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Sustainability: A Campus Initiative*

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The United States Coast Guard Academy is in the process of developing a policy that will encourage and, in some cases, even mandate the implementation of sustainable practices and design for the campus. Buy in from Facilities Engineering and the school Superintendent indicates the policies and procedures developed will dictate property management, facilities operation, and future construction. To execute this initiative, a civil engineering student senior design team was formed to provide a campus starting point, research and create guidelines for the formation of a sustainability policy, and submit a design that would improve the Academy's environmental stewardship. This paper describes the background, motivation, process and ultimate outcomes realized due to the creative and dedicated efforts of the senior design team.

Keywords: US Coast Guard; sustainability; clean air-cool planet

1. INTRODUCTION

WHEN EVALUATING ecological impact, a baseline must be established and metrics developed to quantitatively assess the current conditions and substantiate desired improvements. There are many different systems that quantify sustainability either with respect to a single aspect of a facility or encompassing the campus in its entirety [1]. These systems must be judged based on their relevance to the region, institution, and scope. The student group chose to start the development of their sustainability plan by determining the carbon footprint of the Academy campus. 'Carbon footprint' is an internationally recognized term that refers to a common lifecycle measurement of the environmental impact of an individual or an organization [2]. Through research into available carbon calculators, the group settled on the calculator created by Clean Air-Cool Planet, a nonprofit organization dedicated to finding solutions to climate change [3]. Clean Air-Cool Planet has developed an extensive carbon calculator specifically designed for campuses to calculate their carbon footprint. The calculator is a Microsoft Excel tool that requires the user to input an array of data and then provides a snapshot of the amount of carbon being emitted and the major contributors to the emissions. The results highlight sources that contribute to the carbon footprint and identify areas that have the potential for the most significant improvement. This calculator was deemed by the senior design team to be the best way to measure the Academy's efforts towards sustainability because of its success on other campuses and the clear applicability of the tool. The calculator deals with the lifecycle impact of existing structures where environmental concerns are predominantly due to the operation and maintenance of the facility.

The design team used this calculator to determine the current carbon footprint of the campus while simultaneously fulfilling the requirement of their design assignment by working on a project that will help to reduce the campus's emissions. The design component of the project was selected based on the results of the carbon calculator. The team tackled the largest carbon contributing element on campus and used the baseline calculations to demonstrate the impact of the project and justify its value. The team also developed a sustainability policy for the campus and provided recommendations for steps the Coast Guard Academy could take to launch and maintain the momentum of this sustainability initiative.

The largest challenge to this innovation that the team faced is the fact that that this is the first project of this scope on campus. While the Environmental Protection Agency (EPA) [1] regulates certain aspects of energy usage on federal properties, the regulations are geared towards reducing energy consumption rather than the holistic view of sustainability. A common objection to green projects is that sustainability can be infinitely dissected and therefore is hard to quantify [4]. When starting a brand new project to analyze sustainability, the team found that it is vital to identify the extent to which consumption is broken down. The team worked hard to balance an appropriate level of analysis with the data that is was reasonably available.

The Coast Guard Academy is a relatively small campus, a little over 103 acres, comprised mainly of buildings that were built between 1920 and 1970, before environmental sustainability was a major design consideration. Therefore, identified

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improvements will be retrofits to the existing structures. The design team examined the facilities and determined which buildings have the greatest potential for simple modernizations to increase lifecycle efficiency. Beyond the physical changes that must be made to improve campus sustainability, the attitudes of the people on base also have to change in order for the plan to be fully implemented. This is also a significant challenge in the college environment where the student population is so dynamic. The team sought to overcome the hurdles of the sustainability policy by raising awareness of the issues through the advertisement of their results. The end goal was to start a sustainable movement and cultivate a respect for the environment among future generations of America's leaders.

This project team was unique in that it was comprised of four undergraduate students who volunteered and were selected to advise facilities engineering and the college president on a policy for sustainability on their campus. The group realized that they had the ability and obligation to make lasting changes on the campus. As part of their research, they traveled to other local institutions to collect data on student run sustainability programs and learn from the successes and failures of their peers. At the end of April, their policy was implemented and their design solution was presented at a campus wide presentation. That presentation provided the younger generation of students with the background knowledge that was collected over the course of project and provided the cornerstone from which future generations can build.

2. DEFINING SUSTAINABILITY

At the commissioning of this project, the group realized that the US Coast Guard Academy had made very little progress in terms of sustainability and eco-friendly engineering. The US Coast Guard, on the other hand, as a whole had begun to move forward in this 'green' era. The US Coast Guard, as a service, has begun to educate its members on environmental issues and make changes to reduce the impacts we have on our planet. In the Commandant's Environmental Stewardship Commitment, Admiral Thad Allen challenged the Coast Guard to 'improve the environment, and reduce our environmental footprint,' because as a humanitarian service the Coast Guard is dedicated to the preservation of the environment [5].

In 2000, the US Coast Guard began utilizing energy contracts. Energy contracts are one of the major actions the Coast Guard is taking to promote sustainable technology. More specifically, Utility Energy Service Contracts (UESCs) allow federal agencies like the Coast Guard to operate more sustainably [6, 7]. With UESCs, there is no initial capital investment incurred by the agency, the net cost is minimal, and time and resources are saved by using one rather than several utility companies (EERE). These contracts are vital to the Coast Guard's ability to finance sustainable growth for buildings and facilities. Creating the UESC's facilitates sustainability and endorses behavioral efforts from personnel.

Over the course of this project, the group came to the conclusion that tackling sustainability is accomplished by establishing a two-pronged attack. The first and most obvious element of this plan of attack is to implement new technologies that focus on promoting efficiency and reducing the impact on their surroundings. The UESC's are the first step toward a service wide understanding of this need and they are a vital component for the Coast Guard to reach the goals set out by the Commandant's Environmental Stewardship Commitment. The second, more difficult, element is the need for the plan to inspire behavioral changes in personnel. It is much easier to change an incandescent light bulb to get results than it is to change a person's habitual way of living. Although very tangible results are attained through new technologies, the group found that the greatest impact on sustainability comes from the everyday decisions people make.

Cadets (students) at the Coast Guard Academy can alter the future of the Coast Guard if they are educated about the benefits of sustainability. By exposing cadets to the concepts and benefits of sustainable decisions at the Academy and rewarding sustainable behaviors, the US Coast Guard will benefit from an officer corps that not only understands the benefits of sustainable practices but also feels that implementing these practices is simple and easy. The cadet role is critical to create a sustainable campus and a sustainable Coast Guard.

As this group worked to collect data for the engineering design portion of their project, they also worked with the Sustainability Club at CGA to begin to implement proven beneficial sustainable practices that they collected from other campuses during their research. What they found was friction between the cadet corps and change. They found that the Sustainability Club, that was created three years ago, lacks sufficient membership to alone make a difference in creating an increase in awareness and reduction in waste. One effort that the club undertook was to have tray-less dining for a one week trial period to measure the amount of food and water saved. Large trays in the Wardroom (cafeteria) encourage cadets to stack the trays with food, much of which gets wasted. This small initiative was undermined by angered cadets who were inconvenienced by having to make multiple trips instead of the one they would usually make with the larger tray. Subsequently, some cadets would take excess amounts of food just to throw it away in order to 'prove a point' that sustainable efforts are not worth their time. This attitude is detrimental to the

sustainable principles being pushed by the Sustainability Club and is one of the biggest issues that the group faced in promoting beneficial change.

Personnel, not only at the Academy, but throughout the Coast Guard, demonstrate cynicism when presented with the concept of 'greening' their day to day activities. When pushed, the group found that much of this cynicism came from the idea that this new way of doing things will be a nuisance. Changing the 'way things are' is uncomfortable and therefore people resist change. From discussions with colleges and universities where positive changes were made, the group learned that people will respond better to sustainability if they know their efforts are making a difference. In the final presentation, the group shared the following statistic with the student body: in one day, 'humans will add fifteen million tons of carbon to the atmosphere, destroy 115 square miles of tropical rainforest, create seventy-two square miles of desert, eliminate between forty to one hundred species, and erode seventy-one million tons of topsoil' [8]. This information will begin to provide tangible data that will allow the student body to better comprehend the effects of carbon emissions and their role in reducing them. This project affords a starting point from which future sustainable efforts can launch.

Over the past decade institutions of higher learning have led the way in promoting sustainability [4]. After researching local, New England colleges that are succeeding in terms of new sustainable technologies and policies, it was determined that each of them were able to physically show positive results based on the changes that they made. The initial research for this project was geared towards figuring out how the Academy can measure and document its efforts to become greener specifically in terms of reducing our carbon footprint. The result of this preliminary research led to the Clean Air-Cool Planet Carbon Calculator, a tool designed for college campuses and was used by several of the schools contacted during initial research [3]. Schools used the calculators to estimate their carbon footprint. Originally developed and tested by the University of New Hampshire, the Clean Air-Cool Planet Carbon Calculator [3] was chosen because it has been successfully used by over a thousand college campuses across the country.

As we began to collect the required data for the calculator, it became clear that this task was going to take a significant amount of time and research. The chosen calculator consists of 106 Excel workbook tabs and required information and data that was not centralized, and in some cases not readily available, at our institution. After reading through the User's Guide and meeting with members of Smith College's environmental staff, data collection began.

On the calculator, environmental impact is broken down into three recognized 'scopes' based on how much influence and responsibility the consumer has for the consumption or emission. The Scope 1 and Scope 2 factors, which include stationary emission sources, electricity consumption, campus vehicle fleet, refrigerants, and fertilizers were the first focus of research since they represent the vast majority of the carbon footprint and would be the easiest numbers to find. Fortunately due to regulations by the Department of Environmental Protection and the EPA as well as financial documentation, many of these numbers were acquired through the Facilities Engineering office. Starting with the Chief of Facilities Engineering, the group made its way around campus, setting up meetings with personnel who could provide the required information. The Environmental Branch of Facilities Engineering was found to have much of the data either available or easily accessible, and this proved to be a valuable source since the calculator needed historic values back to 1990. After gleaning much of the data directly from both electronic and paper records that the Environmental Branch had on hand, more contacts were established among the Public Works staff in order to gather more specific information. The only issues that surfaced during this stage were based on the fact that since the current civilian Environmental Protection Specialist had been here less than ten years, some of the records from before he arrived are inconsistent and either not in the same format or incomplete. Some of the data, especially regarding the purchased electricity and fuels, had been lost and required further investigation with the service providers. These were crucial numbers to obtain since they form such a significant portion of the carbon footprint.

The Scope 3 Emissions Sources proved more elusive since they are primarily out of the Academy's control even though they are things the campus relies upon, such as faculty and student transportation and the handling of solid waste and wastewater. Much of this is not documented since it is not widely perceived by faculty and staff as the Academy's responsibility. Initial contacts were made with the heads of various programs on base to determine the precise numbers of people on base, including cadets (full time, 4 year college students), Officer Candidate School students (full time students for 17 weeks), Leadership Development Center students (transient students on base for two week periods), staff, faculty, and contractors. The operating budget and energy budget were obtained from the Comptroller since some of the statistics on the calculator are ratios based on the money that a campus channels to various ends.

All of the data required for the spreadsheet is informative as it shows the relative impact of the Academy's emission sources (Fig. 1). Once all of this data was documented, it became easier to target the major sources that can be realistically reduced. Fortunately much of the research that went into making the calculator a useful tool was completed for the group by the University of New

Fiscal Year	Emissions					
	Operating Budget	Research Budget	Energy Budget	Students	Community Members	Building Space
	g eCO_2 / $	kg eCO_2 / $	kg eCO_2 / $	MT eCO_2 / Person	MT eCO_2 / Person	kg eCO_2 / ft^2
1990	447.4	-	6.5	6.7	3.7	5.6
1991	7.3	-	0.1	0.1	0.1	0.1
1992	8.1	-	0.1	0.1	0.1	0.1
1993	923.5	-	7.9	14.4	7.9	11.6
1994	942.2	-	9.8	14.2	7.7	11.3
1995	1,058.0	-	11.0	16.8	8.8	12.3
1996	1,077.7	-	8.1	16.7	8.7	12.2
1997	965.0	-	7.9	15.0	7.9	11.0
1998	1,019.9	-	8.9	15.9	8.2	11.3
1999	933.7	-	9.1	12.5	7.2	11.4
2000	916.7	-	8.7	11.9	6.9	11.2
2001	891.3	-	7.2	11.3	6.6	10.8
2002	835.9	-	8.1	11.3	6.7	11.3
2003	844.2	-	8.2	11.4	6.9	11.6

Fig. 1. Screen shot of input screen for Clean Air-Cool Planet calculator.

Hampshire when the tool was created. This meant that collecting data was the main issue that the group had to deal with.

Not only does this tool provide a comprehensive and professional numerical result for this project, it also allows for an updateable tool that can be referenced in the future. The information obtained from the calculator provided this group and Facilities Engineering a more complete picture of our baseline metrics and allows for a more complete campus Sustainability Policy to be drafted. Since this pioneering work has been done to document the major sources of emissions and consumption, this tool can be used in the future when making engineering decisions on base. All contacts made while collecting the data for the calculator were documented; therefore any future work done will be much easier. Some numbers were not gathered this year due to priority and time constraints. This data, such as commuting patterns of the staff, can be explored for future projects and can be utilized to further perfect the picture of CGAs carbon footprint.

Since the results of this calculator provide a visual and numerical baseline, this group was able to provide the student body with a picture of their current carbon footprint and will be able to visually demonstrate positive changes that the student body can be proud of. This calculator provided a starting point which then led to many other questions about how to create improvement strategies; how do we get our student body, faculty and staff on board; what technologies are realistically available based on budget and the age of our facilities; and most importantly, how do we begin this huge undertaking?

3. HOW ARE OTHER ENTITIES DOING THIS?

From our research into other New England universities and colleges, we knew that other institutions had the answers to our questions. To provide the group a chance to see first hand what other schools and businesses were doing and to provide a forum where the group could ask these success stories questions, the group set up site visits to several Boston area schools and businesses. The team visited a downtown restaurant whose owner decided to 'go green' for cost savings and publicity. The owner took us on a behind the scenes tour where the group saw low-flow faucets, low energy use lighting, a substantial recycling program (99% of the restaurants waste is recycled or composted) and methods of tightening the building envelope to reduce heat loss and therefore save on energy costs. Our second stop was a university owned building that was originally constructed in the late 1800's. The shell and many of the architecturally distinguishing features had been saved as the building was turned into a LEED Platinum [9] certified building. The building made significant use of daylighting and energy conservation practices like ceiling fans and a tightened building envelope. Walking through the building, it was surprisingly well lit considering there were very few overhead lights and we were in the building on a cloudy day. The building also had items such as tile carpeting for easy removal and replacement, low partitions for easy communication and better use of lighting. These applications are inventive and unique ideas that are becoming more common in the 'green' revolution.

The most interesting part of the trip to the group however, was the technology at Massachusetts Maritime Academy (MMA) [10, 11]. Similar to the Coast Guard Academy in student population and size, MMA has a broad range of sustainable initiatives including solar panels, a wind turbine, and a co-generation plant for the dormitory. There are solar panels throughout the school on roofs and mounted to outside light fixtures giving the school an almost sci-fi dynamic. These panels provide a portion of the school's renewable energy alongside the 142-ft wind turbine. Initially

$1.2 million, the wind turbine now helps the school to reduce energy costs annually by $200,000 (MMA). The co-generation plant on site uses both steam and electricity to produce energy. Surprisingly, these generators were neither large nor exceptionally loud and provided the MMA cadet dormitory with most of its energy. All together these renewable energy resources produce close to 45% of MMA's energy. Looking at these successful design solutions from other schools and businesses provided the group with the background information it needed to imagine where the USCGA can be in regards to sustainability.

4. WHAT CAN WE BRING TO USCGA?

Prior to the completion of the Carbon Calculator, and before we had the opportunity to visit sites that had successfully implemented sustainable practices, the group believed that on-campus stationary emissions sources and purchased electricity would account for the vast majority of the campus's carbon footprint. Research on the topic of sustainability and energy for our region suggested this would be the case [9, 11, 12]. Once we utilized the carbon calculator to prove our assumption, we were left with the issue of how to realistically reduce our energy and fuel consumption. Our trip verified our research; there are many energy and fuel consumption mitigation technologies being successfully implemented in the New England region [9, 11, 12].

One method of addressing energy losses and simplify utilities that was common to the places we visited was the installation of a cogeneration plant, which is basically a power producing generator with the exhaust heat trapped and used for heating. This technology has been successfully implemented at Massachusetts Maritime Academy in their recent LEED Gold certified dormitory. From the installed mini-cogeneration plants in the basement, they are able to supply both the building's power and heat using a single fuel source. This practice conserves energy which in turn saves the school money because they are efficiently utilizing their power source, whether purchased power from the grid or renewable energy produced on campus. As mentioned earlier, Utility Energy Service Contracts have gained ground in updating several of the Coast Guard's facilities. Our campus has been working through this contract vehicle to obtain a co-generation plant of our own.

Several of the campuses that we talked to are using the concept of power decentralization in order to track energy usage more accurately. Other institutions have installed meters on each building or on a small cluster of buildings. This practice allows the energy consumer to gain a more accurate picture of their energy use. Currently the Coast Guard Academy has one source of steam production for heating and five electricity meters for the entire base. This more centralized management approach makes it difficult to pinpoint inefficiencies in the systems. If each building were individually monitored, and perhaps individually powered, each site could be independently tuned and adjusted to achieve maximum efficiency. This group's plan was to implement this type of monitoring in the final design deliverable.

A second technology that was discovered on several of the campuses during the research trip to Boston was an enthalpy wheel, commonly termed a heat exchanger. This device serves as a part of a building's air circulation system to route warm exhaust air past the cold intake air in the winter, and vice versa in the summer. When combined with a tight building envelope, this technology saves large amounts of money on heating and cooling bills by equalizing any temperature difference before the air is treated, thus using less energy during the treatment phase. This technology was implemented at both colleges we visited and, while it promises great results, it must be combined with a tightly sealed building envelope. This technology may not be feasible on small buildings heated by radiant heat, such as the homes on our campus, but it is readily applicable and relatively easy to add to any structure that uses a forced air climate control system, like academic buildings. This technology can be combined with carbon dioxide occupancy sensors to optimize the rate at which air is exchanged based on the number of people who are in a building at any given time.

In addition to these new technologies there are many little steps that the Academy can take to reduce electricity consumption. Some of these are behavioral such as turning down thermostats. Others are more technology based, including replacing regular lights with compact fluorescents and putting low flow fixtures on all faucets. The Academy already requires heat to be set at 68 degrees, or lower in some spaces, and has replaced many of the light bulbs on base. These steps seem small but when implemented throughout the campus they can make a big difference.

5. CHALLENGES TO SUCCESS

As stated earlier, stationary sources on base account for the majority of the USCGA carbon footprint (Appendix A). These stationary sources primarily include the large steam plant that heats most of the base and the base's commercially purchased electricity. Together these two sources account for the majority of the carbon footprint of the Academy. To reduce the carbon footprint it will be necessary to reduce energy consumption on base and to use cleaner technology when producing the electricity that is necessary. This can be done using a plethora of technologies, but will also require people to change their current energy consumption habits and consume less electricity.

The first challenge to energy efficiency the team recognized was the age of our campus. Buildings

on base range in age from 100 years old to 4 years old with most of the buildings built prior to the 1970's. To gain a better understanding of some of the issues an older building could face, the team researched and performed an energy audit on one of the five residential 'quarters' on base. This particular home was constructed in 1932 and after analysis of the home's structural design the team realized that a lot of cutting edge technologies could not be implemented. One of the major energy conservation inhibitors of the house is its triple-layered brick envelope. This exterior design means that installing insulation to the existing shell would be destructive. Auditing the home, the team noticed a number of areas that could be improved. The major improvement required was an improved seal of the house that would control the infiltration of outside air. There were many areas in the house including windows, vents, a fireplace, and doors where a substantial draft could be felt.

While the realization that additional insulation could not be added to the shell of the home based on its design was disappointing, the team did find a number of changes that could be implemented to make the house more sustainable. The ceiling, between the basement and the first floor of the house, is not insulated. The lack of insulation is exacerbated by the fact that the vent in the basement is old and provides almost no temperature control between the indoor and outdoor air. In the winter, the indoor air in the basement is the same temperature as the cold outdoor air. The occupants state that the first floor of the house is constantly cold due to this lack of insulation and the home's heating system is therefore always running in an effort to heat this first floor space. Adding insulation to the basement ceiling is a simple way to reduce the amount of heat necessary in the upper levels of the house. Utilizing a heat exchanger on this basement vent would also help to stabilize the basement temperature.

After the complete energy audit of one building on base, the group had a good idea about the types of issues that plagued the campus and they were able to take what they learned and develop a broader campus-wide plan. Insulation, energy efficient appliances, and more complicated technologies, including solar, wind, and co-generation would make the Academy much more environmentally sustainable. These technologies need to be looked into on a major scale, similar to the way that the Massachusetts Maritime Academy has investigated these technologies. It is necessary for the Academy to start making large scale commitments to sustainability through these technologies. More specific research into the different types of renewable energy needs to be done by future groups to more fully understand the best choice for the Academy.

The second challenge to energy efficiency and improved sustainable practices that the group found was monetary. The US Coast Guard Academy is a federal facility. As mentioned before, the EPA regulates certain aspects of energy usage on federal properties; the regulations are geared towards reducing energy consumption rather than the holistic view of sustainability. Because we are a federal agency, we are required to strictly follow all federal regulations. Many Sustainable initiatives around the country are supported by public and private grants and other types of funding. Being a federal institution there are legal issues with accepting money from private entities and state entities for projects. One of the reasons that the co-generation project may not happen is that the Academy can not accept a major grant from the state of Connecticut. Without this grant the 'co-gen' is not cost effective and as government stewards the Academy can not make this type of risky investment without a certain guaranteed payback time.

The third big challenge to energy efficiency and improved sustainable practices that the group found was higher-level support. There are many little things the Coast Guard Academy could do to become more environmentally sustainable. To encourage the accomplishment of this goal the Academy must implement a Sustainability Policy that can serve as a guide. The proposed Sustainability Policy (Appendix B) requires faculty and staff at the Academy to think about Sustainability in the classroom and in everyday operations of the Academy. It does not have specific goals but it does require people to notice the importance of Sustainability. To successfully implement this policy, it needs to be encouraged and monitored by the administration. Top-down support of sustainable ideas and initiatives, both through monetary and verbal support, have been the key to success at other institutions. This policy is a necessary step, but in order for it to be valuable it requires emphasis and support.

6. SUSTAINABILITY POLICY IMPLEMENTED

One common thread existed at every location we visited: sustainability has to be a leadership supported initiative. The implementation of technology alone will not ensure the future success of a sustainable practice. The administration has to encourage and support the change in culture. With that in mind, this group worked with the USCGA Facilities Engineering Division and the Academy Superintendent (President) to create a Sustainability Policy that will be signed by the Superintendent. This policy is the first step in increasing the sustainability conscience of the current culture. The Coast Guard Academy Sustainability Policy (Appendix B) will educate of our personnel on topics of sustainability and energy conservation, encourage political support of environmental sustainability, and require that an effort be made to reduce carbon emissions (Gesele). The importance of sustainability needs

to be recognized to achieve significant results. All personnel need to be educated on the magnitude of the topic to ensure support and compliance. To help determine ways to encourage commitment to the policy, the initiatives of other schools and facilities were analyzed.

Sustainable policies are implemented in almost every institution of higher education in the New England region. These policies mainly emphasize the importance of cultivating a 'green' mindset and set up realistic goals that their personnel will strive for and inevitably reach. Resistance to change at the Academy makes creating new goals and making innovative commitments difficult; therefore, the new policy to be implemented at the Academy is based upon the Coast Guard Commandant's Stewardship Commitment. This Commitment creates a baseline between sustainability and the Coast Guard as a whole. The policy at the Academy will narrow down the broad ideas provided by the Commitment and formulate specific, attainable ideals for the Academy.

7. MOVING FORWARD

As the first phase, our phase, of this project wraps up and we compile all of the information we gathered, we realize that we have made significant progress in data collection, research, and in identifying tangible starting points, but that our institution still has a long way to go to attain our initial goal of sustainability. We have taken the first step with our command sponsored first draft of the Sustainability Policy and our hope is that, as our institution continues to develop in terms of environmental stewardship, the policy will continue to evolve to guide and drive our school's growth. We have worked to encourage support of the policy and must ensure that our predecessors understand why it is important as they continue to move forward with these ideas after we graduate. We are leaving behind a list of projects and tools to guide future groups and provide them with the background that took us a semester to collect in the hope that they will be able to pick up where we left off. We will leave behind a handbook of how to use the carbon calculator and an explanation of where our values were found. We will also leave a list of suggested topics for future semester long study ideas including: proposed analysis of the use of wind turbines on our windy lower field, proposed implementation ideas for co-generation plants, and potential areas of investigation for increased energy savings measures through alternative building occupant usage. As our final deliverable, we presented our findings to the faculty, staff and student body. We have learned that sustainability is not a short term goal. We recommend the implementation of these broad technologies that will assist in reducing our schools carbon footprint, but we require buy in from our institution's population in order to ensure the technology's success.

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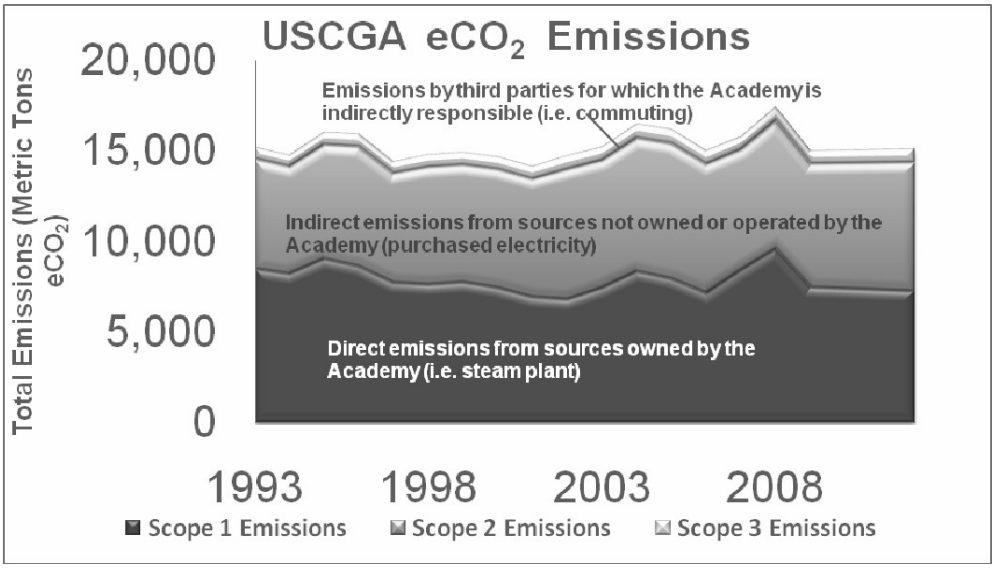
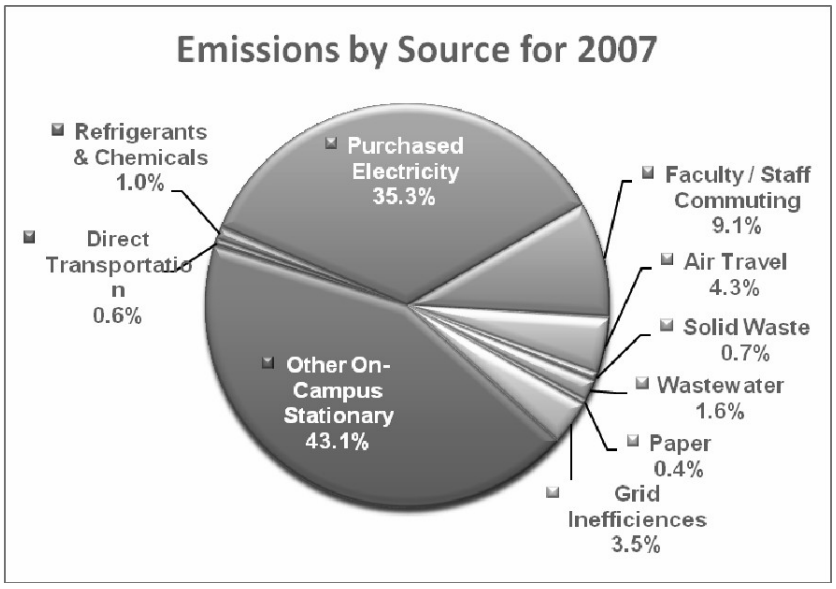
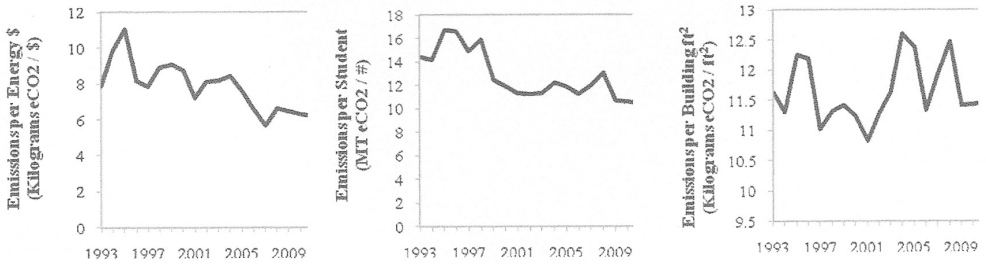
APPENDIX A: USCGA CARBON FOOTPRINT







APPENDIX B: US COAST GUARD ACADEMY SUSTAINABILITY POLICY

The United States Coast Guard Academy exists to educate, train, develop and inspire leaders of character. As such, the Academy is an important role model and representative of the United States Coast Guard as a whole with the ability to positively influence the thinking of future leaders. By implementing a culture of sustainability at the Academy, we will assist in infusing all members of the Coast Guard to be Environmental Stewards. Sustainability starts with each individual and must be a constant consideration in every action we undertake.

In order to uphold our environmental responsibility to the nation and to advance sustainable principles, the Academy will lead the way as Environmental Stewards by:

Academics:

- Infuse curriculum with sustainability topics.
- Ensure 1/c capstone projects discuss environmental impacts.
- Encourage staff research on sustainability topics.

Operations:

- Follow the Environmental Management Systems (EMS) planning cycle of 'Plan, Do, Check, Act' which will open opportunities for research, increase awareness, force action on sustainable works, and follow up and research more environmentally sound projects.
- Follow Leadership in Energy and Environmental Design (LEED) principles for construction and renovation projects.
- Strive to achieve recognition from sustainability/environmental award programs.
- Use resources such as a carbon calculator to monitor change and improvements the Academy is making in regards to carbon emissions.
- Strive to reduce the purchase of hazardous materials or substitute less hazardous materials for more environmentally friendly items. Purchase 'green' products.

Academy community:

- Create and spread awareness on the importance of sustainability.
- Recognize the long-term benefits despite some higher initial costs.
- Reduce energy and water consumption.
- Recycle, reduce the amount of waste we dispose of at landfills.
- Support Cadet Sustainability Club.

J. S. BURHOE
Rear Admiral, Superintendent

Corinna M. Fleischmann is an Assistant Professor at the US Coast Guard Academy (USCGA) in New London, CT. She is an active duty member of the US Coast Guard and currently holds the rank of Lieutenant Commander. In 2004, she was assigned to the USCGA as a member of the rotating military staff. Rotating military are assigned a 4 year tour as instructors during their active duty careers. Since the Spring of 2005, she has been the course coordinator for the Senior Capstone Design course in the Civil Engineering Section. Her interests include sustainability, construction, and water resources. LCDR Fleischmann completed the B.S.C.E. at USCGA (1998), an M.S. at the University of Texas, Austin in Construction Engineering and Project Management (2004), and will start her Ph.D. at the University of Connecticut this Fall. LCDR Fleischmann was awarded certification as a Certified Sustainable Building Advisor through the National Sustainable Building Advisor program in June, 2009 and is member of ASCE and SAME.

Sarah Thompson at the time of this paper was a first class cadet (senior) at the United States Coast Guard Academy and a member of this capstone group. She graduated on May 20th, 2009 with a B.S.C.E. and she was commissioned as an Ensign (O-1) in the US Coast Guard. In June, she reported to her first active duty assignment, USCGC ALERT, a 210′ cutter stationed out of Astoria, OR. At the Academy she was President of the Cadet Sustainability Club and a member of the women's crew team.

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