UNC INSTITUTE FOR THE ENVIRONMENT

ENST 698—Environmental Capstone

DELTA Energy Intern Monitoring

Adapted and expanded from the work of the fall 2010 DELTA Capstone Team:

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Background

1.1 Scope of the DELTA Program

The “Developing Energy Leaders Through Action” (DELTA) program comprises a network of undergraduate and graduate student internships across North Carolina at both UNC-Chapel Hill-based and externally sponsored locations. These internships, running from fall 2010 through spring 2012, are funded by the North Carolina State Energy Office, and administered and coordinated by UNC’s Institute for the Environment. All internships focus on energy and emissions at the placement sites. While some internships generate tangible products and yield quantitative data relating to energy production and consumption, others focus more on energy research as well as education and outreach. Although the tasks and objectives of each intern vary, each position was designed to address conventional energy savings, greenhouse gas emissions reductions, and/or renewable energy production. A description of the internships for fall 2010 is included later in this report.

The fall 2010 DELTA capstone team was assigned to monitor the activities and outcomes of each internship by establishing a comparative framework that can be used by future DELTA capstone teams and provide internship feedback. The team collaborated with interns individually to identify goals and potential outcomes then collected quantitative and qualitative data with which to analyze their impacts. This process is described in more detail in the Methods section. This report considers the overall conventional energy savings, greenhouse gas emissions reductions, and renewable energy production for each intern. Because each internship is unique, it also individually assesses other outcomes for each site, such as community outreach and future goals.

1.2 Internship Descriptions and Placements

Listed below are the locations of the eight fall 2010 DELTA internship sites, the interns placed at those respective sites and a brief description of intern duties.

Location: Highlands Biological Station
Intern: Sean Murphy
Description: Mr. Murphy used existing utility data along with his own research to create a 2010 comprehensive energy audit and plan at the Highlands Biological Station. He also developed a report for future funding opportunities and implementation of energy efficiency measures. This plan highlighted three of the buildings on the Highlands campus. (See Page 10 for full summary)

Location: Morehead City, NC – Institute for Marine Sciences
Interns: Charles Scaife and Grey Redding
Description: Mr. Scaife measured and coded buildings based on square footage and usage in order to characterize the patterns of energy use on site. He also researched HVAC systems and other energy efficiency measures, to recommend retrofits, remodels, and other tactics to improve energy efficiency and decrease the carbon footprint. Mr. Redding collected and analyzed data on bird populations in several areas under consideration for offshore wind farm development, providing the foundation for a scientific paper to be developed into a peer-reviewed journal article. (See Page 12 for full summary)

Location: Energy Management—UNC-Chapel Hill
Interns: Chris Zieber and Noah Kittner
Description: Mr. Zieber and Mr. Kittner both worked with the Energy Star and Labs21 programs to document existing energy conservation practices, identify trends, and provide recommendations for improvement. They also worked to promote energy conservation at UNC by maintaining web-based outreach, creating communication tools, and coordinating outreach events. (See Page 13 for a full summary)

Location: Coastal Studies Institute (CSI)
Intern: Alexandra Shaykevich
Description: Ms. Shaykevich researched the implementation and feasibility of alternative energy technologies on the CSI campus in anticipation of funding becoming available. She specifically looked at small-scale wind turbines and photovoltaic modules, to recommend product choices and placement at the facility. (See Page 15 for full summary)

Location: Chatham County – Pittsboro, NC
Intern: Megan Colonel
Description: Ms. Colonel assisted staff in researching and outlining a point-of-sale energy efficiency program. This program would encourage those selling their homes to conduct an energy audit to provide to the homebuyer. (See Page 16 for full summary)

Location: Durham, NC – Green Oil and Light Campus (GOLC)
Intern: Matthew Scruggs
Description: Mr. Scruggs assisted GOLC staff in identifying donors and investors to support a local, sustainable energy investment group and its Community Sustainable Energy brand. He also worked with the organization to improve communications and marketing, and laid the groundwork for a transit-based ecotour. (See Page 17 for full

summary)

Location: Environmental Finance Center—UNC-Chapel Hill
Intern: Emily Martin
Description: Ms. Martin provided energy planning assistance to communities throughout North Carolina. She modeled community energy program financial impacts and prepared educational materials to support future programs. (See Page 18 for full summary)

Location: Institute for the Environment—UNC-Chapel Hill
Intern: Anne Eshleman
Description: Ms. Eshleman provided support for this DELTA capstone project, as well as another energy-related capstone that dealt with an energy management plan for a local water and sewer utility. Because of her leadership position on the capstone team, her internship is not reviewed here.

1.3 Resources Utilized and Initial Steps

Throughout the semester, the team made use of resources on UNC-Chapel Hill's campus to assist with data collection and analysis. Paul Mihas of the Odum Institute for Research in Social Science was an especially useful contact and advisor. Mr. Mihas determined that the monitoring framework follows a mixed methods approach, because the team collected quantitative and qualitative data. He guided construction of surveys and interview questions for use in qualitative data analysis. The interview questions fell into several categories of broad topics that pertained to all internships, and then two or three questions tailored to individual internships. Mr. Mihas also suggested the team use the ATLAS.ti software to analyze our qualitative data (See Methods).

The team met with Daniel Arneman of UNC Energy Services to learn more about energy-use monitoring. Dr. Arneman's job is to inventory the university's energy use and identify strategies to improve efficiency. He answered questions about energy-monitoring methods that the interns might be using and the time frame in which measurable results could be expected. He also clarified UNC-Chapel Hill's latest Greenhouse Gas Inventory, which shows a 20% reduction in emissions between 2008 and 2009, possibly attributed to the major decline in the economy. That report employs an effective graphic analysis of energy-use data that the DELTA internship program eventually could seek to produce as well. Dr. Arneman helped the DELTA capstone team better understand the work the interns are doing.

The capstone team applied for approval from the Institutional Review Board (IRB) for their interactions with the DELTA interns, because they surveyed and interviewed the interns. If the DELTA capstone report were ever to be published for

public use, it would be important to know whether IRB approval is necessary. As subjects of the proposed study, the interns were covered by standard protections under the Office of Human Research Ethics. The team completed an IRB application, and drafted a consent form and a data-use agreement. Additionally, two of the capstone team members completed Human Research training on “Social and Behavioral Studies” through the Office of Human Research Ethics at UNC-Chapel Hill, as a requirement of the IRB process. After reviewing the submitted materials, the Institutional Review Board notified the team that the project did not require IRB approval. The proposed work does not constitute “human subjects research” as defined under federal regulations, because the research was to be completed as part of a UNC-Chapel Hill course and did not require any information from interns outside of the scope of their work for the UNC internship. In addition, the team does not plan to present the work outside of the UNC-Chapel Hill community, to apply to anything other than DELTA internships. The team collected no personal data or information that did not directly relate to the tasks completed by the interns. Even though IRB approval was not required for the monitoring, the team found the process to be valuable; they learned about the process of applying for IRB approval and what types of studies would be required to gain this approval in our future research careers.

Methods

2.1 Beginnings: Surveys

To begin the monitoring process, once the DELTA staff determined placements for interns, the team emailed the supervisors at each DELTA site to inquire about their interns and establish a reporting relationship. The initial email explained the purpose of the capstone and explained why they sought information regarding internships. They also explained that the State Energy Office, which funded the DELTA program, has a required monitoring and reporting element, which was being fulfilled by this capstone project.

Using the initial descriptions provided by the DELTA administrative staff, they divided the interns into two groups: those with expected quantitative and qualitative results, and those with expected qualitative results but no relevant quantitative data. They then created two initial surveys to send to the interns: one that asked both quantitative and qualitative questions about the scope of the internship, and one that focused solely on qualitative aspects. By so doing, they were able to determine what quantitative aspects each intern was expected to measure, while avoiding burdening some interns with questions that did not apply to them.

Both surveys included questions about the job description of the internship, main objectives and goals, as well as a personal statement about how the internship fit into the scope of the DELTA program. Additionally, the quantitative survey requested information on the intern's strategies for data collection and plans to assess collected data (see Appendix A). The qualitative survey did not include those questions (see Appendix B). By creating standardized questions to apply to all internships, the team was able to get a more specific job description from each intern in order to report on early work and summarize the objectives of each intern. They used responses from this survey later in the semester to request specific information from the interns. The initial survey facilitated the standardization and reporting of both quantitative and qualitative results. These surveys were distributed by email and returned to DeltaUNC@gmail.com, an email account created to keep track of the surveys and intern information, as well as provide a way to easily contact interns without overlap by group members.

The team also developed a work plan for the semester, (See Appendix C), outlining the major tasks and objectives as well as proposed deadlines through the semester. This plan was designed to be preliminary and provisional, since content was dependent on obtaining data and deliverables from the interns The team encouraged the interns to return surveys as soon as possible. Some surveys were returned within a week or two, but others took substantially longer. This was due, in part, to the fact that some of the internships had not yet been established when the surveys were drafted. Eventually, all surveys were returned and the team began to devise new questions for the interns based on the initial responses. In general, the surveys provided high-quality

information that yielded a better idea of the scope of each internships, as well as baseline data and information from the site.

2.2 Intern Interviews

As interns returned the initial survey, the team contacted them individually to coordinate an interview, to explain the information and data they sought as well as to monitor progress. One internship was not covered by the interview process, because of logistical constraints; however, the survey information was sufficiently descriptive to contribute to this report. They conducted interviews either in person or via Skype, at the intern's convenience. These interviews gave the interns a better idea of the mission of the DELTA capstone team and why the information about their internships is valuable. They went into each individual interview with general questions to ask each intern relating to the tasks the intern had completed during the semester since the initial survey, as well as to the general internship experience.

2.3 Qualitative Data

With basic descriptions of the internships available from the surveys, the team was able to focus the interviews on internship progress and deliverables in addition to the interns' experience. The interview included follow-up questions about reports, write-ups and data mentioned by interns in their initial surveys. Thus were the interviews standardized, starting with general questions, and ending each with specific questions tailored to each intern. All of the interviews were recorded, except for one completed at the internship site (Energy Management, which hosted another intern whose interview was recorded) and followed by an informal tour of the site.

Recorded interviews were transcribed, then converted into the ATLAS.ti program, which facilitates content analysis using deductive codes . This allowed the team to compare the similarities and differences among the internships in accordance with the three overarching goals of the DELTA grant: conventional energy savings, greenhouse gas emissions reduction, and renewable energy production. The ATLAS.ti program allows users to highlight key phrases and words that are then used to formulate deductive codes. For each deductive code defined, the program generates a count, which allows the user to comparatively analyze the text.

Two capstone team members defined each code independently. The results were then compared to assess the inter-rater reliability and to yield a standard set of codes relevant to multiple interns. Atlas.ti provided a tool to quantitatively compare and analyze the progress of the interns at a midway point in their internship.

In the interviews, the team asked the interns to provide updates often, including any data analysis or reports interns drafted, to avoid missing important data missed in the surveys. This information, along with the initial survey, was used to write summaries of the internships and their expected outcomes (see Interns section). Each

member of the team was ‘assigned’ one or two interns to summarize and report on, so that they could effectively sift through all materials received.

2.4 Quantitative Data

Several members of the group analyzed the quantitative aspects of the relevant data sent by the interns. Based on the information collected, the team decided to focus on energy consumption at the various internship locations and on comparison of energy consumption on a monthly basis. The interns with quantitative data obtained information about energy consumption primarily from past utility bills. As a result, the team members were able to compare energy use and energy savings across several locations based on the analysis of the data sent by interns. The measurements were made comparable by converting the information from several sites and sources into a standardized unit (kilowatt-hours).

2.5 Internship Summary Analysis

Before Thanksgiving break, the team contacted the interns via email, reminding them to send any relevant data or information to support the quantitative analysis as well as the basic descriptions and summaries of the internships. The following week, they sent out final surveys that included questions about any other progress interns had made. This survey was sent via email, with a request that each intern return it to DeltaUNC@gmail.com within a week—a deadline that was much more successful than a simple “at your earliest convenience” request.

The Internships

3.1 Highlands Biological Station

Summary of Internship:
The intern was assigned to several different projects during the semester. The first task was to create a strategic energy plan for the Highlands Biological Station (HBS) campus, which HBS required to apply for a grant from the North Carolina State Energy Office; the HBS plans to use this grant to fund future projects. With the help of Cynthia Soderstrom from HBS administration and Guy Cook from the HBS maintenance department, the intern gathered past utility bills and used them to compile data on energy use at the site over the past twelve months; this information served as baseline data. The plan also included any energy savings programs implemented in the past twelve months and proposed projects for the next twelve months. The intern requested technical assistance through a strategic energy plan and funding from the Recovery and Reinvestment Act. He also contacted an engineer from Waste Reduction Partners to request a complete detailed energy assessment of three buildings at the HBS: Coker Laboratory, the Valentine House, and the Nature Center. Lauren Bishop, the energy manager at Western Carolina University (WCU), guided the intern through the process of creating a strategic energy plan.

Additionally, the intern researched renewable energy projects that would be cost-effective and easy to implement at the HBS, focusing on solar-thermal panels and a heat pump for Coker Laboratory. He contacted solar energy companies in Western North Carolina, and provided them with the HBS's water consumption data and hot water heater information. In response, he received estimates on the type of system needed, the cost of that system, and the payback period after implementation. The intern used this information to make recommendations for future projects at the HBS.

Most of the intern's research and projects are planned for implementation in the future. However, during the internship period, the intern created and distributed fliers (see Figure 1) to encourage behavioral change in students, staff, and visitors of the HBS to conserve water and energy. Because renewable energy technology is not currently installed at the HBS, the intern wanted to initiate a sustainable project that would immediately reduce energy costs and promote energy conservation. These fliers were posted around the HBS campus in places such as in shower stalls, above sinks, in computer labs, and near light switches and thermostats.

Because the research at HBS focused on ecology and biology, the intern relied on outside sources for information on energy (e.g., Lauren Bishop of WCU). He also used the AASHE (Association for the Advancement of Sustainability in Higher Education) website as well as other Internet resources for ideas and information on the projects.

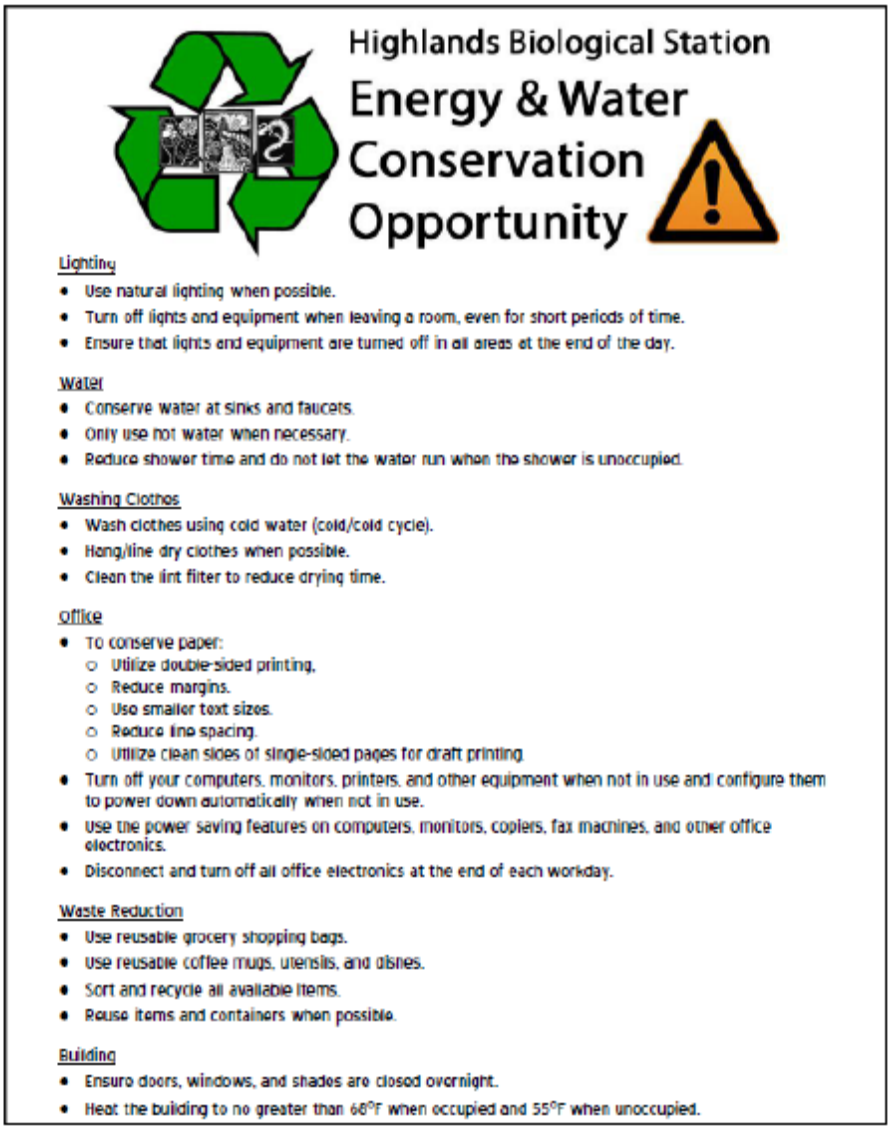
Description of deliverables:

The intern created a strategic energy plan for the HBS using data from the energy assessments of Coker Laboratory, the Nature Center, and the Valentine House, as well as from their utility bills. He made recommendations based on feasibility for installing a heat pump system for Coker Laboratory and a solar-thermal system.

In addition to creating the fliers, he updated the HBS website to include information about energy savings initiatives, sustainability, and future projects. As part of his outreach, the intern prepared and made public presentations about what he learned and accomplished during his internship.

Example outcome: Fliers to encourage behavioral change

Figure 1: Energy Conservation Recommendations



Highlands Biological Station

Energy & Water Conservation Opportunity

Lighting

- Use natural lighting when possible.
- Turn off lights and equipment when leaving a room, even for short periods of time.
- Ensure that lights and equipment are turned off in all areas at the end of the day.

Water

- Conserve water at sinks and faucets.
- Only use hot water when necessary.
- Reduce shower time and do not let the water run when the shower is unoccupied.

Washing Clothes

- Wash clothes using cold water (cold/cold cycle).
- Hang/line dry clothes when possible.
- Clean the lint filter to reduce drying time.

Office

- To conserve paper:
  - Utilize double-sided printing.
  - Reduce margins.
  - Use smaller text sizes.
  - Reduce line spacing.
  - Utilize clean sides of single-sided pages for draft printing.
- Turn off your computers, monitors, printers, and other equipment when not in use and configure them to power down automatically when not in use.
- Use the power saving features on computers, monitors, copiers, fax machines, and other office electronics.
- Disconnect and turn off all office electronics at the end of each workday.

Waste Reduction

- Use reusable grocery shopping bags.
- Use reusable coffee mugs, utensils, and dishes.
- Sort and recycle all available items.
- Reuse items and containers when possible.

Building

- Ensure doors, windows, and shades are closed overnight.
- Heat the building to no greater than 68°F when occupied and 55°F when unoccupied.

Example outcome: Energy use monitoring
The intern set up a data-entry system to allow a future user to enter data from utility bills and thus track basic changes in energy costs and consumption. Future evaluation tools including surveys and focus groups could be helpful for determining whether the behaviorally targeted fliers were successful. Continued tracking of utility bills is necessary to determine the impact of the energy plan on energy conservation.

Table 1: Energy Use at the Highlands Biological Station, fiscal year 2009-2010

Building	Electricity Consumption (KWH)	Water Consumption (gal)	Propane Consumption (gal)
Nature Center	14,092	102,800*	2,013.20
Coker Laboratory	70,024*	N/A	2,112.6*
Valentine House	14,579	76,590	2,958.9*

(=Measurement includes other buildings metered together but not listed here). This example spreadsheet is a summary of consumption by three. The spreadsheets are designed to be updated in the future, in order to track consumption trends and make comparisons before and after implementing projects.*

3.2 Institute for Marine Sciences

Summary of Internship:
The main goal of one of the internships at UNC's Institute for Marine Sciences was a thorough assessment of associated energy consumption at the site. The intern approached the site's energy use from three angles: buildings, the boat fleet, and the truck fleet. Analyzing the fleets was straightforward, given the access to mileage logs and gas receipts archived from previous years.

Description of Deliverables:
This project involved an in-depth analysis of total energy consumption and carbon emissions for the truck fleet; the boat fleet has not yet been analyzed. In addition to compiling raw data, the intern performed a baseline analysis of the truck fleet data. By running a regression analysis on each truck's curb weight versus its published fuel economy, he was able to show the effects of towing large loads on energy consumption. This is particularly important for IMS because the primary purpose of

many of the trucks is to tow boats and other scientific machinery, which constitute large loads.

The intern did not analyze the buildings fully during the course of the internship. However, he completed a coding rubric for Coker Hall, classifying all of the spaces and rooms based on usage. The internship advisor anticipates that this meticulous classification scheme will aid with future analysis and strategies for reducing building energy consumption.

Summary of Internship:
The Institute for Marine Sciences also hosted a second intern, who examined potential impacts of offshore wind turbines on bird populations from the ecological perspective. This intern worked with a bird survey dataset, looking at spatial and temporal variation in bird populations among survey areas. The intern gained experience with new statistics software, and collected and organized a large volume of data on bird populations (resident and migrating) in areas under consideration for wind farm development.

Description of Deliverables:
The intern performed a variety of statistical tests on the dataset, and drafted a long research paper outlining the main findings, which establishes the foundation for a research paper the team will submit for peer review once the dataset is complete. The intern gave a public presentation of his work at the Morehead City field site.

3.3 Energy Management, UNC-Chapel Hill

Summary of Internships:
The UNC Energy Management office in the Giles Horney building hosted two interns, who worked to organize baseline energy-use readings for eight buildings on UNC's main Chapel Hill campus. These buildings were chosen because they are scheduled for renovation, an ideal opportunity to implement new energy-efficiency measures. The interns entered past energy-use data, primarily from utility bills, for each room in each building into the Energy Star Portfolio Manager (ESPM), an online program to organize data and establish a baseline for energy use. Because the ESPM codes rooms in the database too vaguely to accommodate science labs, the interns also entered data into the Labs21 database, which gives a more detailed analysis of energy use for science labs, tracking every Bunsen burner and desktop computer.

With guidance from supervisors, the interns retrieved measurements of building and room sizes and types through the online resource: www.planroom.unc.edu. Energy Management expects the impact of these internships to be more visible in the future, after the analysis leads to new energy-efficiency measures in specific buildings.

Description of deliverables:

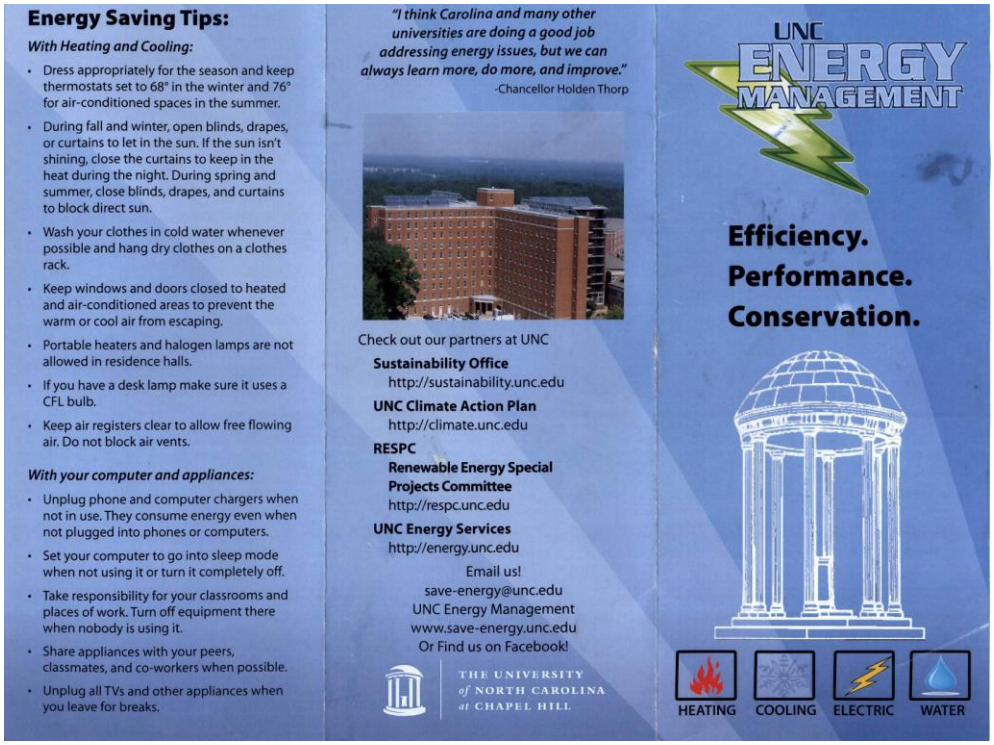
The interns worked to establish baseline energy-use readings for eight buildings on UNC's campus. The primary activity for these internships was data entry. The interns provided a critical step by populating Energy Management's online ESPM account, as well as the Labs21 database, which facilitates energy-use analysis designed specifically for scientific laboratory conditions. They communicated frequently with Jessica O'Hara at Energy Management, and department director Chris Martin.

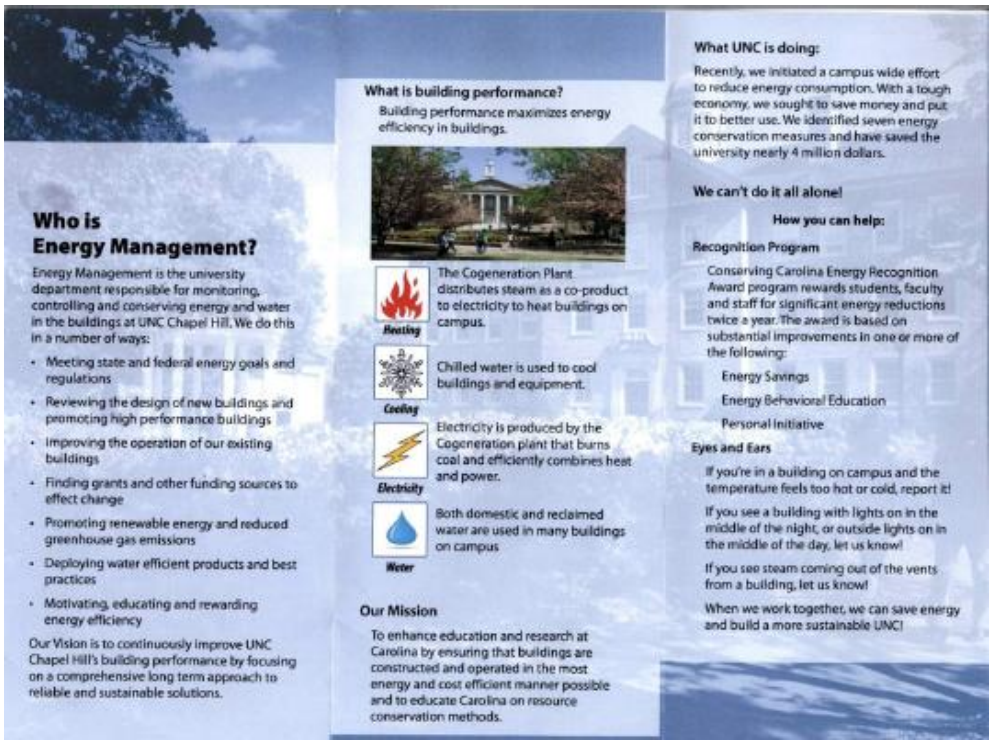
In addition, because one intern came in with experience with Adobe Photoshop, he first took on the task of developing a brochure , to introduce Energy Management to the public and offer tips on energy-efficient behavior such as turning out lights and taking short showers (see Figure 2 below).

Example Outcome: Energy Management Brochure

One intern produced a brochure for Energy Management, which includes everyday tips for citizens to help reduce their energy use.

Figure 2: Energy Management Brochure created for UNC Energy Management





3.4 Coastal Studies Institute

Summary of Internship:

The Coastal Studies Institute (CSI) offered an internship focused primarily on researching new renewable technologies. The intern helped develop recommendations for the application of alternative technologies to a new campus facility at CSI, based on demand, energy offset and CO_2 equivalents, reduction of peak energy production costs, potential environmental impacts, and installation costs and economic feasibility. The intern compiled data to estimate the total energy demand for the CSI campus, and then worked with an architect using construction documents to establish goals for the new CSI buildings, guided by Leadership in Energy and Environmental Design standards.

The research that comprised the core of this internship focused on small-scale wind turbines and solar photovoltaics. The CSI has a unique opportunity to expand this research and development because of its location, but more public awareness and local educational outreach is needed before this technology can be integrated into the community. The intern concluded that the wind turbines would be a more viable option in the future.

This internship was primarily research, and the proposal inherently theoretical. The construction plans for the new CSI facility are set, so the recommendations will be taken into account after construction begins and officials discuss which applied technology option is the best. The sponsors hope the research will be continued and that evolving technologies will be applied to the new facility.

Description of deliverables:
After researching renewable energy technologies, the intern created a detailed proposal outline that discusses the importance and benefits of implementing renewable energy at the CSI facility. In addition, she described the feasibility of small-scale wind turbines and photovoltaic solar panels. In her proposal, she examined the general design, capacity, and cost of new technologies and discussed the feasibility of implementation in the Outer Banks. She made use of information from correspondence with Claiborne Yarbrough of Waldt Renewables (see Figure 3) and North Carolina Central University's Solar Center staff to better understand the economic feasibility of wind turbines. She also described site-specific recommendations for the CSI facility based on anticipated energy use from RMF Engineering, Inc. and the on-campus research building site plan. The research, while theoretical and dependent on future investment and assumed innovation, will be useful to CSI in considering investment in and application of photovoltaic solar panels and wind turbines.

Figure 3: Image from Waldt Technologies

Waldt Technologies was a source of information with regard to the viability of small-scale wind farm and solar voltaic technology at the CSI

3.5 Chatham County

Summary of Internship:
One DELTA intern worked with Chatham County and UNC's Environmental Finance Center (EFC) to develop of point-of-sale energy efficiency program. Other point-of-sale programs around the United States provided data in support of a pilot for Chatham County, along with utility bills and housing data from the county to estimate energy and economic impacts from such a program. In collaboration with EFC, the intern organized focus groups with local citizens in Chatham County, to identify and reach out to

community leaders interested in helping to implement a future point-of-sale program , engage the community, and encourage real estate agents and citizens in the housing market to use energy efficiency to sell more homes.

Description of Deliverables:
Because this internship got a late start, the intern spent most of the time collecting data and setting up contacts, as well as working with UNC's EFC to finalize the internship objectives. The main output was an outline of a pilot point-of-sale program for Chatham County along with a comparison of housing data, highlighting the reductions in energy consumption and economic savings achieved after energy audits. She also researched the feasibility and impacts of community renewable energy projects that could be implemented in Chatham County. In addition, the intern worked on a Community Solar Grant for Chatham County, writing the "innovative components" sections focused on job creation collaboration among various groups in Chatham County. The intern delivered a plan for implementing a point-of-sale program for Chatham County; full implementation and follow-on analysis of energy impacts will follow in spring 2011.

3.6 Green Oil and Light Campus

Summary of Internship:
This intern first assisted in the planning, marketing, and advertising department of the Green Oil and Light Campus, an alternative energy company located in the Triangle area. At the start of this internship, he helped to improve the exposure of the company by updating and integrating web-based communications across various social network platforms, such as Facebook and Twitter. He next took part in the process of identifying and evaluating potential community green job education and grant partners. The intern worked under the guidance of Marc Dreyfors, an entrepreneur who serves as the president of The Forest Foundation and manager of Carolina Biodiesel enterprises.

Description of Deliverables:
Near the conclusion of the semester, the intern began to construct the framework for a future Gateway Transit Tour, identifying various business partners and future tour sites. The tour, which will focus on attracting potential investors, job seekers and community workers with the primary purpose of informing key agents about developments in alternative energy, has the potential to be an efficient and effective way to communicate with the public about alternative energy.

Example output: Preliminary list of partners in Transit Tour

Table 2: Gateway Transit Tour Connections and Partners

NC Brewer's Guild	Haw River Assembly
Brixx Wood Fired Pizza, Chapel Hill	Biofuels Center of North Carolina
West End Wine Bar	Piedmont Biofuels
The Republic Bar and Lounge	Environment and Finance Enterprise
Top of the Hill Restaurant and Brewery	

Triangle-area businesses contacted for participation in the Gateway Transit Tour

3.7 Environmental Finance Center

Summary of Internship:
This internship placed a graduate student with UNC's Environmental Finance Center (EFC), to develop plans and tools to aid decision-making involving energy efficiency in communities that have received Energy Efficiency and Conservation Block Grants (EECBG funds). The intern was charged with creating decision-making tools for the communities in order to assist them in allocating their funds efficiently. Specifically, she committed to creating two cash flow models, one for initial capitalization of financing mechanisms, and one related to renewable energy investment.

Description of Deliverables:
The intern had two main deliverables, which she produced over the course of the semester. One was a financing strategy for the communities based on US EPA standards regarding compliance with new Boiler MACT rules. This required correspondence and understanding of EPA air pollution regulation and a general understanding of existing financing strategies. The second deliverable was a Loan loss reserve model for Southeast Energy Efficiency Alliance for grant recipient communities. This model included two million dollars of loan underwriting and credit enhancement.

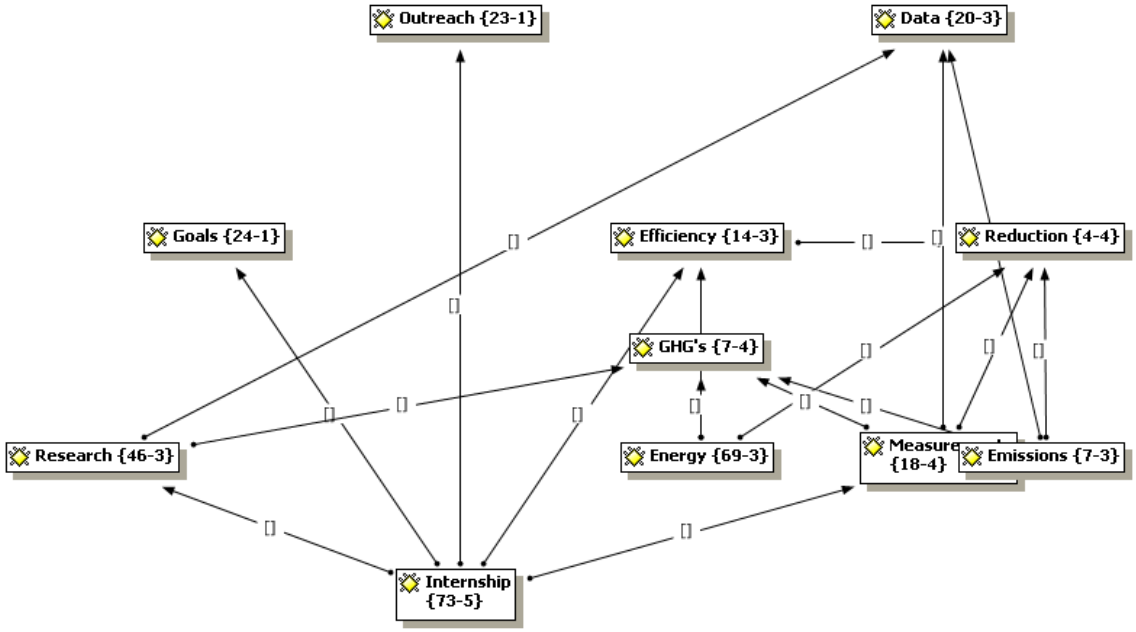
Results and Analysis

4.1 Qualitative

4.1.1 ATLAS.ti

The DELTA capstone team analyzed interviews and surveys from the interns to qualitatively compare and contrast their various goals, focuses and internship experiences. At the beginning of the semester, they met with Paul Mihas of the Odum Institute, who suggested they use qualitative analysis software called ATLAS.ti. This program recognizes themes and trends in a text document through the use of deductive codes. Interview transcripts entered into the ATLAS.ti program were analyzed for recurring words such as “Community,” which were defined as part of a larger themes such as “Outreach.” The deductive codes defined by DELTA capstone team members are displayed in Figure 4 and Table 3 below.

Figure 4: Map of Deductive Codes from ATLAS.ti



Map of the deductive codes used in ATLAS.ti to compare the interview transcripts from each intern. The boxes (i.e., “Internship,” “Research,” “Goals,” etc.) are the deductive codes themselves and they are linked by “[]”, meaning that the outlying boxes are linked to their origin “as a part” of each respective linkage. The numbers within each box show the code count for each specific code in the primary documents. {X-Y}: X = code count, Y = number of codes that each respective code is linked to.

Table 3: Frequency of Deductive Codes from ATLAS.ti First Analysis

PRIMARY DOCS>	**1**	**2**	3	4	5	6	
CODES:	**Code Count**						**Totals**
Data	4	5	2	5	3	1	20
Efficiency	4	1	5	0	0	4	14
Emissions	3	1	0	0	3	0	7
Energy	11	9	11	7	14	17	69
GHG's	3	1	0	0	3	0	7
Goals	2	3	2	9	6	2	24
Internship	11	15	4	14	20	9	73
Measurements	3	2	2	3	5	3	18
Outreach	1	1	12	1	6	2	23
Reduction	0	1	0	0	3	0	4
Research	10	11	3	5	7	10	46
Totals	52	50	41	44	70	48	305

Document key: 1.IMS; 2.Chatham County; 3.Energy Management; 4.Green Oil and Light; 5.CSI; 6.HBS

Table 4: Frequency of Deductive Code Count for ATLAS.ti Second Analysis

PRIMARY DOCS>	1	2	3	4	5	6	
CODES:	**Code Count**						**Totals**
Data	15	11	12	5	3	10	56
Efficiency	14	4	11	1	10	10	50
Emissions	1	2	1	0	2	1	7
Energy	12	9	11	7	14	17	70
GHG's	1	2	1	0	1	1	6
Goals	12	3	5	12	14	9	55
Internship	17	24	13	20	24	16	114
Measurements	5	6	2	3	2	3	21
Outreach	5	10	1	6	7	3	32
Reduction	1	2	1	0	1	1	6
Research	8	11	3	5	7	10	44
Totals	91	84	61	59	85	81	461

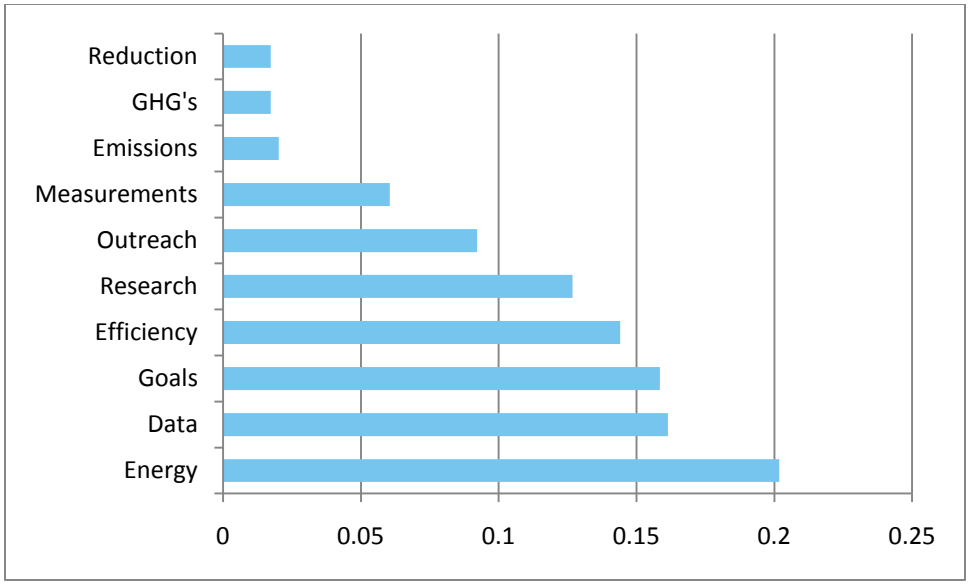
In both tables, codes were defined by choosing words related to each code. The ATLAS.ti program counts the various words defined for each code to determine the code count. Table 3 shows the result from the first analysis, where one capstone member defined the codes using words she felt were related to the codes without considering the interviews. In Table 4, two different capstone members defined the

codes with words they chose after reading transcripts, looking for commonly recurring words related to the codes and using this information to define codes. This was done to check inter-rater reliability as well as to determine the difference between defining codes based on the interviews and defining the codes based on deductive reasoning.

Overall, the results in Table 4 show much higher code count totals. In general, however, codes with higher totals in Table 3 related to relatively higher totals in Table 4, respective of the overall total. The team considered the second table to be more relevant because they used a more inductive approach to define the codes. However, both tables are important to explain responses from the interviews.

From these tables, they drew conclusions about the internships. One of the most commonly found code words was “Energy,” used 69 times in the first analysis and 70 times in the second. The least commonly used code words were “Emissions,” “Greenhouse Gases (GHG’s),” and “Reduction.” This suggests that some of the interns’ work may not have been directly involved with greenhouse gas emission reduction, but rather was concerned more with outreach and research on emissions and alternative energy sources. For instance, “Outreach,” “Research,” and “Data” were more commonly found code words in the transcripts.

Figure 5: Total Frequency of Codes in Primary Documents (from Table 4)



Total frequency of the deductive code words in all six primary documents analyzed in the ATLAS.ti software program during the second run.

The ATLAS.ti data resulted in some unexpected findings. For instance, one intern at Energy Management registered the code word “Data” only twice, but has 12 counts of the code word “Outreach” in the first analysis, even though the majority of this internship involved data entry, with a relatively small portion of his time spent on

creating a brochure for outreach. However, the second analysis registered the code "Data" 12 times and "Outreach" only once. This may indicate that the way in which the team defined the codes reflected how they registered his responses. The Green Oil and Light intern also had some surprising results. His transcript had a code word count of zero for "Emissions," "Greenhouse Gases (GHG's)," and "Reduction" both times the codes was generated. Yet Green Oil and Light is a facility that produces and distributes biodiesel. It is possible that the reason for these unexpected findings is that the code words were taken from interviews and surveys completed towards the beginning of the semester, and only reflects that period of the internship. In addition, the internships were only a semester long, so reductions in emissions were difficult to assess in such a short period of time.

4.1.3 Outreach

A few of the internships involved a community outreach component. The interns at UNC Energy Management helped their department develop an online presence with Facebook and Twitter. The intern at Green Oil and Light also worked to improve his firm's Facebook page. At the Institute for the Environment's Highlands Biological Station, the intern updated the station's website to include information about energy- and water-conservation. From these examples it is clear that businesses and other institutions related to energy-conservation see the Internet, new media and social networks as significant tools for gaining the attention and involvement of the community.

These efforts appear to have been somewhat effective, but may need time to develop. As of November 2010, The UNC Energy Management page had 44 "Likes" on Facebook, and the department's Twitter account had only one follower. Perhaps in the future, Energy Management interns could expand upon the current interns' development of the Facebook and Twitter pages by focusing on publicizing them. The Green Oil and Light campus Facebook page is actually a Facebook "group"; this might make it difficult to see how much attention the page is getting, because the process for becoming a member of a Facebook group constitutes more of a commitment than pressing "Like" on a Facebook page. As of November 2010, the Green Oil and Light Facebook group had six members.

In addition to online outreach, one Energy Management intern skilled in Photoshop spent a week creating a brochure, which went through several revisions before it was finalized. In Chatham County, the intern worked on a point-of-sale program and planned to organize focus groups of local citizens in the area to provide feedback on the program. The intern at Green Oil and Lilght helped preliminary development of a Triangle ecotour, which will involve the collaboration of alternative-energy and energy-conservation businesses and leaders in the Triangle area. The hope for the tour is that it will showcase local energy-related ventures and attract investors and entrepreneurs to the area. These outreach efforts illustrate the variety of ways in which organizations can reach their target communities.

4.1.4 Research

Research was a key component of many of the DELTA internships. For example, the Chatham County internship was primarily research into successful point-of-sale programs from around the nation, in order to find a model for a similar pilot program in Chatham County. One of the cities with a successful point-of-sale program, Berkeley, California, published a helpful document that served as a principal source of information. The internship at the Coastal Studies Institute was research into the feasibility of installing wind turbines on the coast of North Carolina, along with the environmental impacts the turbines would have. These two interns used a broad range of resources that included literature and expert contacts for their research.

At the Highlands Biological Station, the intern researched renewable energy installations that may be cost-effective at the site. His research focused on solar panels to provide electricity as well as the possibility of switching to a more efficient heat pump system to conserve energy. Similarly, the intern at the UNC Institute for Marine Sciences in Morehead City researched energy-efficient HVAC systems to reduce energy use at the site.

For the internships with a large research component, the inquiry was focused on alternative energy possibilities for a specific site or region. All interns concluded that solar panels would be the most likely option for small-scale renewable energy at their sites. This includes the Coastal Studies Institute, whose internship initially was focused specifically on wind energy. The Chatham County internship, although engaged primarily in research, was different from the rest in that it involved financial and policy inquiry. For those internships that focused on energy-use surveys of buildings or sites, the research documents were mostly utility bills, mileage records, and building plans for room measurements.

4.2 Quantitative

When the DELTA capstone formed, the team expected that all the interns would be collecting similar quantitative data related to conventional energy reduction, greenhouse gas emission reduction, and renewable energy production, and they were prepared to track this data. They planned to create a standardized format that could be used to organize and compare the quantitative data from the interns.

Although they collected quantitative data this semester from HBS, IMS, and Energy Management, the focus of their work was too diverse to be able to effectively compare their data. For example, the IMS intern collected data on vehicle fleets, the HBS intern collected data on buildings, and Energy Management interns did not collect raw data themselves but instead entered past data into UNC's Energy Star Portfolio. Even though the latter worked with quantitative data, the team did not include their information in their analysis because they did not collect or analyze the data themselves. They entered data into the Energy Star Portfolio Manager online in order to qualify the buildings for Energy Star certification in the future.

Because the team could not compare the interns' data, they looked at each intern individually and used the information they sent to determine whether their research and recommendations had any impact on energy consumption. They created spreadsheets and line graphs of the baseline data from HBS and IMS (see Figures below). The HBS data focused on propane, electricity, and water consumption from three buildings at the Highlands Biological Station field site (Nature Center, Coker Laboratory, and Valentine House). The IMS data dealt with gasoline consumption by the vehicle fleet at the Institute for Marine Sciences field site in Morehead City. Both interns collected their data from past and current utility bills.

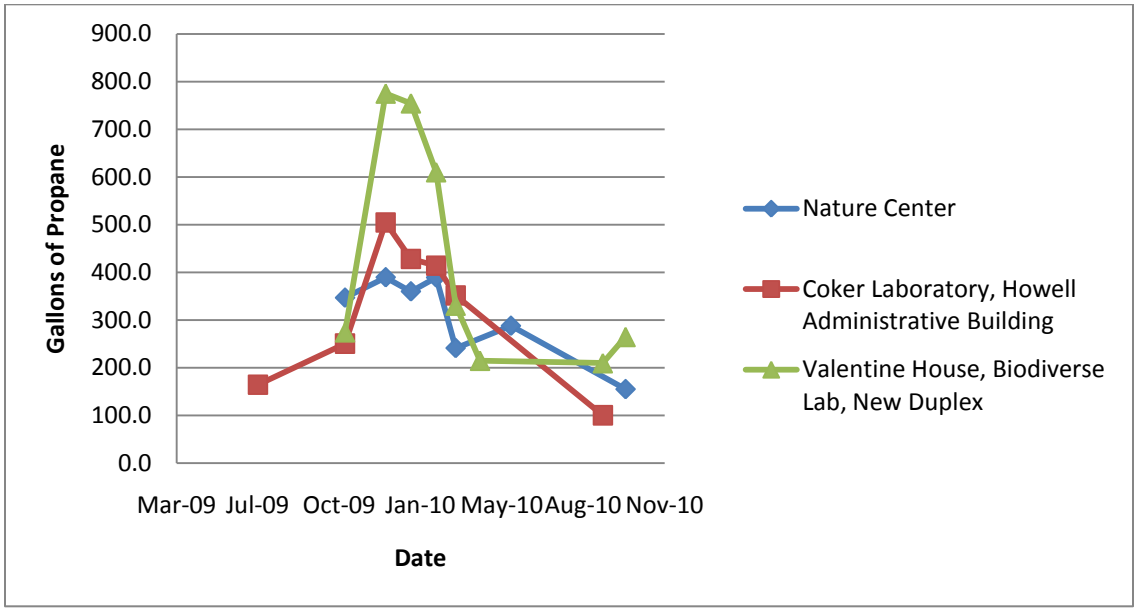
Future monitoring groups can continue to track energy consumption at these locations in order to identify energy impacts over time. No impacts were apparent this semester because many of the recommendations have yet to be implemented and many of the education campaigns were begun midway through the term. In the future of the DELTA program, an overall decrease in conventional energy consumption and greenhouse gas emissions and an overall increase in renewable energy production can reasonably be expected—but this remains to be documented.

Because this was the first semester of the DELTA program, the interns did not begin their work until after the start of the semester. Because much of the internship work began later in the semester, the interns did not have enough time to completely collect and analyze the data. Moreover, capstone deadlines differed from those of the interns. For instance, when the capstone team sent the final surveys to the interns, most of them were still collecting their data and had yet to make their final analyses and conclusions. However, future DELTA internships will start at the beginning of the semester, allowing more time for the interns and monitoring group to collect and analyze data.

The interns with qualitative data also will have impacts that can be tracked quantitatively. For example, if the research at CSI on wind turbines is implemented, there should be a decrease in greenhouse gas emissions and conventional energy consumption along with an increase in renewable energy production. However, without baseline data on current energy consumption, future monitoring groups will not be able to quantitatively determine whether the intern's work made an impact on energy consumption.

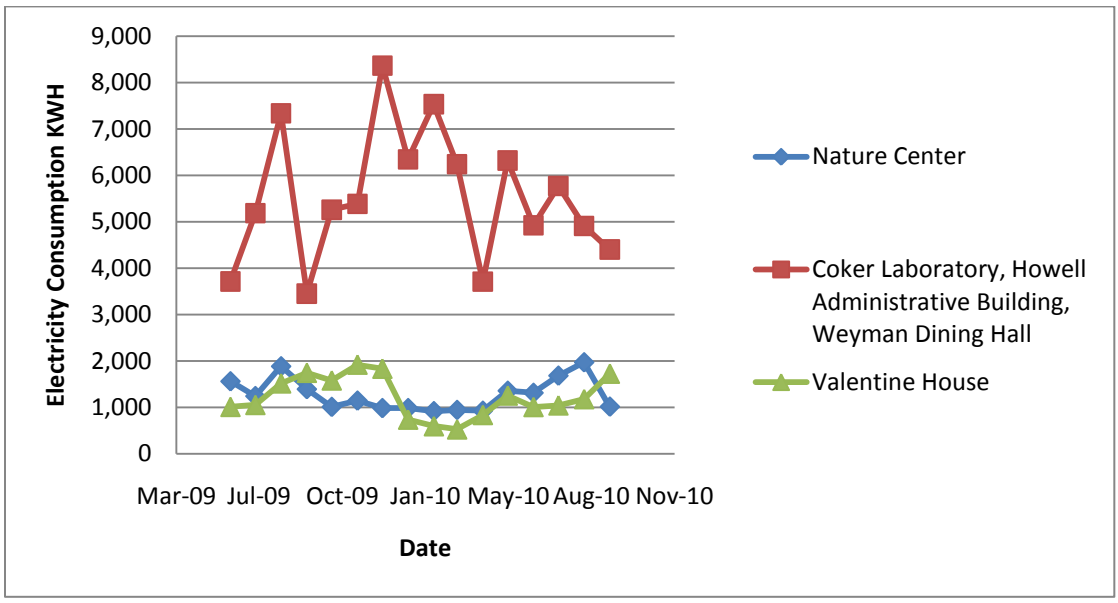
Additionally, the capstone team realizes that each intern has to follow the requirements of their internship, and it is outside the scope of their work to request interns to collect data for the capstone in addition to the projects the interns are required to complete. Ideally, future DELTA internships will be set up so that quantitative data on energy consumption is collected with ease, and future monitoring groups will be able to record and track the impacts the interns have on energy consumption, greenhouse gas emissions reduction, and renewable energy production.

Figure 6: Propane Consumption at Highlands Biological Station



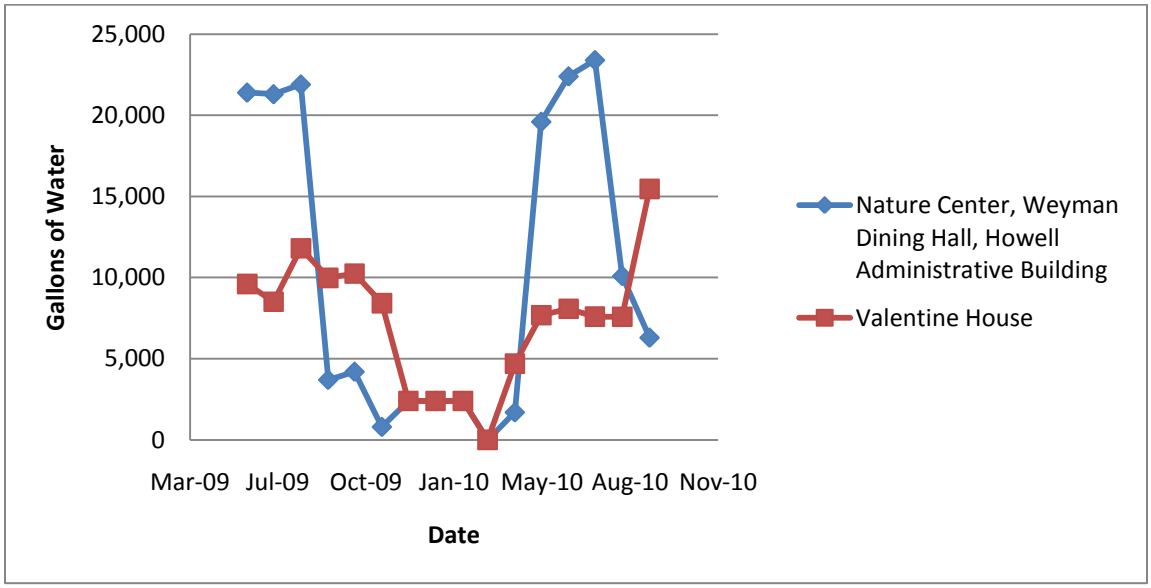
Propane consumption of three buildings at HBS over the 2009-2010 fiscal year, collected from past and current utility bills.

Figure 7: Electricity Consumption at Highlands Biological Station



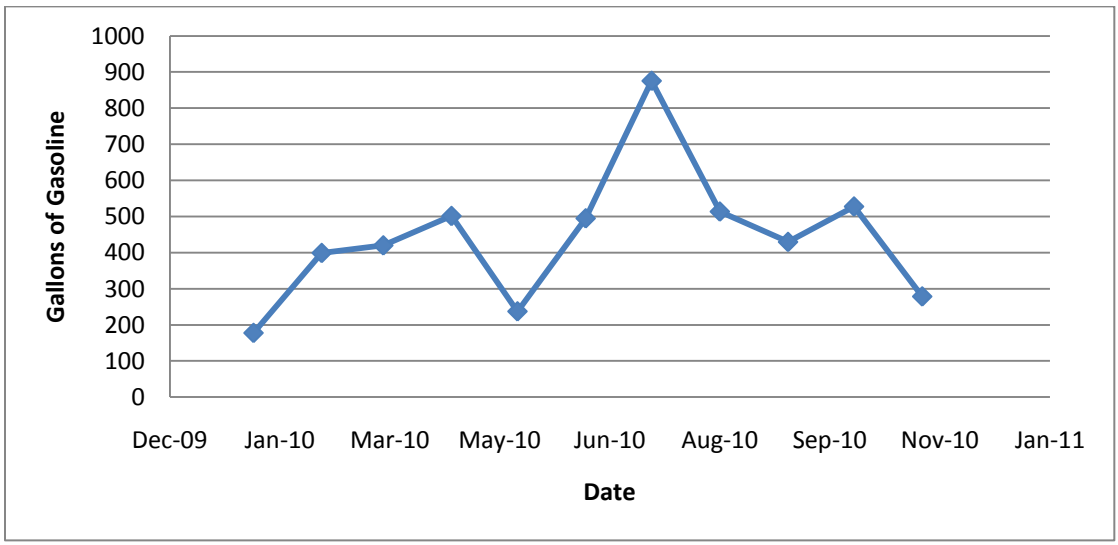
Electricity consumption of three buildings at HBS over the 2009-2010 fiscal year, collected from past and current utility bills.

Figure 8: Water Consumption at Highlands Biological Station



Water consumption of three buildings at HBS over the 2009-2010 fiscal year (the measurements for Coker Laboratory are included in the measurements for the Nature Center), collected from past and current utility bills.

Figure 9: Gasoline Consumption at Institute for Marine Sciences



Gasoline consumption by the truck fleet at the Institute for Marine Sciences in Morehead City for 2010.

Reflection and Recommendations

Feedback from this first semester's DELTA interns informed recommendations for future internships. Many of them provided excellent insight into the experiences of the first round of DELTA internships, which generally produced valuable data and other outputs. The capstone team concluded that those projects with an energy monitoring and/or auditing component are most important to continue into the future. Certain internships, such as those with Chatham County, the Coastal Studies Institute, and the Environmental Finance Center, had stand-alone deliverables that were relatively complete. While these certainly would benefit from follow up, especially in cases where intern recommendations are implemented, there is not an urgent need.

In the case of the monitoring-intensive internships, there is a clear and compelling reason for continuing them. Energy use is constantly changing, and it is important to know whether the DELTA efforts are leading to a reduction in energy consumption. Interns at the Institute for Marine Sciences, Highlands Botanical Station, and UNC Energy Management all collected concrete energy consumption data for their respective sites. It would seem wasteful and inefficient to not follow their efforts with further data compilation. In addition, the recent interns have implemented outreach programs at the Highlands Botanical Station and UNC Energy Management. It would be interesting to track the effectiveness of these programs and to use these programs to help guide future endeavors to reduce energy consumption and green house gas emissions.

Most of the interns provided excellent recommendations on ways to improve their internships. There was near-consensus that the time allotted for the internships was not sufficient. This is most likely a result of the DELTA grant having been issued just before the fall 2010 semester. Some interns felt that their internships were too broad to be thoroughly covered by one intern over one semester. This could be alleviated by allowing several interns to work at a single location or by simply narrowing the scope of internships to create a more focused project.

Several interns noted that they would benefit from more energy-specific guidance from mentors or staff of the UNC Institute of the Environment. It may be helpful for the DELTA team or the Institute for the Environment to provide educational materials to the advisors as well as the interns, and to support the interns with planning their objectives. This finding by the DELTA capstone team drove creation of more concrete guidelines for the interns as well as the advisors. Future capstone teams will spend time in the beginning of the semester compiling information to help the interns once they begin.

A few interns indicated an interest in collaboration with other interns; future monitoring groups may begin the semester by putting interns with similar objectives in contact with each other, to enhance information/resource sharing. Interns with similar data collection methods or similar research may be able to guide others. Simply

providing interns with a contact information sheet of other past and current DELTA interns may dramatically help the program.

The capstone team believes that a more constant stream of information from the interns would be helpful, possibly with a reporting requirement such as an intern log that could include weekly tasks performed, progress on deliverables, and perspectives on broader long-term goals. This would also prevent the monitoring group from missing any relevant data or deliverables and provide a better idea of the progress of each intern. The internships appear to be functioning well, delivering generally positive experiences to the interns and useful products to the sponsors. In many cases, the work proved to be more complex and time-consuming than originally anticipated, perhaps reflecting pent-up demand for the kind of data collection and analysis interns performed. Some of the projects are expected to generate measurable energy impacts in the coming months (which will be captured by subsequent DELTA capstone monitoring teams), while others may take more time to produce tangible impacts. This capstone team addressed both quantitative and qualitative measures, and both near-term and delayed impacts expected to flow from the DELTA internships. This capstone team reported learning valuable skills from their semester's work monitoring the assigned DELTA interns. As a team, they evaluated the available ways to quantitatively and qualitatively measure the internships and then applied them systematically for comparison. They faced many challenges, such as time constraints, communications barriers, and lack of quantitative measurements to analyze. However, they believe that they were successful in laying a framework for future capstone teams to continue the Delta energy internship monitoring.

Appendices

Appendix A—Quantitative survey

Please complete this form and return it to the DELTA Capstone Monitoring Team in a timely manner.

DELTA Intern Initial Survey, fall 2010

Intern Name:
Organization and Intern Title:
What is your job description?
What do you plan to accomplish this semester? Be specific (i.e. Include quantity and type of work):
What strategies will you use for data collection?
How will you quantitatively assess measurable energy changes?
Within the DELTA Project, the Institute for the Environment must monitor "*conventional energy savings, greenhouse gas emissions reduction, and renewable energy production*." How will you fulfill this requirement as part of your internship?
Additional Comments:

Appendix B—Qualitative survey

Please complete this form and return it to the DELTA Capstone Monitoring Team in a timely manner.

DELTA Intern Initial Survey, Fall 2010

Intern Name:

Organization and Intern Title:

What is your job description?

What do you plan to accomplish this semester? Be specific (i.e./ Include quantity and type of work):

Within the DELTA Project, the Institute for the Environment must monitor "*conventional energy savings, greenhouse gas emissions reduction, and renewable energy production*." How will you fulfill this requirement as part of your internship?

Additional Comments:

Appendix C—Work plan

Delta Energy Monitoring Capstone Team Fall 2010 Work Plan

Group Members: Laura Brookshire, Aaron Johnston, Jordan Manning, Sara Mishamandani, Lauren Visser, Frederick Wellborn
Project Overview: The vision of this project is to develop a monitoring plan to track the progress of the Delta Energy Internships. Monitoring will include tracking energy conservation, emissions reductions, and renewable energy research and innovation that will stem from the new Delta internship program.
Goal 1: Collect Baseline Information from interns

Tasks:

- Contact all advisors to determine the intended scope of each internship.
- Determine which internships have measurable data. For those with non-measurable outputs, create a framework for assessing social impacts.
- Produce surveys to send to each intern to determine individual intern goals, vision for the internship, potential data collection methods, and resources they plan on using.
- Apply for IRB approval to interview interns.
- Collect information on baseline status at each intern site if information is not provided in the initial intern form. If this information is not provided by the intern in the initial survey, we will contact the adviser or other employees by email in the department for additional information. This may also include interviews with the interns.

Goal 2: Compile information and develop methods of monitoring

Tasks:

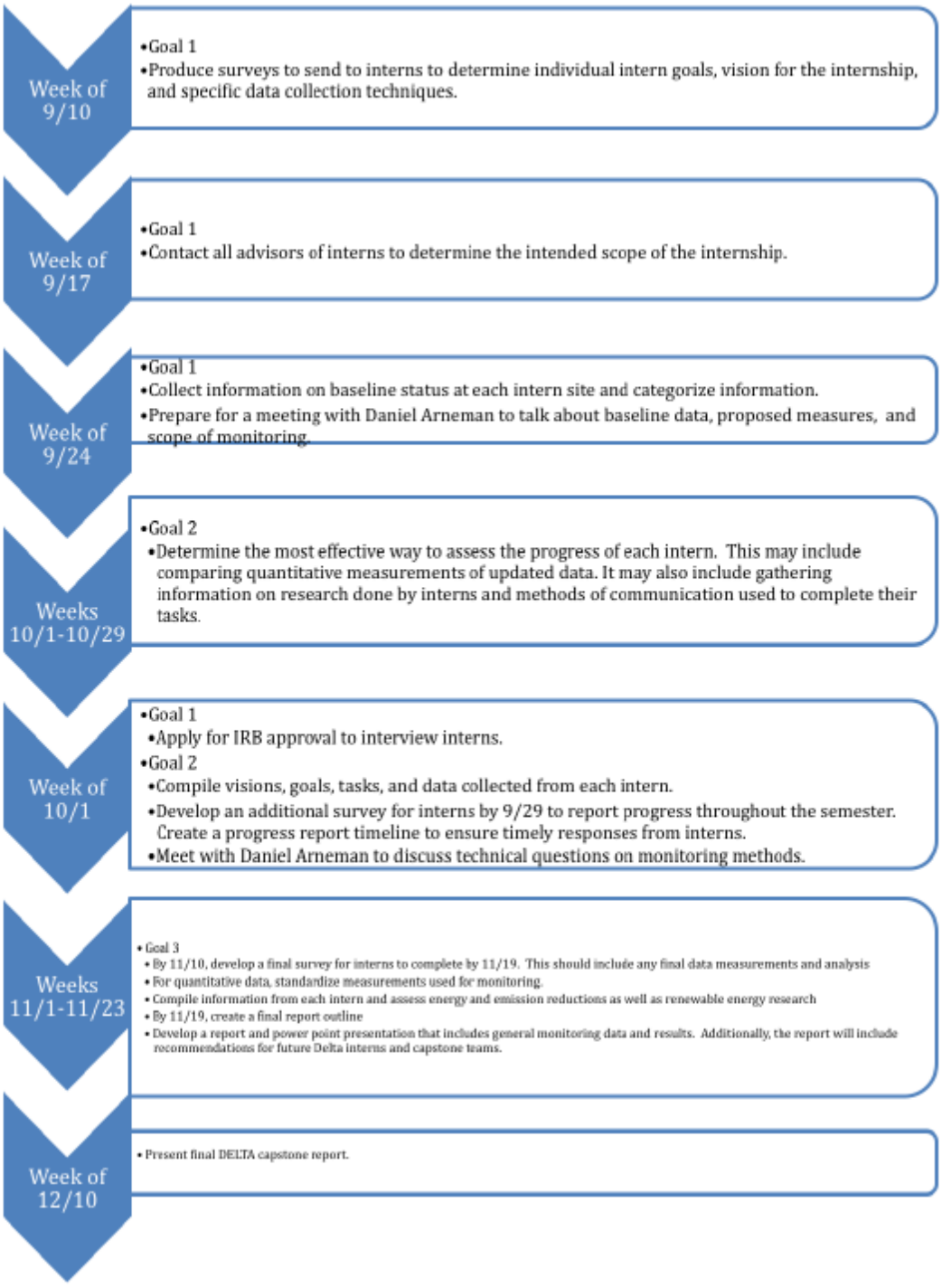
- Compile visions, goals, tasks, and proposed techniques for data collection gathered from the interns.
- Identify relevant measures from baseline data, and develop another form for interns to report progress throughout the semester. Create a progress report timeline to ensure timely responses from interns.
- Determine the most effective way to assess the progress of each intern based on the measurements chosen. This may include a comparison of quantitative data. It may also include qualitative comparisons of research done by interns and the methods of communication they use to complete tasks. Because we don't yet

know the scope of data collection, this will be assessed after the follow-up surveys have been returned.
- Develop a final progress form for interns to fill out that includes final data and general comments about the internship.

Goal 3: Evaluate effectiveness of each internship and develop a report

Tasks:

- Analyze quantitative data in order to compare techniques and evaluate the measures chosen for future capstones.
- Compile information from each intern and assess total energy and emission reductions, renewable energy research, and other outreach and research accomplishments.
- Develop a report and power point presentation that includes general monitoring data and results. Additionally, the report will include recommendations for future Delta intern
- Develop a transition document for future capstone monitoring teams so that the work done this semester can be used efficiently and built upon rather than redone.


Week of 9/10
•Goal 1
•Produce surveys to send to interns to determine individual intern goals, vision for the internship, and specific data collection techniques.
Week of 9/17
•Goal 1
•Contact all advisors of interns to determine the intended scope of the internship.
Week of 9/24
•Goal 1
•Collect information on baseline status at each intern site and categorize information.
•Prepare for a meeting with Daniel Arneman to talk about baseline data, proposed measures, and scope of monitoring.
Weeks 10/1-10/29
•Goal 2
•Determine the most effective way to assess the progress of each intern. This may include comparing quantitative measurements of updated data. It may also include gathering information on research done by interns and methods of communication used to complete their tasks.
Week of 10/1
•Goal 1
•Apply for IRB approval to interview interns.
•Goal 2
•Compile visions, goals, tasks, and data collected from each intern.
•Develop an additional survey for interns by 9/29 to report progress throughout the semester. Create a progress report timeline to ensure timely responses from interns.
•Meet with Daniel Arneman to discuss technical questions on monitoring methods.
Weeks 11/1-11/23
• Goal 3
• By 11/10, develop a final survey for interns to complete by 11/19. This should include any final data measurements and analysis
• For quantitative data, standardize measurements used for monitoring.
• Compile information from each intern and assess energy and emission reductions as well as renewable energy research
• By 11/19, create a final report outline
• Develop a report and power point presentation that includes general monitoring data and results. Additionally, the report will include recommendations for future Delta interns and capstone teams.
Week of 12/10
• Present final DELTA capstone report.