Cornell University Initiates Energy Awareness Program Through Campus-Wide Power Monitoring

Power Metering Case Study

Figure 1: Cornell University is a pacesetter in taking steps to drive energy conservation. Duffield Hall is pictured.

Figure 2: Typical electrical panel installations on the Cornell campus include PowerScout meters and CTs for whole building load monitoring and multi-circuit submetering.

As centers for cutting edge research and the transfer of knowledge, universities are often pacesetters in pursuing programs for the betterment of society and ecology. Progressive universities know that it's one thing to discuss the need for behavioral change in the interest of improving our stewardship of resources, but it's another to put into place programs that can actually affect that change. Often a microcosm of our society as a whole, universities present a highly diverse and complex environment in which to experiment with policies that may later be applied to society in general.

A case in point is Cornell University. In the fall of 2009 the University approved its president's statement of climate commitment and began to put in place a plan to achieve a climate-neutral future. According to the plan, by 2050 the university will achieve climate neutrality. The university developed a technical road map for achieving this goal including a very ambitious $46 Million overall energy conservation initiative. They are well on their way after having invested about $25M in projects since then which was preceded from 2001 through 2009 by a separate $10 million to increase sustainable practices with regards to in energy efficiency.

Understanding Consumption

At the core of the energy conservation program is real-time metering of energy consumption and comparing current usage with historical data. As one of the first steps, Cornell's Energy and Sustainability department installed real time power meters on the main service supplies of over one hundred and eighty of the university's buildings, selected because they represent most of the electricity used on campus. "The rationale behind continuous power monitoring is that we can't affect permanent change without identifying the results of conservation efforts," said Lanny Joyce, Cornell's Director of Energy Management. "We wanted to understand our consumption patterns on a real-time basis, and establish base-line energy usage levels that we can measure our progress against."

Like most electric consumers, the university used to have only monthly power consumption data available for each of its buildings. The lack of granularity of the data made it virtually impossible to identify with certainty how localized conservation efforts would result in reduced energy consumption. By adding continuous consumption monitoring for each building (updated about every 15

Electric

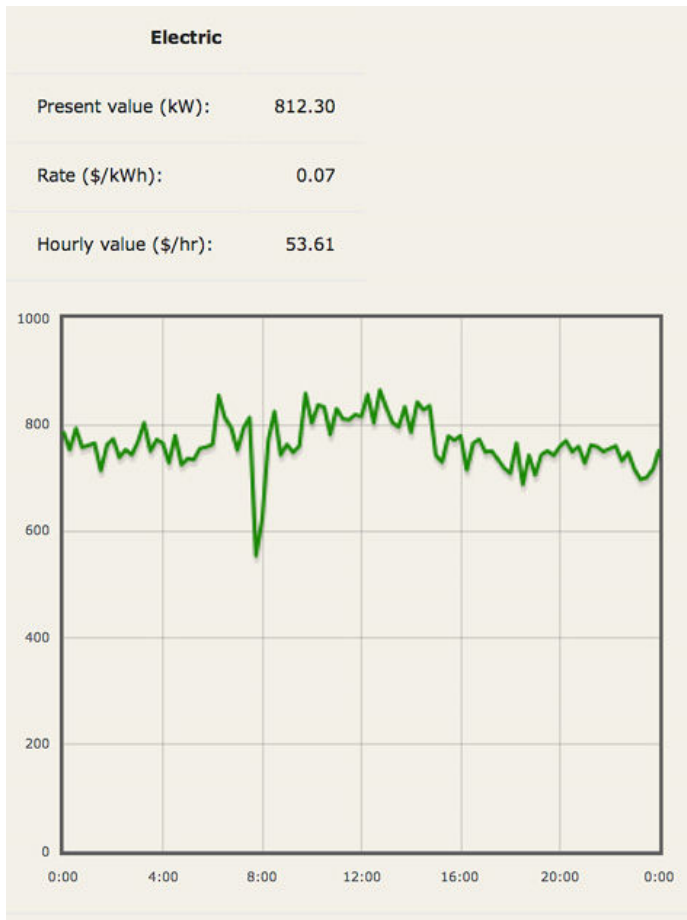|	
Present value (kW):	812.30
Rate ($/kWh):	0.07
Hourly value ($/hr):	53.61

Figure 3: Duffield Hall houses the university's nano-science centers and, as such, is a very large energy user. The new real-time metering there is used to help evaluate energy use and energy savings features on a continual basis.

minutes), interested facilities personnel can see how real-time conservation projects impact the load. But beyond the facilities team, the decision was made to make Cornell's energy consumption data available to the entire campus community to encourage broader involvement, and even an element of healthy competition to reduce energy usages, among members of the university community.

In selecting monitoring devices for installation, the Cornell team had some specific requirements. Foremost was the need to ensure that the installation of monitoring devices did not disrupt any currently installed electric supply networks, because of a variety of factors such as ongoing critical research studies requiring continual flow of electricity. In addition, the monitors needed to be compact in size in order to fit unobtrusively inside existing electrical panel structures. As well, it was important that monitoring data be readily available via the university's existing campus-wide data network, so the monitors chosen needed to easily interface with Ethernet networks. These requirements combined would save money and avoid disruption to existing

programs and campus life. An additional requirement, driven by the local electrical contractor community was to select commonly-available devices from proven switchgear suppliers.

Metering with Efficiency

After surveying the market for available real-time metering devices, Cornell engineers chose two types of meters manufactured by DENT Instruments of Bend, Oregon (See Figure 2). The first type was used for single-point monitoring of three-phase electrical circuits – typically whole building loads. And the other type was for sub metering of multiple circuits (up to six 3-phase circuits or 18 single-phase loads) simultaneously. Ease of installation was accomplished using millivolt output current transducers (CTs) that attach around conductors without the need to disconnect power, and interrupt activity within the building.

"The metering solution products we chose were efficient because they overlaid the conventional wiring already in place, including existing metering," says Lanny Joyce. "For cost and efficiency reasons, we chose to get the data out of the meters via RS-485 to IP connection to our campus Ethernet."

Real-time consumption data is made available in graphical form on the school's portal website, one graph per building (see Figure 3, and for a live picture, visit the following link: portal.emcs.cornell.edu), and is also displayed via a new university dashboard in a more user-friendly visual format (see Figure 4, and for a live picture, visit the link: http://buildingdashboard.cornell.edu).

"The dashboard provides a graph of energy consumption, cost, and carbon equivalent per hour of energy consumed for each utility in each building," said Lanny Joyce. "It's important to highlight the cost of the energy we use in addition to the kilowatt hours," continues Joyce, "because the ultimate result of wasting energy is wasting money, and no university has funds to waste these days." Besides electricity, the Cornell dashboard is being enhanced to show the cost of producing chilled water, heating hot water and steam for use around campus.

Friendly Competition Yields Major Savings

Having each building's consumption easily viewable has become the catalyst for implementing change in energy consumption, and what better way to make this happen than through some good-spirited competition between building occupants. After a certain number of buildings had been metered and connected to the online dashboard, a competition called Energy Smackdown was held, and

included 10 buildings within the College of Engineering. The competition ran from Nov 11 until December 31, 2013. Some people were designated 'Green Ambassadors' and had the job of posting signs and encouraging other occupants to participate.

Social media was involved in the course of the competition. The school sponsored a contest through Facebook to get people to visit the dashboard online. Those who participated were entered into a drawing. They were asked, "How do you reduce your carbon footprint?" and answers posted to the individual's Facebook page, to encourage others to participate.

To add to the momentum of the competition and increase awareness and engagement, the Cornell Energy & Sustainability Department held an event called Swap It Out, in the College of Engineering where faculty and staff could trade in their outdated power strips for energy-saving ones, and their old energy-hogging space heaters for electric foot warmers, which use only 75 watts instead of 1500 watts. The competition results were posted on the dashboard website (see Figure 5), and at the end of the period, the winner was Carpenter Hall, with a 23.7% reduction in energy consumption.

Cornell held another contest this spring—Unplugged 2014, April 7–25th. This one involved residence halls as well, encouraging a larger audience to make sustainable changes to their habits. "The programs to engage students will be different than those used to engage faculty and staff. We are curious to see the difference in the amount of energy reduction," said Erin Moore, Cornell's Energy Outreach Coordinator.

"We've installed over 180 power monitors so far," explains Lanny Joyce, "and the monitoring program with the new dashboard is well on the way toward facilitating campus wide behavior change. ◆
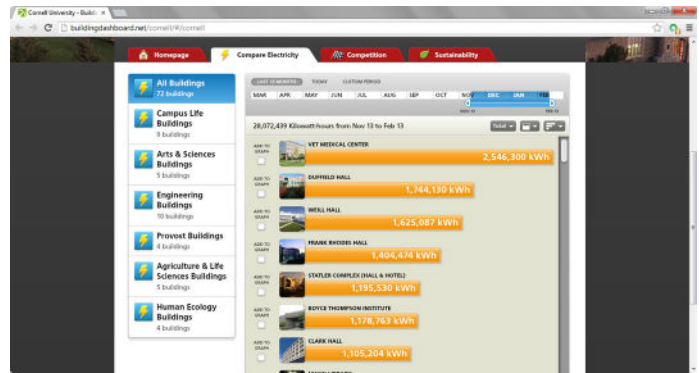

Figure 4: The university's energy consumption dashboard provides an at-a-glance way to monitor energy consumption of campus buildings.
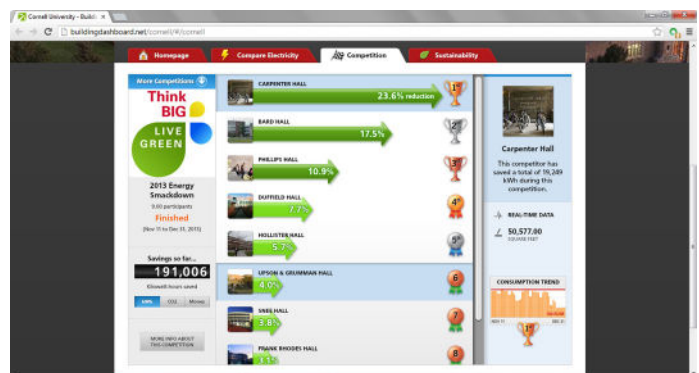

Figure 5: With the energy consumption dashboard in place, university energy usage centers can "compete" to see who is more effective in eliminating waste.