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Develop Energy Dashboard for Real-Time Campus Energy Use Monitoring

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Status Report

Develop Energy Dashboard for Real-Time Campus Energy Use Monitoring

Cornerstone #3 – Interdisciplinary Informatics

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A) Project 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 work more closely with the Pace Grounds Department, with Bill Batina as our lead person to evaluate and assess the most effective approach to install monitoring instruments. Our main project tasks will be to analyze the energy data, to design lessons for the learning community classes, and to have our student on the project test and evaluate the lessons.

B) Progress Made Toward the Above Goals

Project Modification – We modified our original plan such that we will request Pace Building and Grounds to purchase the required energy sensors for 3 sub-systems and to install those systems with the necessary software and tools.

Student Selection – We have recruited undergraduate Rebecca Bloom to work for about 120 hours in the spring and summer semesters to assist with data analysis and to test some of the prototypes when they become available.

Existing Data analysis – Bill Batina has provided access to existing data about our energy usage. The live data in every 15 minutes interval is also available from ConEd for our Pleasantville campus account. We have done a preliminary analysis on one large account (Pleasantville campus) and one small account (Castleton account). Some results are shown in the Appendix to illustrate the energy usage fluctuations and how installing sub-meters can help to understand and optimize energy usage.

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 self-study Pace University green practices. Our project results and the lessons learned in the process will become inputs to AASHE's activities from Pace.

C) Project Impacts on Students

At this point, Becky Bloom is the undergraduate student actively working on the project research including data analysis and Web site design. She will also test drive the course content developed in this project that will be used by the learning community. We anticipate the outcomes will be integrated into the course content for a class of 20 in the learning community of BIO170/CIS101. We will also post our results to the general CIS101 community with 'environment theme' in the Fall of 2011.

D) Project Impacts on Faculty

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 plan to integrate what we will learn in this project in terms of energy use into our course assignments. We plan to publish these course materials in the CIS101 environmental theme group to share with other instructors.

E) Our Next Steps

For the second half of the project time, we will complete our planned tasks as described in the following.

- o We will continue working on curriculum design to show how the energy dashboard can be used for 'energy and environment' courses. The learning community of BIO170/CIS101 will be our test bed for the curriculum designed in this project.
- o We will continue to analyze energy usage data with broader scope which will include correlation with factors such as temperature and building use types and comparing our campus with other campuses with published data, i.e., from AASHE's reports.
- o We plan to complete the installation of the three sub-systems and connect them to the dashboard system. This will include evaluation of how we may reuse some of the currently available sub-meters. We anticipate that the solar paneling project will be installed in the summer and the monitoring of the energy generation from the roof-top solar panels will be included in our analysis.
- o Prepare a final project report.

Appendix 1 – Data Analysis Results

Preliminary Analysis for the Pleasantville Campus Electricity Usage

Usage Data Download and Selection

Two sets of data are shown here for the Pace Pleasantville campus electricity usage from ConEd https://apps1.coned.com/ccg/default.asp. The first set of data is from a large system of the Pleasantville campus which contains an aggregated energy usage in every 15-minute interval in the academic year of 2010-2011. The second set is from the Castleton building data, which is from a single-building energy usage archived from

July 2007 to 2010 June. Although single-building electricity data is not sub-meter data that can reveal detailed correlation of different usages, it reflects the change in usage and provides clues on how to optimize usage.

Case 1 - Large System Energy Usage in Pleasantville Campus

Daily and Electricity Usage

We plotted in Figure 1 daily electricity usages from Pleasantville campus from May 1 to May 7 this year. The horizontal axis is the daily time starting at midnight and the vertical axis is the usage in kilowatt. Seven curves are shown on the plot. Each represents one day demand as function of time. Two main features are observed here: 1) The daily peak usage is in mid-afternoon and the lowest demand is before dawn or early morning. The demand difference is quite large, about 600 kW, which is about half of daily peak demand. 2) The difference in weekday vs. weekend is also visible at about 200 – 250 kW, which is less than the daily fluctuation.
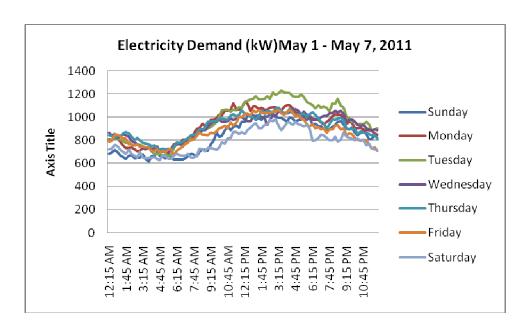

Figure 1 Daily electricity demands from Pleasantville campus.

Monthly Electricity Usage

If we show the daily average electricity usage for the most recently month in a bar-chart, the weekly fluctuation of the demand is easily shown in Figure 2. Again, the change is

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about 250 kW from the peak on Tuesday to the trough on Saturday and Sunday.   Note that after May 15, the final exam started and the weekly pattern began to fade.
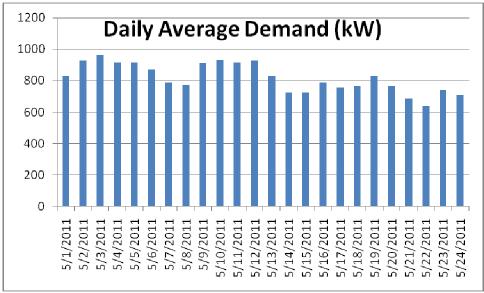

Figure 2 Daily electricity demands in the month of May 2011 from Pleasantville campus.

Yearly Electricity Usage

In Figure 3, we show the monthly average usage for the academic year beginning on Sept 4, 2010. The interesting feature is that the peak month of demand is September when the semester first began. Then it levels off. The lowest demand month is January when the campus is in recess. Then it peaks again in the early spring and again it levels off.
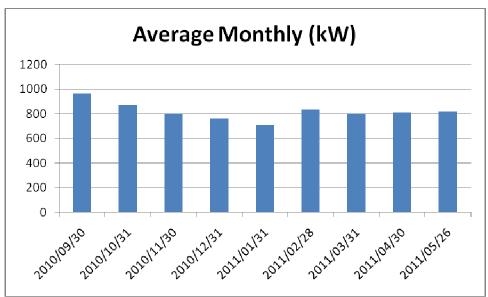
Figure 3 Monthly electricity demands in the academic year of 2010-2011 from Pleasantville campus.

Case 2 - Small System or Single-Building Energy Usage of Castleton Building

<u>Yearly Electricity Usage</u>

We plotted the monthly electricity demands for the Castleton Building during the academic years of 2009 – 2011 in Figure 4. Note that the demand in general is less than 50 kW, or less than 5% of the rest of the campus complex. The highest demands in both years (from May 2009 to April 2010 and from May 2010 to April 2011) appear to be in August. In the summer of 2010, the demand is continuously high in all summer months. This pattern is the opposite from the campus complex and it reflects the fact that smaller monitoring system can provide detailed data to manage and optimize energy usage. This small building's summer demand is similar to some household electricity usage patterns since cooling systems are used in the summer months. It will be interesting to study further on the impact of temperature on energy use.

The most interesting observation from these two-year data sets is the drastic reduction of electricity consumption during the regular semester year (from September to April). There is almost a factor of three reduction in electricity usage in the year 2010-2011

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relative to the previous year of 2009-2010. We learned that this was due to a department relocating to another building.

This also suggests that the importance of having sub-meters that can provide guidance on where and how to manage the energy usage. In a smaller building even without sub-metering, we were able to observe changes that are not shown in an aggregated large system outcome.
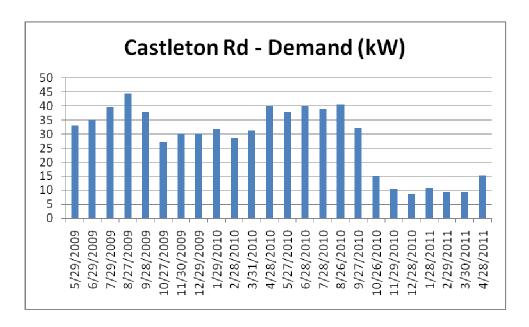

Figure 4 Monthly electricity demands in two academic years.