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Develop Energy Dashboard for Real-Time Campus Energy Use Monitoring

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Final Report

Thinkfinity Grant 2010-2011

Develop Energy Dashboard for Real-Time Campus Energy Use Monitoring

Cornerstone #3 – Interdisciplinary Informatics

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A) Original goals.

Our project has the goal of setting up an energy dashboard that will serve as a center for the Pace community to learn about our building energy use and to integrate our results into teaching lessons.

The main revision from our original proposal was to have the Pace Ground Department evaluate and assess the most effective approach to install monitoring instruments. Bill Batina is our lead person on this task. Our main project tasks are to analyze the energy data, to design lessons for the learning community classes, and to have our students use the data in learning projects.

B) Progress made to date towards the original goals of project.

Project Modification – We modified our original plan such that we will work with Pace Building and Grounds to purchase and to install systems with the necessary software and tools.

Student Selection – We recruited undergraduate student Rebecca Bloom (from BIO170/CIS101 learning community class) to work on the project. She spent about 120 hours in the spring and summer semesters assisting with data analysis and preparing results for conference presentations as they become available.

Data Analysis and Lesson Design – Live data in 15-minute intervals are available from Con Edison for our Pleasantville campus account. An example is shown in Appendix A. We have completed analysis on one large account (Pleasantville campus) and one small account (Castleton account). The data displays interesting patterns and reflects our academic, seasonal and weekly usage information as a university campus. We believe analyzing and viewing energy usage data can provide teachable lessons as to how electricity is consumed in the campus environment. Some of the results were in our project midterm report. We plan to present results in external conferences. We will also publish the results on the energy dashboard once it is operational.

AASHE Contribution – As a college member of AASHE (http://www.aashe.org/), Bill Batina has been working on filing reports on behalf of Pace University to provide updates on the self-study of Pace University green practices. Our project results and the lessons learned in the process also contributed to inputs to AASHE's activities from Pace University. As of July 25, Pace has been awarded Bronze in the campus sustainability in teaching, operation, policy and administration aspects.

C) Activities have been completed to contribute to meeting/progressing toward these goals.

- We have completed the analysis of electricity energy use in the campus in identifying demand and usage patterns.
- An energy dashboard design is in place, real-time data, either from Con Edison or from our solar building, is yet to be streamed onto the site. Appendix B has shown an image of the dashboard.
- A learning community consistent of BIO170 and CIS101 is in the 2nd year with good student enrollment.

- New and modified course curriculum and student assignments were developed both as a result of this project as well as contributing to the progress of the project. One such assignment is attached in Appendix C.
- Solar panel installation in both the Law School building and in the main campus will further contribute to student learning in energy use.

D) Activities have not been completed.

The 3 sub-meters for smaller building installation were not completed (delayed) due to both budget constraints and due to a larger plan that all campus buildings would have monitoring meters installed in the near future.

E) Project outcomes.

- Real-time energy data analysis results – We have completed energy data analysis for the current whole building energy use. Energy monitoring can reflect many energy demand patterns in daily, weekly, and in our campus situation, academic and seasonal change. Variations in different buildings can provide many teachable lessons for our students.
- Learning community lesson design – We have incorporated the project results into course design for our learning community class. A learning community with environmental and technology focus can provide proactive learning in both energy use and in how technology can help make decisions in energy consumption.
- We have continued our learning community class of BIO170 and CIS101 in the Fall of 2011. The energy dashboard data will be part of the lesson plan for the year 2012 learning community.

F) Project impacted students.

Students (20 in 2011 Fall semester and 18 in 2010 Fall semester) are sensitized to collecting and analyzing data and using charts and graphs to interpret their

environmental impacts. A sample student work in the learning community is shown in Appendix D. In addition, Becky Bloom is the undergraduate student actively working on the project research including data analysis and Web site design. We will also post our results to the general CIS101 community with 'environment theme'.

G) Project impacted other faculty members.

In the learning community course offered by both Dr. Hoegler (BIO170) and Dr. Winkler (CIS101), we have designed quantitative energy usage concepts and exercises using Excel. We have integrated what we learned in this project in terms of energy use into our course assignments. We will publish these course materials in Web pages in the CIS101 environmental theme group to share with other instructors.

H) Unintended outcomes achieved.

- The current electricity usage data is in real-time and displays many interesting usage patterns from our data analysis results.
- Both the data and results are used to develop teaching lessons.
- We expect to include solar energy monitoring in the energy dashboard design.

I) Conference plan.

- Becky Bloom will present our energy analysis project as undergraduate research inTriBETA Conference on 4/28/2012 at Pace University NYC campus.
- Winkler, Hoegler and Batina will present the learning community and the energy project in the ABLE conference at UNC Chapel Hill, N.C. in June 2012.

J) Outcomes reflect the benefit.

We learned a lot from our campus energy demands and usages. We derived alternate benefits in solar panels with meters to demo live data; streaming Con Edison data feed; and plan on having all buildings on campus sub-metered in the future.

K) Project furthered the interdisciplinary Thinkfinity Cornerstone.

Our project integrates environmental study, information technology, undergraduate research, and energy usage; it is a real-life practice of an interdisciplinary project. Pulling interdisciplinary resources together is the only way we can move a project like ours forward.

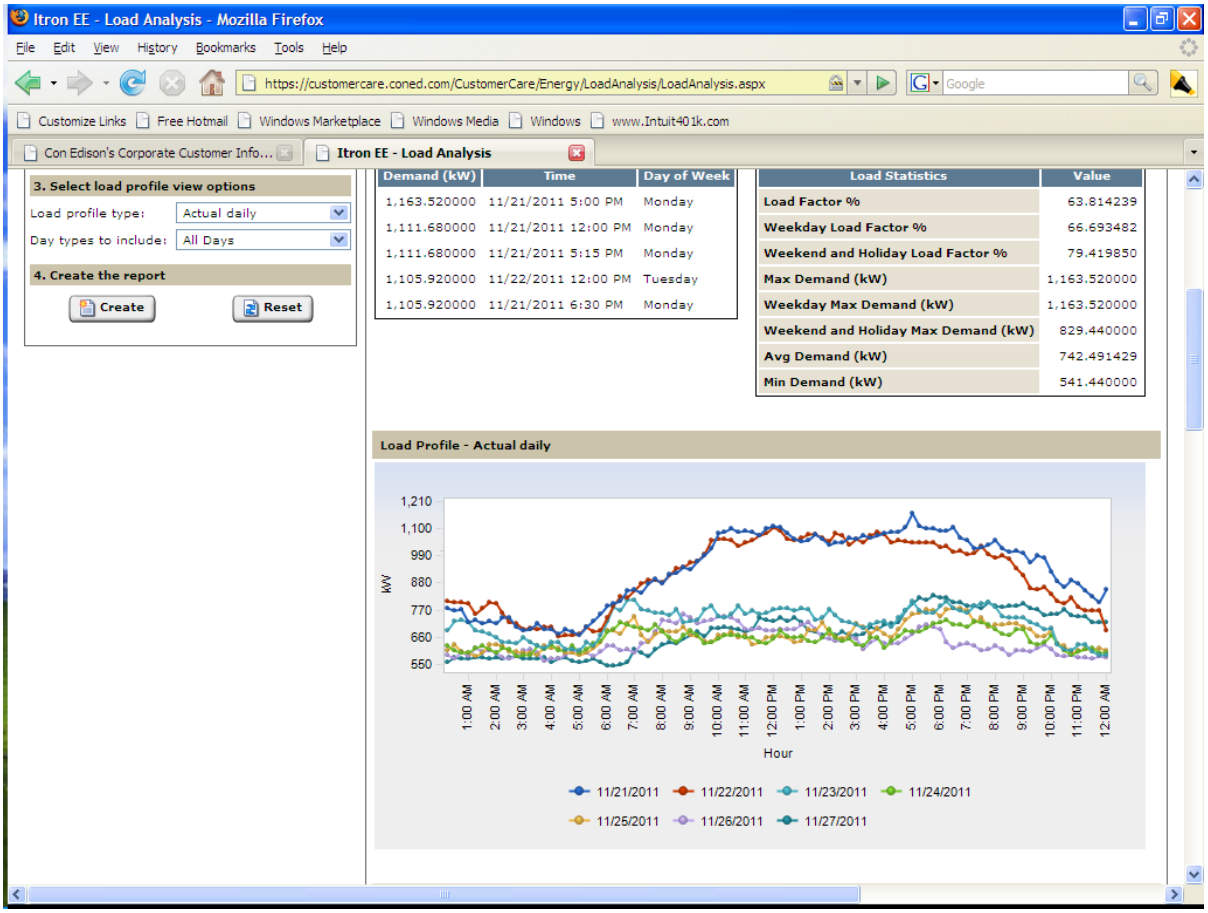
L) Future plans for sustaining the project.

- We plan to reach out both within and outside the Pace Community to continue the energy monitoring initiatives to support our data gathering efforts.
- We will continue to encourage our students in the learning community to use the data for research and expand our energy gathering efforts to other buildings and to other environmental monitoring in the campus.

Appendix A - Real-time Data

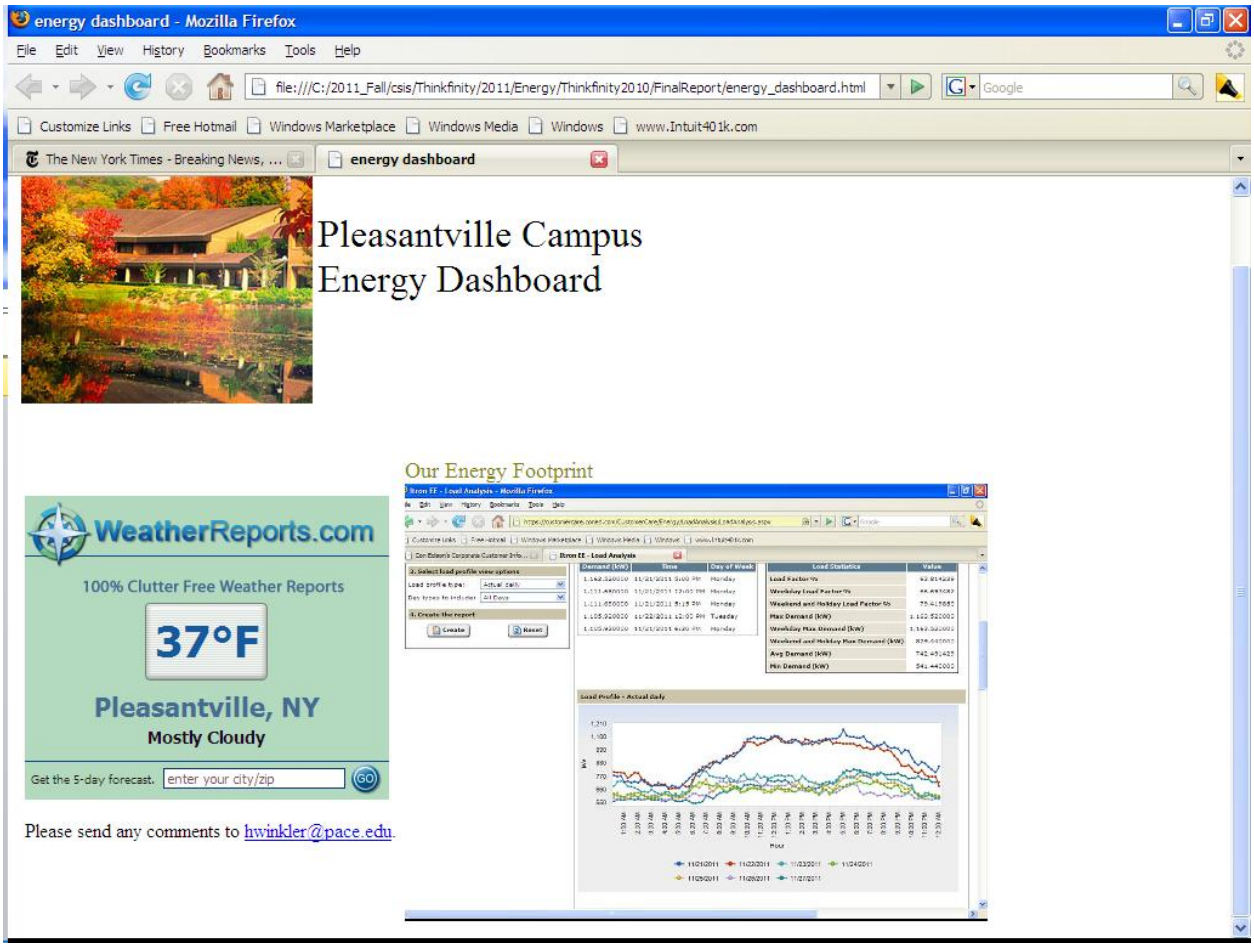
The aggregated electricity usage data is available in real-time in 15-minute intervals from Con Edison https://apps1.coned.com/ccg/default.asp in the Pleasantville Campus. The data display interesting patterns and reflects our academic, seasonal, and weekly usage information as a university campus as summarized in our midterm project report. We believe it can provide valuable lessons as to how electricity is consumed in the campus environment.

(An example of the real-time data is shown in the following for one week (21st – 27th) of November 2011. Since the Thanksgiving holiday begins on the 23rd, the electricity usage indicates when the campus is closed, since the electricity demand is close to the night-time demand, which is about 60% of the day-time demand.)



Appendix B - Energy Dashboard Design

A basic energy dashboard will show daily local weather vs. real-time energy consumption. The current design uses Con Edison's real-time electricity demand data in 15-minute intervals. We will add solar energy data when it becomes available in the Spring of 2011. (The following image was captured on December 8 with the real-time data.)



Appendix C – Assignment/Lab 6 – Personal Energy Consumption Assessment

It is noteworthy that except for a few small countries like Luxembourg, Bahrain, Qatar and Oman, North Americans use more energy per person than all other parts of the world. There is historical basis for this fact. North America has always had abundant, inexpensive energy in the form of wood, coal and oil. As a consequence, there has been limited interest and scarce funding to develop and implement alternative renewable sources such as solar (photovoltaic), wind, wave, geothermal, nuclear fusion (not fission), hydrogen fuel cells etc.

In order to bring this issue into perspective, we will assess aspects of our personal energy consumption. There are some categories of personal energy consumption over which we have a degree of control. In our homes we can regulate home air heating, air conditioning, water heating, lighting and the use of electrical appliances. We can also determine the modes of transportation we use and how often we use them.

The units used in North America to measure quantities of energy are quite diversified. Heat energy is generally given in British Thermal Units (BTUs), electrical energy is measured as kilowatt-hours (KWH) and the efficiency of gasoline powered cars as miles per gallon (MPG). Rather than try to convert all of these to equivalents, we will use the standard units of ordinary commerce.

BTUs in various amount of fuel: (Please attach your calculation sheet to this exercise.)
1 gallon fuel oil: 145,000
1 cubic foot of gas: 1,031
1 KWH electricity: 3,412
1 ton coal: 25,000,000
1 cord wood: 20,000,000
1 gallon gasoline: 125,000

In order to complete this project, you may need to ask your parents to allow you to access some of the household maintenance bills. If you are living independently, I am sure that you already keep meticulous records of your bills for tax purposes. Check the information on the HOME HEATING BILLS that detail the number of gallons of fuel oil used... annualize this number and record it after calculating the number of BTUs involved. Repeat this process of the ELECTRICAL BILLS, annualize and record this information after converting it into BTUs. Estimate the number of miles you travel by auto each year and the gallons of gasoline used by your car (you will need to adjust for the MPG of your car)… record the BTUs for this aspect of lifestyle. Do you use natural gas for heating your home, hot water or cooking? Factor this info into your records after you annualize the amounts of BTUs. Do you heat with wood, coal? etc…

Home heating: _____ (BTUs)/year
Electricity: _____
Auto use: _____
Misc.: _____

ROUGH E STIMATE TOTAL: _____ (BTUs)/year

Appendix D - Sample Student Work In the Learning Community

Students in the learning community are required to reflect their semester learning by gathering and analyzing data to support their study subject of a selected environmental interest. The following link shows a project completed in the learning community on 'Depletion of the Ozone Layer'.

http://csis.pace.edu/~hwinkler/CIS101/SandB/Ozone%20and%20CFC.html

(An image of the home page is shown below.)