more than 50%.

UNC can follow and expand these programs. If students were educated about this source of energy waste, then the percentages displayed in the figures should decrease. This could be accomplished with fliers throughout campus and in the common areas and suites of the dormitories, and with stickers on electrical outlets. A more effective strategy would be for the university to supply power strips for each dorm room occupant. This would allow students to turn off one switch when they leave the room instead of unplugging each individual item. Successful implementation of this program is estimated to save the university thousands of dollars annually. For example, if 25% of on-campus students who currently do not unplug their electronic devices used a power strip for their TV, DVD player, microwave, video game console, and stereo, the university would save about $18,000 and 150 metric tons of carbon dioxide annually after the costs of the power strips were covered.[18] If the same 25% of students each unplugged their laptop when not in use, the university would save an additional $2,000 and 20 metric tons of CO_2 per year.[19] The savings would further increase if other dorm electronics were taken into account and, more significantly, if a higher percentage of students utilized the power strip. With an average power strip costing less than $5, the cost of providing power strips for each dorm room would be vastly outweighed by the environmental and financial benefits.

Recommendation #3: Expand Energy-Efficient Lighting

Estimated Annual Savings: $247,000 and 2050 metric tons of carbon

When it comes to lighting, compact fluorescent light bulbs (CFLs) are 75% more energy efficient than traditional incandescent light bulbs.[20] According to an Energy Star survey, the majority of Americans are aware of the differences in efficiencies between CFLs and incandescent lighting, yet 90% continue to use the less efficient incandescent bulbs.[21] Aside from the type of light bulbs used, an easy way to limit energy use is to turn the lights off in a room upon leaving. The majority of college students from a University of South Carolina survey reported that they turn off the lights when leaving a room[22]. According to survey results, students at UNC follow the same pattern as students in South Carolina with 74% of survey respondents turning off the lights 75-100% of time when they leave a room. While the survey results indicate that most students are already turning the lights off when they leave a room, a simple and cost effective way to raise the amount that do so could be to place reminder stickers over light switches in campus rooms. While these stickers are currently present in some classrooms and dorms, increasing the number would remind all students more frequently to save energy and reduce costs by simply turning a switch. Aside from relying on students to reduce lighting costs, UNC has enabled ITS to remotely control multimedia and lighting systems in classrooms and has set up the lights in classrooms to dim to 50% after the multimedia system has been turned off by the instructor. Also, classrooms that do not have sensors to automatically determine if lights are needed, have their lights cut off between the hours of midnight and 6am. Because most UNC students do already turn the lights off when not in use, the best way to help reduce energy use

through lighting would be to replace all incandescent lighting with CFLs, and to educate and encourage students about the efficiency levels between the two different types of lighting as several students in the survey responded that they were unaware whether or not the lights in their residence were CFLs. Currently UNC has the goal of replacing all T12 lighting with T5 or T8 lighting by 2010.[23] Although T12, T5, and T8 light bulbs are all fluorescent bulbs the T8 and T5 varieties require less energy and offer improved lighting quality.[24] Given the current movement that UNC has made in implementing the use of more efficient lighting, a useful recommendation would be to incorporate more student involvement and education. By educating students, especially off-campus students, about the benefits of using more efficient CFL lighting, not only could UNC aid in limiting the amount of energy used in lighting on-campus, but also in Chapel Hill and Carrboro therefore aiding in meeting the carbon reduction goal set by the CRed program. The means of reaching out to on-campus students could involve such things as CFL giveaways to on campus students in which they are able to exchange their incandescent light bulbs for CFLs and will require implementation of a disposal or recycling system for broken or burnt-out CFLs. If every student at UNC replaced one incandescent light bulb with a CFL that was 50 watts more efficient and was on six hours per day, it would lead to a savings of $247,000 and 2050 metric tons of carbon annually.

Recommendation #4: Increase Local Foods in Dining Halls

Increased consumption of locally grown food can reduce energy use associated with food production and transport, thereby lowering carbon dioxide emissions. It has been estimated that food items travel an average of 1,500 miles from producer to consumer.[25] The energy needed to preserve and transport those items would be greatly reduced if products were produced and

consumed locally, perhaps within a 150 mile radius. Additionally, local farms are often considered environmentally friendly, using fewer (if any) petroleum-based fertilizers and fuel-consuming, heavy-duty machinery, both of which are characteristic of industrial farms. Local farm products are generally healthier and tastier than those produced hundreds or thousands miles away due to a variety of factors including freshness and quality.[25] It is also important to note that buying locally helps the community because more money stays within the community.

However, there are disadvantages with choosing to consume locally grown food. Of primary concern are higher prices, which could discourage consumers living on tight budgets. Another issue is that these items may not be accessible at all stores. The seasonality of many foods could prevent year-round availability, which may frustrate some customers. For large operations, the quantity of food needed would require many small suppliers and thus increase complexity while decreasing convenience.

Yet, despite these drawbacks, a majority of consumers prefer locally grown food. A national poll conducted by Roper Public Affairs for a farmer cooperative, Organic Valley Family of Farms, found that 73% of Americans deemed it important to know if their food is grown or produced locally.[26] Over 75% of respondents preferred locally grown products, according to a survey conducted by Iowa State University in the Midwest in 2003.[26] The University of Nebraska found that about 70% of surveyed households indicated supporting local farms played an important role in their decision to purchase locally.[26] The freshness, quality, and taste of the products were major factors in the decision as well.

The results of two in-depth surveys, one of Connecticut and Massachusetts residents and the other of chefs of food service establishments, revealed similar sentiments.[27] Nearly all

respondents in CT and MA said they would purchase locally grown food near their home or work. This is most likely due to the fact that most believe locally grown food is healthier and fresher, and they want to support local farms. A little more than half of the respondents actually said they would pay up to 30 cents more per gallon for local milk. In the survey of food establishment chefs, 73% of the chefs said that purchasing locally grown food has had a positive impact on their business, primarily due to freshness, quality, and taste.[27] Those attributes, along with safety and dependable delivery, were the primary considerations in their decision to purchase locally, not price or year-round availability.

The results of our survey revealed similar opinions among UNC students. Indeed, 43.3% of survey-takers considered local food to be important or very important (Figure 6).

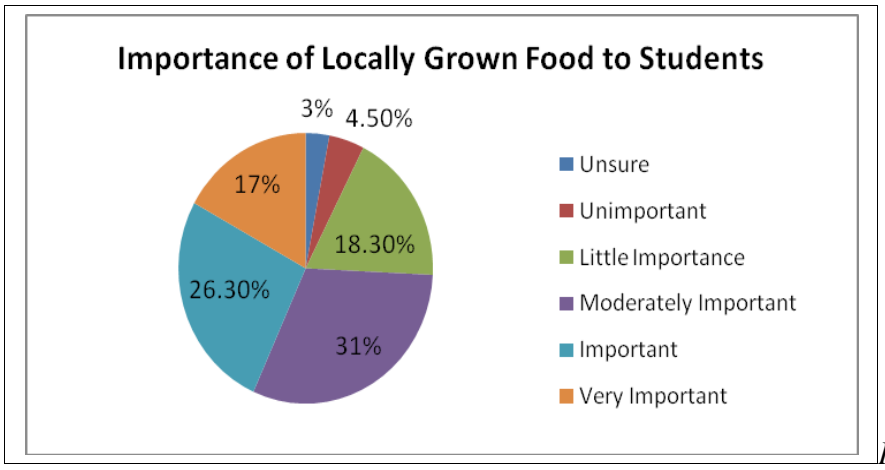

Figure 6: The importance of locally grown food to UNC students.

Most students cited increased energy-efficiency, healthiness, and quality as their motivation in supporting locally grown food, while cost, availability, and selection were the cited drawbacks. Despite possible hindrances, 47% of students surveyed said they were willing to pay an extra $1 per food item if it was locally grown. An additional 18% of students were willing to pay $2-$3 more per food item. These data indicate that many UNC students want locally grown food.

However, 53% of students were unsure of how much food they consumed was local. It is possible that they simply do not know where to buy local products or which items are local. Thus, improved promotion and labeling of locally grown products by on-campus food vendors could increase student consumption. For example, FLO Food (Fair, Local, and Organic) is a student organization that has worked to educate students and increase awareness about the benefits of local and organic food through special nights at dining halls and information tables during meals.

For Carolina Dining Services (CDS), the food distributor on campus, buying more locally grown food would decrease the university's carbon emissions attributed to food production and transport. FLO Food is working to establish communication between local farmers and CDS to increase local purchases. A product where this could prove beneficial is apples. According to members of FLO Food, most, if not all, of the apples in the dining halls are produced in the state of Washington. Meanwhile, apples are the primary product of many farms in western North Carolina. If farmers from western NC and CDS can do business, energy and carbon emissions will be reduced. Other major obstacles are convenience and quantity, since CDS has such a large operation. For this, farmers can join together and form a co-op so that CDS can make all of its local purchases in one place instead of buying from many small suppliers. Establishing a food processing facility in Orange County would also make it more convenient for CDS to buy locally. A final suggestion is for the university to establish a campus-run farm (a larger version of the Carolina Garden Co-Op), perhaps in Carolina North, that would serve as an education tool and provide produce to campus dining halls.

Some progress has already been made with local food. CDS works with distributors to purchase locally grown products and "alter menus to incorporate as much locally grown food as

possible."[28] Depending on the month, CDS purchases up to 15% of its produce from local farms, though this fraction is normally between 0.5% - 3%.[28] According to FLO Food, about 90% of the milk and dairy products purchased by CDS are produced in North Carolina and Virginia. Locally grown products are labeled in the dining halls. In the fall of 2008, CDS began selling hamburgers made from 100% grass-fed beef that is produced on a farm about 100 miles away, though that practice has recently been canceled due to communication and ordering difficulties.[28]

Many other schools have promoted local food on their campuses. According to campus sustainability profiles on the Association for the Advancement of Sustainability in Higher Education website, Aquinas College, Bemidji State University, California State University in Chico, Duke University, Harford Community College, and Northern Arizona University have all pledged to increase locally grown food in campus dining halls.[29] Duke University's campus food vendor, Bon Appétit Management Company, labels foods that are local, organic, vegetarian, etc. and creates its menus based on the seasonality and availability of local products.[30] Hamburgers made from 100% grass-fed beef have been introduced on campus. Furthermore, a "low carbon diet day" is scheduled on Earth Day to educate students in ways they can reduce their carbon emissions through food choices.[31] Colby College adopted the "Maine First" policy, which calls for the purchase of out-of-state goods only when native ones are not available.[29] Their dining services work with more than 100 local growers and processors, and about 20% of their budget goes toward purchasing local food. Dickinson College, Furman University, Green Mountain College, and the University of Florida each operate farms or plots that provide organic products to university dining facilities.[29] Oberlin College established the "Buy Local" program in 2000 to promote purchasing locally grown food and products.[29] As of 2006, the program has succeeded,

with 35% of the food in dining halls being locally produced. The University of California, Berkeley has introduced 100% organic salad bars to their campus dining facilities.[29]

As discussed above, buying local products reduces pollution and carbon emissions. It will also prove less expensive in the future as fossil fuels become more expensive, increasing production and transportation costs for industrial farms. Advantages of local farms include fewer pesticides and petroleum-based fertilizers and shorter transport distances. Regardless of the quantified savings, campuses across the country have demonstrated a commitment to reducing their carbon emissions by promoting locally grown food. UNC must continue to build upon the progress it has already made to further decrease their emissions through this recommendation.

Recommendation #5: Promote Reusable Beverage Containers

The use of reusable bottles and mugs could further reduce UNC's carbon emissions by decreasing the amount of trash generated by the university. Approximately 8.3 billion gallons of bottled water were consumed in the United States alone in 2006.[32] The Container Recycling Institute (CRI) estimated that 8 out of 10 plastic water bottles become garbage instead of being recycled and can take up to 1,000 years to biodegrade.[33] Furthermore, about 15 million barrels of oil are needed per year to manufacture plastic water bottles.[33] It is estimated that if everyone in the city of New York used a reusable water bottle, 24 million bottles would be saved in a week, 112 million in one month, and about 1.3 billion in one year.[32] Clearly, the amount of waste generated and energy used would be greatly reduced if recycling and reusable beverage containers were the norm.

Many college campuses around the country offer beverage discounts to those with reusable mugs, as publicized on their university websites. Owners of a reusable mug at the

University of Vermont can buy any size coffee or soda for just $0.99.[34] Additionally, people receive a free drink if they are spotted on campus using the mug. Similar programs, where people receive coupons for free drinks if they are seen using a reusable mug, were instituted at UC Davis and Dickinson College.[29] Students at the University of Buffalo instituted a discount program with hopes of reducing the number of paper and Styrofoam cups used on campus (about 1.2 million cups were used in 1998 alone).[35] A similar initiative was also established on the University of Colorado campus.[36] Harford Community College sells reusable mugs at cost to its students, while Northern Arizona University actually gives each incoming freshman a reusable mug with accompanying discounts on drinks.[29]

The goal of such programs is to reduce the environmental impact of the university by limiting the number of disposable cups used by students. UNC should follow these other schools and start its own reusable mug program. Though many students already use reusable beverage containers, as shown in Figure 7, many disposable cups and bottles are used for coffee and soft drinks at campus stores.

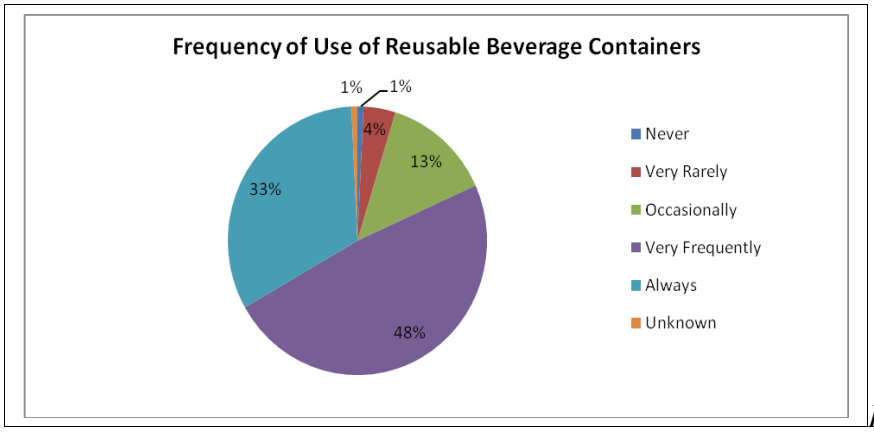

Figure 7: Respondents' frequency of use of reusable beverage containers.

Student Stores, Alpine Bagel Company, and the Daily Grind could each sell mugs

designed and purchased by a University sponsor. For example, these mugs could advertise CDS or the UNC Sustainability Office. When asked how much they would be willing to pay for such a mug, 34% of survey-takers said $5 while 38% said that they would pay $10. Students who purchase and use the mugs, in addition to reducing waste and saving energy, would receive a discount (amount decided by the university) on all coffee and soft drinks purchased at the above locations. Another possible incentive is to have members of student government's Environmental Affairs Committee give out coupons (perhaps 10 coupons per week limit per committee member) to students they see using the designated reusable mug on campus. Discounts could also be provided for students using personal mugs. The program could be promoted on campus by student environmental organizations. It would be a simple yet effective method to reduce waste produced by the university and its students, as well as cutting UNC's trash-disposal costs. It would also indirectly cut carbon emissions since fewer cups and plastic bottles would be produced, a process that uses fossil fuels.

Recommendation #6: Provide Drying Racks and Clothes Lines

Estimated Annual Savings: $43,000 and 350 metric tons of carbon dioxide

Clothes dryers are among the most energy-intensive appliances used by Americans, often sucking electricity at a rate of 1800-5000 watts.[37] The UNC dormitories contain pay-per-use washing machines and dryers, and our survey results suggest that the university could save energy and money by offering an alternative to clothes dryers. Two alternatives are collapsible drying racks and clothes lines. The racks are light and store flat, but fold out to accommodate a full load of clean clothes.

When asked how they currently dry their clothes, 57% of survey respondents indicated that they use a dryer and 39% said they use both a clothes line or drying rack and a dryer. This implies that a significant number of students already use an alternative at least some of the time.

It was important to distinguish between on and off-campus students' willingness to use an alternative drying method because different methods would be appropriate for different situations. Of on-campus students, only 2% use an alternative method exclusively and 33% use an alternative method in addition to a drying machine. So, there remains room for increased use. When asked how often they would use an alternative if the university made one available, 55% of on-campus students said that they would use a drying rack occasionally, very frequently or always (Figure 8). This result indicates that UNC could decrease dryer use by offering lines or drying racks. If the university offered such an option and 55% of students living on campus used it occasionally, it would save the university $43,000 and 350 metric tons of carbon dioxide annually from the dryer runs not made.[38] The university could also likely increase its income and provide an incentive for using alternative drying methods by raising the price of the drying machines per use.

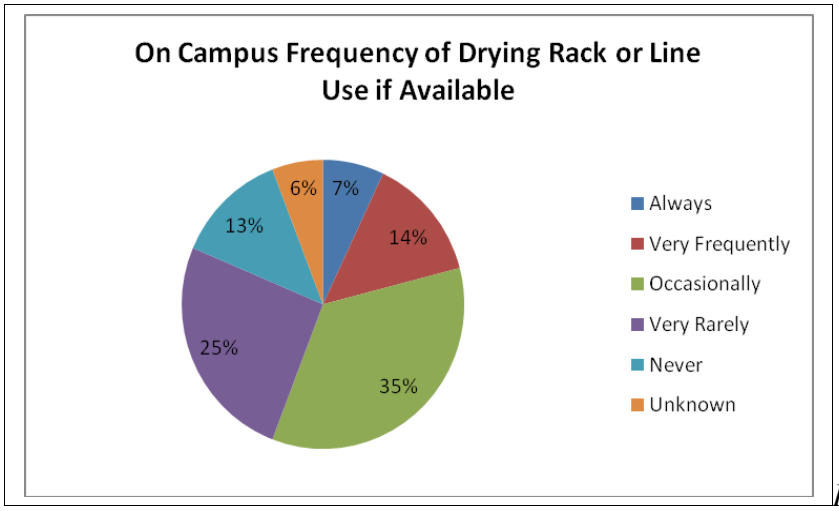

Figure 8: Potential frequency of alternative drying method use on campus.

In light of concerns about clothing theft, we recommend that the university help the dormitories offer folding drying racks that students could check out and set up in their rooms. Already the residence halls use a system where students may check out vacuum cleaners and other cleaning tools. These racks would need to be compact enough to fit in a dorm room, as clothes often take a full day to dry completely.

It appears that no other college offers this type of program, although many suggest collapsible drying racks on packing lists for freshmen.[39,40,41] Perhaps these universities see the benefits of students' using drying racks, but do not wish to make the initial investment or are worried about damage to the racks, causing their replacement cost to outweigh any monetary savings. Considering the University's resources and commitment to sustainability, it seems wise to help students build this habit early.

The university could also reduce the town's energy use by offering a drying alternative to students living off campus. Our survey showed that 4% of off-campus students already use an

alternative exclusively, and 42% use both a dryer and an alternative. Students responded that they were also willing to use an alternative if one were made available by the university (Figure 9). For off-campus residents, it may be safe to set up a rack or line inside or in a yard. Also, off-campus housing sometimes does not share the same problem of tight space in rooms with dorms. Therefore, it may be feasible for the university to offer drying lines with an effective anchoring system along with clips at a low price or free to students.

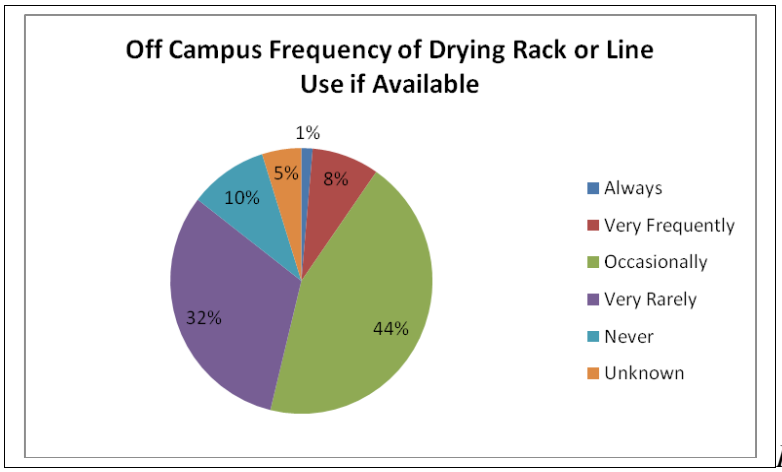

Figure 9: Potential frequency of alternative drying method use off campus.

Recommendation #7: Promote the Use of Alternative Transportation

The means of transportation and frequency of use varies depending on the area in which a person lives. Regardless of this fact, the majority of college students have access to some sort of personal vehicle[42]. If people prefer to continue to use their own personal car, truck or SUV, carpooling is one method of to reduce the number of vehicles used and the amount of energy consumed through personal transportation. While only 12.6% of University of Prince Edward Island students currently carpool, 28.5% would be willing to carpool in an attempt to reduce energy consumption.[43] Students at UNC carpool more than students at other universities and the

general population, with 90.7% of survey respondents carpooling at least occasionally (Figure 10). Despite the already high participation of carpooling among students at UNC, increasing both the amount of students who carpool and the number of places they do so would help in reducing student energy use. Carpooling among students could be encouraged by providing preferential parking to those who carpool or discounted parking fees at sporting events. Duke University currently has a carpooling program in which three or more students, or two or more employees who can demonstrate carpool arrangements, are able to qualify for a half-priced parking permit.[44]

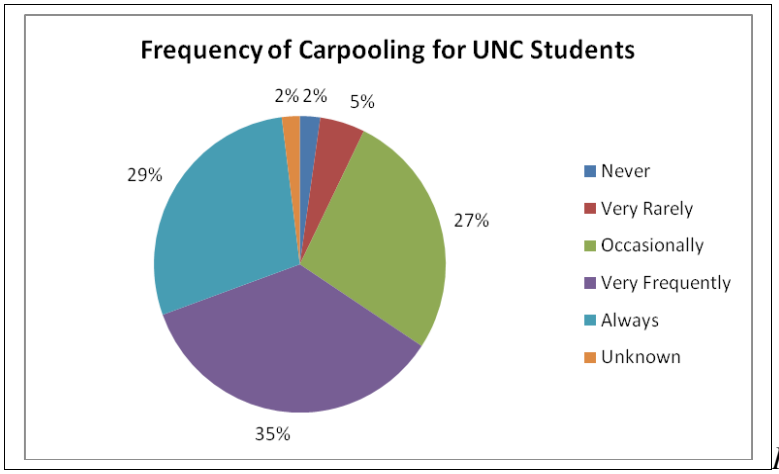

Figure 10: Frequency of carpooling for UNC students.

Aside from personal vehicle use, public transportation is another means of travel for college students, although its accessibility varies depending on location.[45] The town of Chapel Hill does have a system of public transportation which meets commuting needs through the town, in addition to campus and the town of Carrboro.[46] The bus system in Chapel Hill is fare-free and serves over thirty-one different routes.[47] Outside of the immediate Chapel Hill-Carrboro area, there are other means of public transportation, such as the Triangle Transit Authority (TTA), which provides bus service throughout the Triangle area.[48] Students at Clemson University

indicated they would be willing to consider taking or use public transportation when given a financial incentive; this represents one possible way to increase the use of public or university provided transportation among UNC students[49]. When asked if they would be willing to ride the bus for some sort of financial incentive, 68% of respondents said they would do so always, very frequently, or occasionally. An example of a financial incentive would a discount at a local restaurant which could be honored through a coupon or certificate a student would receive after riding the bus. These incentives could also be encouraged through expansion of the Commuter Alternative Program (CAP) at UNC in which the use of alternative forms of transportation is rewarded through parking permits on campus, free bus ridership on the TTA, and merchant incentives throughout Chapel Hill and Carrboro. While currently available to students who live outside a two mile radius of campus, expanding the program would encourage more students to use alternative forms of transportation to their own personal vehicles.

Ridership for the buses provided by Chapel Hill Transit is currently the highest in the state, with over 5.5 million riders during the 2006-2007 fiscal year. Comparatively, 29% of people take the bus to work in Chapel Hill as opposed to only 9% in the region[50]. The public transportation system in Chapel Hill became fare-free in January of 2002 and the high ridership can be attributed, at least in part, to this fact.[51] While survey respondents ride the bus as their primary mode of transportation to campus, personal vehicles were more popular for other destinations such as shopping or the movies (Figure 11). Encouraging students to use the local bus systems for more diverse destinations would help in reducing the use of personal vehicles on campus and would therefore limit the amount of carbon emissions associated with student transportation. One strategy by which to accomplish higher participation of public transportation

would be to make information about local public transportation systems easily accessible for students, for example posting bus schedules and routes for Chapel Hill Transit and the TTA in high traffic areas of campus, such as the student union.

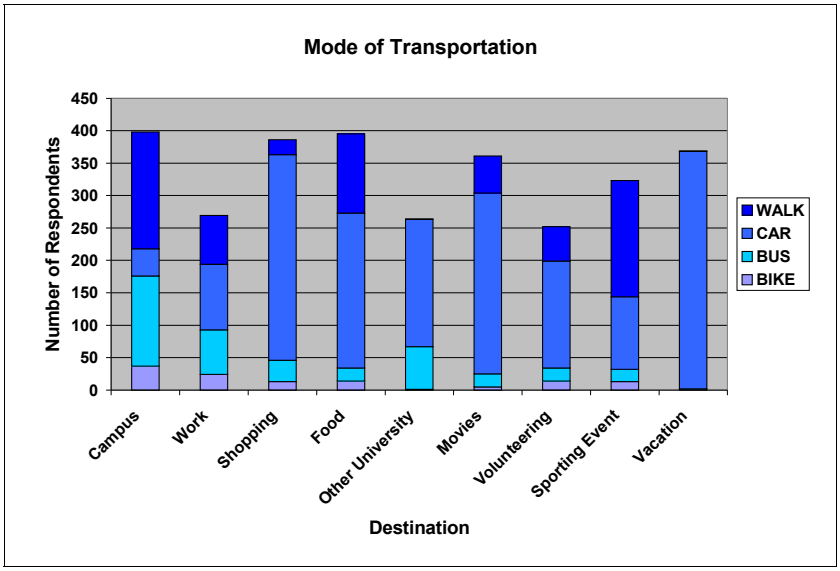

Figure 11: Modes of transportation used for various destinations.

One feasible alternative to the use of personal vehicles and public transportation would be to encourage the use of bikes around campus and the Chapel Hill-Carrboro area. In comparison to several other college towns, Chapel Hill can be considered less biker accessibly. For example, Boulder Colorado has over 300 miles of bike lanes and bike paths available and the Chapel Hill only has approximately 43 miles of bike lanes and paths, most of which have recently been added. Consequently, for a campus that is contiguous and comparatively compact and that has a reputation for being extremely parking unfriendly, the number of survey respondents who list biking as their primary means of transportation is strikingly limited. Of survey respondents, 9.3% use a bike as their primary mode of transportation to campus and

between 1 and 6% use a bike to go to other destinations including shopping locations, restaurants, movies, work, and other universities. The town of Chapel Hill, in partnership with Carrboro and UNC, has currently established a bike-loaner initiative, the Blue Urban Bike program (BUB) which will provide an initial thirty bikes to be rented out across Chapel Hill and Carrboro.[52] BUB has begun on March 10, 2008 with the opening of its lending library on Martin Luther King Jr. Blvd. The program is free for town employees and community members may take advantage of the bike-loaner program for a fee of $10 per year.[53] While the town of Chapel Hill has begun BUB in hopes of reducing driving for employees, publicizing the program more broadly and expanding the program to include more student use would aid in reducing the dependence on energy consuming modes of transportation and encourage students to find alternative ways of getting around besides their personal vehicle. Specifically, through this program, the use of bikes would be encouraged since survey results indicate that bike use is low among UNC students. In addition to providing bikes for use in the community, Chapel Hill, Carrboro, and UNC need to provide safer and more accessible bike routes.

Recommendation #8: Increase On-Campus Recycling

Estimated Annual Savings: $92,000 and 770 metric tons of carbon dioxide

Recycling is an important way that students can reduce the amount of carbon emissions they are responsible for generating. According to the US Environmental Protection Agency (EPA), Americans recycle 32.5% of their solid waste. UNC's recycling program already beats this average.[54] The University has recycled between 33% and 43% of its solid waste since 1996. Despite adding around 6000 people on campus between 1996 and 2007, the annual total volume

of trash and recycling has remained between 9,000 and 10,500 tons during the same period. Since 1991, the amount of solid waste each member of the university community sends to the landfill each year has dropped from 531 to 297 pounds, and the amount recycled has risen from 48 to 222 pounds. Recycling of fiber[55] alone saved the university more than ten thousand kilowatt hours in the 2006-2007 school year, which would have cost more than $846,000.[56]

A number of other colleges have also implemented successful recycling programs. Many schools use programs and games, like Duke's Eco-Olympics or UNC's Green Games, to change student attitudes and habits related to recycling. In Green Games and Eco-Olympics, dormitories compete to reduce energy, water, and waste. Duke has also started rechargeable battery and cell phone recycling programs.[57]

Our survey indicates that students are an important part of UNC's recycling program. 65% of respondents indicated that they always recycle. Moreover, 58% said they recycle all of their glass, plastic, aluminum, paperboard, newspaper, cardboard, and magazines. Only 1% replied that they did not recycle. These statistics imply that most students are responsible recyclers.

Even though UNC already has a successful recycling program with a high rate of participation, UNC should strive for 100% participation in on campus recycling and encourage students living off campus to recycle at home. The survey distinguished between students living on and off campus, and this was important in determining where the recycling program could improve the most. While students living off campus may do most of their recycling at home, they may also do so between classes. In addition, the waste stream off campus still affects Chapel Hill's total carbon output, as well as the availability of landfill volume for the university.

On-campus and off-campus residents recycle almost all the time; 59% of students on campus and 68% of those off campus replied that they recycle all the time, and the other frequencies were similarly close. The averages of the Likert-weighted values for on-campus students' recycling frequency was 4.46, which means that most recycle always or very frequently. The average for off-campus residents was 4.56.

The survey suggests that one of the primary obstacles to more frequent recycling is the inconvenient location of recycling bins. Respondents who indicated that they "never," "very rarely," or "occasionally" recycle were asked what prevents them from recycling more often. The most frequent response, given by 56% of respondents, was that collection bins are inconveniently located. This suggests that UNC could increase on-campus recycling by providing bins at more convenient locations.

What students were referring to when asked what prevented them from recycling more depended on where they live. For students living on campus, the distribution of reasons is show in Figure 12. This shows that the most-cited problem was inconvenient location of bins, although our survey did not distinguish between bins located behind dorms or those in and between classroom or support buildings. In addition, 22% of students cited uncertainty about what is recyclable as a reason for not recycling more.

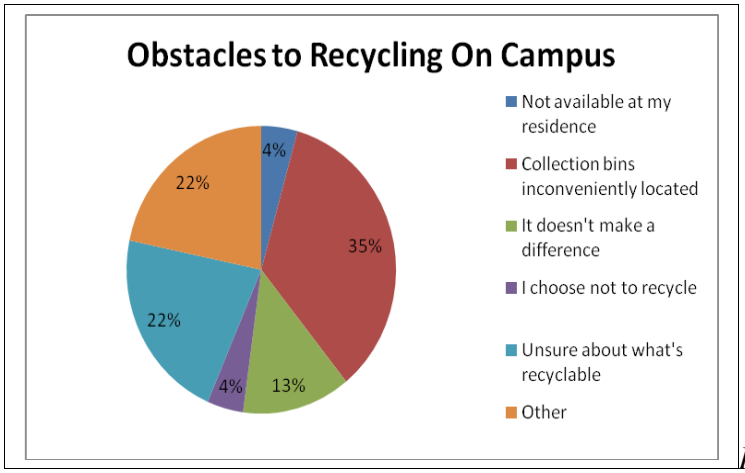

Figure 12: Obstacles to student recycling on campus.

Students living off-campus also cited inconvenient location of bins most frequently as a barrier to more frequent recycling (Figure 13). Chapel Hill and Carrboro, the towns where we assume most students live, have curbside pickup for houses, but apartment complexes may have only one recycling depot that is inconveniently located. Or, some students may have assumed that the survey question referred specifically to on-campus recycling, in which case this result shows that the university could increase recycling by offering bins at more locations around the main campus.

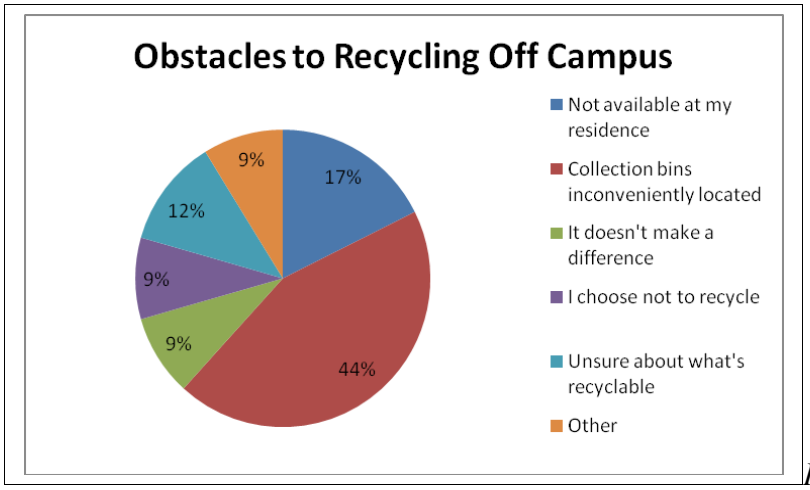

Figure 13: Obstacles to student recycling off campus.

Inconvenient bin location was not the only obstacle to more frequent recycling by students. One respondent said that "Only aluminum has value - recycling uses more money, energy, and resources than making things new." This response puts the burden of profitability on recycling and ignores the cost of disposing of recyclables in landfills. Perhaps students who think as this one did would be swayed if Orange County's desperate search for a new landfill was better advertised.

Another way that UNC might be able to increase on-campus recycling is by educating students as to what is and is not recyclable. Of those who were asked what prevents them from recycling more frequently, 24% responded that they are unsure about what is recyclable. Because a smaller portion of off-campus residents cited confusion about what is recyclable than on-campus residents, we conclude that on-campus recycling guidelines could be better advertised. For example, many plastic containers have a small logo on them, usually with a number, which indicates whether or not they are recyclable. At recycling collection centers in Carrboro, there is signage to indicate that only bottles whose neck is smaller than the body are recyclable. This is

due to the different processes involved in making and recycling the plastic, but the average student or citizen may not understand the limitations on what plastic can be recycled. More effort in educating students and the public about plastic recycling may help. If another 10% of students began recycling as their peers do, the total annual savings would be $92,000 and 770 metric tons of CO_2.[58]

Recommendation #9: Reduce Hot Water Use in Showers

Estimated Annual Savings: $230,000 and 370 metric tons of carbon dioxide

Another way people can reduce their energy use is to use less hot water by taking shorter showers. The average shower length is just over 7 minutes.[59] According to this survey, 56% of students take 10 minute showers and 24% take around 20 minute showers, while only 17% take 5 minute showers. This comes out to an average shower length of 11.25 minutes for the UNC sample. Most students (73%) also noted that they shower once per day. Because water has a very high heat capacity, it takes a lot of energy for a water heater to heat the water used for showers. A 1-2 minute shorter shower conserves up to 700 gallons of water per person per month.[60] It has been estimated that shorter showers can also save up to $99 on water and electric bills and 350 pounds of carbon dioxide emissions per year per person.[61] Though 33% of respondents said they already take shorter showers, another 44% indicated that they would be probably, definitely, or always willing to take shorter showers. In dormitories, the percentage of respondents willing to shorten their shower by 1-2 minutes was 38%. If 25% of dormitory students shortened the duration of their showers, possibly motivated by a shower timer that digitally displays the time a person has been in the shower, the university would save approximately $230,000 and 370 metric tons of CO_2 emissions annually.[62] An educational campaign promoting the benefits of a shorter

shower, perhaps in the form of fliers on the bathroom doors and walls, could also be an effective method in accomplishing this recommendation. While there clearly are monetary and environmental benefits for shorter showers as shown from the above estimates, they have not been quantified for UNC specifically. The university should investigate this recommendation further, perhaps through a pilot program in one dormitory, to examine its feasibility, popularity, and the magnitude of the benefits.

Progress has already been made at UNC concerning hot water conservation. Low-flow showerheads have the same benefit as shorter showers, cutting shower energy costs by up to 50% and saving about 300 pounds of carbon dioxide per year per person.[62,63] The university has replaced all showerheads in dormitories with low-flow versions to reduce hot water and energy use. Additionally, the solar thermal panels installed on the roof of the newly-renovated Morrison dormitory generate hot water with energy from the sun. At any given time, the panels provide 40% - 60% of the hot water for the residence.[64] Solar thermal panels should be considered during future renovations and new building projects as a way to reduce the university's energy use from heating water. These strategies would bring UNC closer to its goal of carbon neutrality.

Recommendation #10: Encourage Thermostat Adjustment

Students have the ability to reduce their energy use by changing the way they heat and cool their residences. According to the survey, 98% of students living off campus have control over their thermostats, and 75% of students living on campus do. Students living on campus reported setting both their winter and summer thermostats to 69° Fahrenheit. Meanwhile, students living off campus set their winter thermostats slightly lower at 68° (t-test, $p=0.03$) and summer

thermostats significantly higher, at 74° (t-test, $p=2x10^{-10}$). The median setting for on-campus students was 70° for both seasons, and the median for off-campus was 68° in the winter and 74° in the summer. This difference shows that off-campus students set their thermostats closer to the seasonal temperature and may be motivated by their responsibility for paying their own power bills, which provide them with an incentive to conserve energy that students in dorms do not feel.

Students were asked how willing they would be to lower their winter thermostats, and both groups reported that they were, on average, probably or definitely willing to do so. The averages of willingness on a five-point Likert scale (definitely not, probably not, possible, probably, definitely) was above 4.1 for both groups. However, both groups were less willing to raise their summer thermostat settings, averaging 3.7 and 3.5 on the Likert scale for off- and on- campus residents, respectively. Both of these results indicate that students would probably be willing to change their thermostat settings by 1-2 degrees. However, students are more willing to bundle up in the winter than endure hotter living spaces in the summer. Future studies may help identify the messages and incentives that maximize students' willingness to change their thermostat settings.

In addition to spending less energy on space heating and cooling while present, students could save energy by making sure that their heating and cooling systems are not engaged while the students are away from their residences. Depending on the specifications of the heating or cooling system, the temperature difference between indoors and outdoors, and the time a room is unoccupied, it can save large amounts of energy to stop heating or cooling it until a user returns. Our survey asked respondents how often they adjust the thermostat in their rooms when they

leave during the day, and the responses varied significantly between on- and off-campus students, as shown in Figure 14.

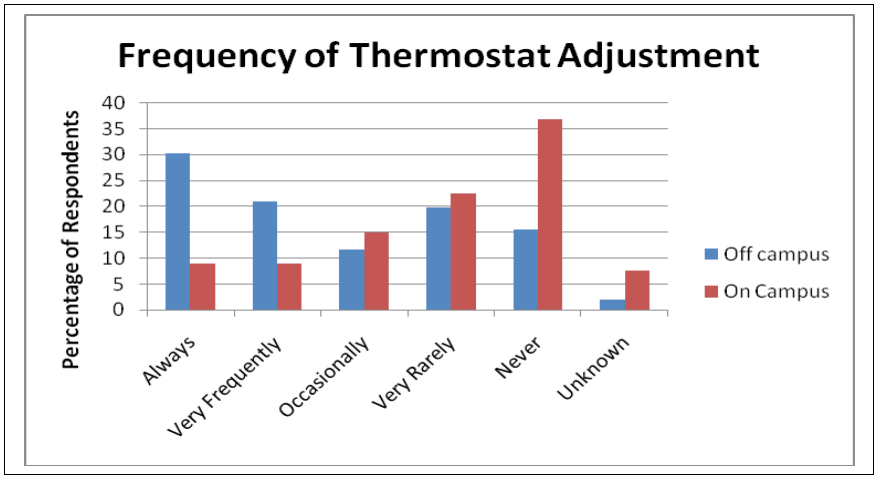

Figure 14. The frequency with which students on campus and off campus adjust their thermostats when they leave their residence.

The five-point Likert average for the frequency (never, very rarely, occasionally, very frequently, always) for off-campus residents was 3.4, but only 2.3 for on-campus residents. This means that students off campus are much more likely to adjust their thermostats when leaving than on-campus students. The survey did not distinguish between those who do not adjust their thermostats because they are already programmed and those who do not use or do not have a programmable thermostat. Assuming that the number of students who use programmable thermostats now is small, this result indicates that students on campus are much less likely to adjust their thermostat when leaving compared with students living off campus.

While students on campus may not adjust their thermostats often, further research may indicate that they would be willing to if educated about the importance of energy savings or motivated to by somehow being charged for their electricity use. It is also possible that the universi-

ty could save energy by installing programmable thermostats, which allow students to control the temperature in their room without physically changing it multiple times a day.

Improvements and Suggestions for Future Research

Our recommendations could have been strengthened if additional questions had been asked on the online survey. It would have been useful to assess the willingness of students to pay more for a meal plan if the dining halls had more local options, since locally grown food is typically more expensive than industrially produced food and as such would raise costs for CDS. The survey should have directly asked students if they would prefer more local food in the dining halls. Another possibility that requires further research is if students would support a student fee that would subsidize the costs of local food, which would make it more appealing to CDS. Additionally, a later capstone group could research the food suppliers of Carolina Dining Services and try to quantify their production and transport costs, both financially and environmentally. Perhaps those results would bolster support for increased local food.

To improve the argument for a reusable beverage container program, the survey should have asked students how often they use a disposable coffee cup or plastic bottle. Based on the personal observations of the authors and the amount of bottles collected in trash cans on campus over a single day (Focus the Nation on January 31, 2008), the frequency of such use is high and an estimate of the total amount of disposable cups and plastic bottles used on campus would have been useful. The students should also have been directly asked their willingness to participate in a reusable beverage container program, not just how much they would pay for a container. Future research could include quantifying the manufacturing costs of mugs for the program.

Likewise, it would be useful to know how many students already have a power strip in their rooms, but just do not turn it off when the electronics are not in use. The willingness of students to turn off their power strip to save energy should have been assessed.

Additionally, future research could investigate the feasibility and costs of installing shower timers in all dormitory shower stalls, as well as the likelihood that they would decrease shower lengths. A pilot program in one dorm could study the effectiveness of this recommendation.

Other questions could have been asked to improve the recycling and programmable thermostats recommendations. The addition of recycling bins could have been made more effective by identifying the locations where students most wish they had one. More information about students' use and willingness to use programmable thermostats would help justify the initial investment of that recommendation.

There were several aspects of student behavior that were too specific to be addressed through the survey's design and purpose. Yet, these questions could still be addressed through further research. First of all, the survey addresses the idea of raising the current student fee for renewable energies. While it was suggested that the money could be used for purposes other than renewable energy, further research would be helpful in deciding exactly how students would want this money spent.

Another suggestion for further research would be to ask students about their knowledge and level of willingness to ride other systems of public transportation other than just those through Chapel Hill Transit. By focusing on ridership outside of Chapel Hill by students, it would help to limit further demand of personal vehicles by students and therefore limit the

amount of greenhouse gases in Chapel Hill. Additionally, future research should look at biking in Chapel Hill among students, such as the accessibility of bikes, how many students own them and do not use them, reasons why students would not consider biking to certain destinations, and the feasibility of expanding the current bike-loaner program in Chapel Hill to on campus locations.

Perhaps the greatest obstacle to making a larger impact with this survey was the lack of control and understanding of who was taking it. Although we polled students for environmental awareness and concern about global warming, their responses were not used to normalize the data to any other measure. More advanced statistical methods would have been helpful in creating and analyzing the survey.

Appendices

Appendix A. Final Survey Questions

1. Which best describes your residence? (Dorm, Other university housing, Off campus house, Off campus apartment, Greek house, Other)
    a. [If Dorm] Please name the dorm you live in:
2. What temperature do you set your thermostat to in the winter?
    a. [If greater than 65 degrees] During the winter months, how willing are you to lower your thermostat 1-2 degrees and put on an extra layer of clothing? (Not at all, Probably not, Possibly, Probably, Definitely, Not sure)
    b. [If not at all, not sure, probably not, or possibly] What prevents you from lowering your thermostat 1-2 degrees?
3. How many months of the year do you have the heat on in your residence?

4. What temperature do you set your to in the summer?
    a. [If lower than 75 degrees] During the summer months, how willing are you to raise your thermostat 1-2 degrees? (Not at all, Probably not, Possibly, Probably, Definitely, Not sure)
    b. [If not at all, not sure, probably not, or possibly] What prevents you from raising your thermostat 1-2 degrees?
5. For about how many months of the year do you have the air conditioning on in your residence?
6. Do you have central air conditioning or window units?
7. When you leave your residence during the day, do you adjust the setting of your thermostat?
8. What was your approximate total energy bill in October?
9. What was your approximate total energy bill in February?
10. How many times do you use the following appliances in your resident per week?

	0	1-2 time/wk	3-4 times/ wk	5-6 times/wk	Daily	> Daily	N/A
Oven							
Toaster Oven							
Stove-top							
Microwave							
Toaster							
Coffee Maker							
Rice Cooker							
Other							

11. How often do you recycle? (Never, Very Rarely, Occasionally, Very Frequently, Always, Don't Know)

a. [If Never, Very rarely, occasionally] What prevents you from recycling [more often]? (Not available at my residence, Collection bins inconveniently located, It doesn't make a difference, I choose not to recycle, Unsure about what's recyclable, Other)

b. [If not never] Please indicate which items you recycle below.

Category	**Recycle**
Glass	
Plastic	
Aluminum/steel	
Paper, junk mail, paperboard	
Newspapers	
Cardboard	
Magazines	
Other (please specify):_____	

12. In your opinion, how important is eating locally produced food? (Unimportant, Of Little Importance, Moderately Important, Very Important, Not Sure)
13. How much extra would you be willing to pay per item (like a dozen eggs or a gallon of milk) for locally grown food? ($0, $1, $2, $3, Any amount)
14. What percent of the food that you eat is locally produced? (0%, 25%, 50%, 75%, 100%)
    a. [If >25%] What motivates you to purchase locally produced food?
    b. [If<25%] What prevents you from purchasing [more] locally produced food?
15. How often do you use reusable beverage containers like a water bottle or coffee mug? (Never, Very Rarely, Occasionally, Very Frequently, Always, Don't Know)
16. If UNC offered 5%-10% beverage discounts with the purchase of an insulated, reusable mug, how much would you be willing to pay for the mug? ($0, $5, $10, $15, Don't Know)
17. How often do you usually shower? (<1 Time Daily, Daily, Twice Daily, >Twice Daily)

18. On average, how long is each shower? (3 minutes or less, 3-5 minutes, 5-10 minutes, 10-20 minutes, >20 minutes)
19. Do you wash your laundry with hot water? (Never, Very Rarely, Occasionally, Very Frequently, Always, Don't Know)
20. Do you dry your clothes in the dryer or hang them out on a laundry line? (Dryer, Line, Both)
    a. [If dryer] How often would you hang your clothes on a line or drying rack if it was available? (Never, Very Rarely, Occasionally, Very Frequently, Always, Don't Know)
21. Do you have a dishwasher in your residence? (Yes, No, Don't know)

22. How willing would you be to adopt the following water-saving and energy efficient actions in response to the extreme drought currently facing North Carolina?

Action	N/A	Not at all	Probably Not	Possibly	Probably	Definitely	Already changed	Have always done it
Take shorter showers								
Install low-flow showerhead								
Turn off water while brushing teeth								

23. For each device below, indicate whether you unplug it when not in use?

Device	Do you unplug it when not in use? (yes, no, don't have it)
Laptop computer	
Printer	
IPod/MP3 player charger	
Digital camera charger	
Cell phone charger	
Television	
DVD/VHS player	
Video game system	
Radio/stereo	
Alarm clock	
Cordless phone	
High-speed internet modem	

a. [If yes or no on television] Is your TV a flat screen television?

24. Is your laptop computer set to sleep or hibernate when not in use? (Yes, No, Don't Know)

25. What percentage of the light bulbs in your room or house are compact fluorescent (CFLs)?

(None, 25%, 50%, 75%, 100%, Don't Know)

26. Do you usually turn off the lights when you leave the room? (Never, Very Rarely,

Occasionally, Very Frequently, Always, Don't Know)

27. For each of the destinations below, check your primary mode of transportation?

Destination	Automobile	Bicycle	Bus	Walk
Campus				
Work				
Shopping				
Restaurants				
Another university				
Movies				
Volunteer				
Sporting Events				
Vacation				
Other				

a. [If no buses above] Are you aware that Chapel Hill Transit buses are free to ride?

b. [If an automobile] Do you drive a passenger vehicle, truck/SUV, or hybrid?

c. [If an automobile] About how much money do you spend on fuel each month?

28. If you were to receive a discount at a local business for riding the bus, would you use public transportation more often? (Never, Very Rarely, Occasionally, Very Frequently, Always, Don't Know)
29. Do you try to carpool whenever possible? (Never, Very Rarely, Occasionally, Very Frequently, Always, Don't Know)
30. Please indicate your sex. (Male, Female)
31. With 1 being the least aware and 10 being the most aware, please rate your level of environmental awareness. (1, 2, 3, 4, 5, 6, 7, 8, 9, 10)
32. Do you make a conscious effort to save energy? (Never, Very Rarely, Occasionally, Very Frequently, Always, Don't Know)
33. You currently pay $4 per semester to support renewable energy improvements on campus. How much more would you be willing to pay per semester? ($0, $1, $2, $3, $4 or more)
34. How concerned are you about global warming? (Unconcerned, Mildly Concerned, Moderately Concerned, Very Concerned, Not Sure)

Appendix B. Summary of raw data for survey questions

Recycling

Recycling Frequency	Off Campus	On Campus
Always	181	80
Very Frequently	63	37
Occasionally	16	14
Very Rarely	6	1
Never	1	1
Likert Average	4.56	4.46

Table 2. Recycling frequency of on campus and off campus survey respondents.

Recycling Prevention	Off Campus	On Campus
Not available at my residence	6	1
Collection bins inconveniently located	15	8
It doesn't make a difference	3	3
I choose not to recycle	3	1
Unsure about what's recyclable	4	5
Other	3	5
Total	21	13

Table 3. Reasons hindering/preventing recycling that were cited by survey respondents.

Recycled Items	Off Campus	On Campus
Glass	256	114
Plastic	253	127
Aluminum / Steel	230	94
Paper, Junk Mail, Paperboard	224	117
Newspapers	235	123
Cardboard	223	116
Magazines	208	98
All of These	167	64
None of These	3	1
Other	33	8
Total	267	132

Table 4. Breakdown of how many respondents recycled various materials.

Heating and Cooling

Heat Temperature	Off Campus	On Campus
Average	68	68

Table 5. The average temperature at which respondents keep their residences during the winter.

Cooling Temperature	Off Campus	On Campus
Average	74	69

Table 6. The average temperature at which respondents keep their residences during the summer.

Number of Months Heat Is On	Off Campus	On Campus
0	5	9
1	4	7
2	14	15
3	69	45
4	108	37
5	56	12
>5	11	8
Average (if >5 is represented as 6)	3.81	3.22

Table 7. The approximate number of months students heat their residences per year.

Number of Months AC Is On	Off Campus	On Campus
0	6	12
1	2	6
2	11	10
3	64	28
4	92	20
5	63	27
6	29	30
Avg if >5 is represented as 6	4.02	3.80

Table 8. The approximate number of months students cool their residences per year.

Willingness to Lower Winter Residence Temperature	Off Campus	On Campus
Definitely	83	19
Probably	51	9
Possibly	31	5
Probably Not	12	3
Not at all	3	0

Table 9. The willingness of respondents to lower the temperature at which they keep their residences during the winter in an effort to save energy.

Willingness to Raise Summer Residence Temperature	Off Campus	On Campus
Definitely	43	13
Probably	30	12
Possibly	30	20
Probably Not	22	7
Definitely Not	3	2
Not Sure	1	1

Table 10. The willingness of respondents to raise the temperature at which they keep their residences during the summer in an effort to save energy.

Freuqency of Thermostat Adjustment	Off Campus	On Campus
Always	78	12
Very Frequently	54	12
Very Rarely	51	30
Occasionally	30	20
Never	40	49
Unknown	5	10
Likert Average	3.40	2.33

Table 11. The frequency with which respondents adjust their thermostats when they leave their residences.

Approximate Energy Bill for Off-Campus Students	Weighting	October	February
$0 - $25	13	8	6
$26 - $50	38	46	28
$51 - $75	63	70	50
$76 - $100	89	47	57
>$100	113	32	72
Unknown	0	64	54
Average		69	82

Table 12. The number of respondents for approximate amounts of their October (fall) and February (winter) energy bills.

Locally-Grown Food

Level of Importance	Number of Responses
Unimportant	18
Of Little Importance	73
Moderately Important	124
Important	105
Very Important	68
Unsure	12

Table 13. The number of responses for various levels of importance of locally grown food to students.

Amount Extra per Food Item	Number of Responses
$0	8
$1	188
$2	60
$3	11
Any amount	4
Unsure	50

Table 14. The responses to how much respondents would pay extra per food item for locally grown food.

Percent of Food that is Local	Number of Responses
0%	36
25%	115
50%	29
75%	10
Unsure	210

Table 15. The percent of respondents' food that is local and the number of responses for each.

Reusable Beverage Containers

Frequency of Reusable Beverage Container Use	Number of Responses
Never	3
Very Rarely	16
Occasionally	54
Very Frequently	194
Always	130
Unknown	3

Table 16. The frequencies with which respondents use resuable beverage containers.

Amount Willing to Pay	Number of Responses
$0	28
$5	137
$10	150
$15	37
Unknown	48

Table 17. The responses to how much respondents would pay for a reusable beverage container if drink discounts were offered with it.

Water Use

Shower Frequency	Number of Responses
< 1 time per day	97
Daily	291
Twice Daily	12

Table 18. Shower frequency of survey respondents.

Shower Length	Number of Responses
0	8
5	66
10	225
20	97
A lot	4

Table 19. Typical shower lengths for survey respondents.

Frequency of Hot Water Use for Laundry	Number of Responses
Never	96
Very Rarely	120
Occasionally	129
Very Frequently	29
Always	6
Unknown	20

Table 20. Frequencies of hot water use when doing laundry.

Method for Drying Clothes	Number of Responses
Line	12
Dryer	231
Both	157

Table 21. Number of responses for methods used to dry clothes.

Use Frequency of Drying Rack if Provided	Number of Responses
Never	25
Very Rarely	68
Occasionally	94
Very Frequently	24
Always	8
Unknown	12

Table 22. For the respondents who use the dryer, the willingness/frequency that they would use a line or drying rack if it were available.

Dishwasher in Residence (Off campus and Greeks only)	Number of Responses
Yes	224
No	43

Table 23. The number of respondents that have dishwashers in their residences (for off campus and Greeks only).

Action	N/A	Not at all	Probably Not	Possibly	Probably	Definitely	Already changed	Have always done it
Take shorter showers	1	10	30	54	72	54	130	49
Install low-flow showerhead	28	20	42	62	54	136	28	30
Turn off water while brushing teeth	_	_	2	6	12	18	73	289
Wash only full loads of laundry	1	_	_	2	10	15	75	297
Wash only full loads in dishwasher	99	1	_	1	7	14	46	232
Do not wash car	58	2	8	8	22	34	158	110

Table 24. The number of responses for each willingness category for various water-saving actions.

Electronic Devices

Device	Yes	No	N/A
Laptop computer	149	242	9
Printer	79	210	111
IPod/MP3 player charger	248	46	106
Digital camera charger	291	18	91
Cell phone charger	156	235	9
Television	20	333	47
DVD/VHS player	25	283	92
Video game system	26	99	275
Radio/stereo	30	207	163
Alarm clock	22	293	85
Cordless phone	14	99	287
High-speed internet modem	9	261	130

Table 25. Do you unplugged various electronic devices when they are not in use?

Flatscreen TV?	Number of Responses
Yes	91
No	260
Unknown	2

Table 26. The number of respondents that own flatscreen TV's.

Frequency Laptops are Set to Sleep/Hibernate	Number of Responses
Never	18
Very Rarely	22
Occasionally	37
Very Frequently	67
Always	247
Unknown	9

Table 27. Frequency with which respondents use the sleep or hibernate mode when their laptops are not in use.

Lighting

Percentage of Light Bulbs That Are CFLs	Number of Respondents
0%	65
25%	58
50%	66
75%	69
100%	36
Unsure	106
Total	400

Table 28. The percentage of light bulbs in respondents' room or house that are CFLs.

Frequency of Turning Off Lights	Number of Respondents
Always	212
Very Frequently	163
Occasionally	16
Very Rarely	5
Never	1
Unknown	3
Total	400

Table 29. Frequency with which respondents turn off the lights when they leave the room.

Transportation

Mode	Campus	Work	Shopping	Food	Other University	Movies	Volunteering	Sporting Event	Vacation	Other
Bike	37	24	13	14	1	5	14	13	0	11
Bus	139	69	33	20	66	20	20	19	2	5
Car	42	101	317	239	196	279	165	112	366	65
N/A	2	131	14	5	136	39	148	74	31	308
Walk	180	75	23	122	1	57	53	179	1	11

Table 30. Breakdown of the number of respondents that use each of the listed modes of transportation as their primary mode to get to various destinations.

Aware of Free Buses?	Number of Respondents
Yes	158
No	3
Unknown	5
Total	166

Table 31. The number of respondents that are or are not aware that Chapel Hill Transit buses are free.

Frequency	Number of Respondents
Always	52
Very Frequently	95
Occasionally	127
Very Rarely	53
Never	14
Unknown	59

Table 32. The frequency with which respondents would use public transportation if riders received a discount at local businesses.

Frequency of Carpooling	Number of Respondents
Always	114
Very Frequently	141
Occasionally	108
Very Rarely	20
Never	9
Unknown	8

Table 33. Frequency that respondents carpool.

Vehicle Type	Number of Respondents
Car	335
Hybrid	15
Truck/SUV	42
Total	392

Table 34. The number of respondents that drive a car, truck/SUV, or hybrid.

Approximate Amount Spent on Fuel	Number of Respondents
$50	164
$100	131
$150	79
$200	14
Greater than $200	4
Total	392

Table 35. The approximate monthly fuel cost for survey respondents.

Respondent Profile

Sex	Number of Respondents
Male	116
Female	284

Table 36. The number of males and females that completed the online survey.

Amount Willing to Pay	Number of Respondents
$0	20
$1	15
$2	18
$3	17
$4	283
Unknown	47

Table 37. The amount that respondents were willing to pay per semester to support renewable energy improvements, in addition to the current $4 fee.

Level of Concern	Number of Respondents
Very Concerned	235
Moderately Concerned	119
Mildly Concerned	32
Unconcerned	11
Unknown	3

Table 38. The level of concern that respondents have in regards to global warming.

Level of Awareness	Number of Respondents
1	1
2	2
3	7
4	8
5	22
6	37
7	103
8	117
9	71
10	32

Table 39. The level of environmental awareness at which respondents considered themselves to be.

Frequency of Conservation	Number of Respondents
Always	117
Very Frequently	193
Occasionally	81
Very Rarely	7
Never	1
Unknown	1

Table 40. The frequency with which respondents make a conscious effort to conserve energy.

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