United States Environmental Protection Agency New England

Energy

Sub-metering Campus Buildings

Updated January 2007

Summary: Today, few universities have energy metering equipment to track and measure the energy performance of their facilities on an individual building and sub-building basis. With both state and privately-funded schools facing major budget constraints or cutbacks, many institutions are actively searching out ways to reduce operating costs in the face of increasing electricity and fuel costs coupled with increased energy demand. Operating and maintaining campus facilities can account for upwards of 10 percent of a university's annual budget and energy-related costs constitute a significant portion of this amount.

Southern Connecticut State University

Campus Profile

Southern Connecticut State University
New Haven, CT
Student Enrollment: 12,300
Full Time Faculty & Staff: 1000
No. of Buildings: 45
Campus Area: 168-acre
Construction Program: $260 million – 5 year

Project Goals

- To measure actual energy costs within individual buildings objectively rather than by pro-rata allocation;
- To account for energy use on a time-of-day basis;
- To compare energy demand on heating and cooling degree days;
- To monitor the efficiency of high energy demand equipment including chillers, boilers, and compressors;
- To provide data for planning and subsequently evaluating energy efficiency projects;
- To prioritize energy projects on a building-by-building basis in order to realize the greatest return on energy-related investments of scarce capital;
- To identify performance problems and guide preventive maintenance; and
- To verify energy and dollar savings from energy projects.

Description

The growth of the economy and our need for modern technology (e.g., computers, refrigerators, air conditioning) have led to increased energy demand, especially electricity. The classrooms and dormitories of today are dramatically different than 20 years ago. Today's typical classroom may have plug-load equipment such as computer consoles, an overhead projection system, a camera system, VCR and DVD players, and draws electricity load for air conditioning. Energy-demanding computer labs for instructional use and student use are commonly found on campuses. These typical instructional equipment have increased the demand for energy at the same time other costs for institutions have grown.

Facilities Operations Building

A recent audit conducted at SCSU revealed that computers, lights, and air conditioners left on overnight and on weekends were costing the University more than $100,000 a year. Simply turning off these devices when not in use would actually have a meaningful affect on the University's $2.5 million annual electric bill. Realized dollar savings from such simple energy-saving actions could easily be applied in support of additional energy saving projects or directly to bolster academic programs. Sub-metering equipment, applicable in a variety of situations, has allowed SCSU to obtain savings of tens of thousands of dollars a month depending on the type of facility being metered. Savings like these are possible because advanced metering equipment, energy management, and control are directly in the hands of facility operators. By comparing historical energy usage with current kWh values, facility managers can identify energy savings opportunities that will guarantee the largest and quickest paybacks. According to Patrick Norton, Director of Facilities Engineering, Environmental, Health and Safety, Southern Connecticut's new sub-metering system can pinpoint which computers, lights, and air conditioners are on or off, and whether there might be a need to adjust operating schedules for larger system elements or equipment. Meter-derived data can reveal locations and situations that call for change-outs of equipment to more high efficient designs.

A new facilities operations building constructed on the Southern Connecticut campus was designed to be a model for energy efficiency and it now serves as a benchmark for comparison to other buildings at the school. This building incorporates a fully automated system and so sets a standard of energy performance for the campus and demonstrates how much energy can be saved in a properly controlled and monitored situation. The energy use in this building complex can be and is reduced by 80 percent during non-occupied periods even though the building houses computer servers, an air conditioned telephone PBX complex, outside lighting, security lighting, and the central control center for energy management for the University.

Pre-Project Considerations:

Participation Campaign

The original purpose of sub-metering the SCSU campus was to respond to a legislative mandate to accurately distribute costs associated with various buildings in accordance with their source of funding. This initial project consisted of installing 14 sub-meters at various locations. Direct Digital Control (DDC) systems were also installed for building automation. The sub-meters were integrated into the DDC system, allowing the system to piggyback off the DDC's fiber optic communications system. This integration now allows real-time data generation without the need to install a second communications network. Sub-meters were placed on the secondary side of the buildings in the load centers, easing installation and resulting in much lower equipment costs compared to primary metering. At the same time, a tap was made from the utility company's primary meter to provide a master meter pulse into the monitoring system.

The sub-metering connected to SCSU's central energy management system is capable of recording eight electrical parameters on a daily basis (broken down into four time periods with 15 minute demand and Kwh for read-outs for each period). Peak demand times are also recorded.

The load profile data received from the original metering indicated that there were many opportunities to reduce energy consumption across the entire campus. The system has now been expanded to include all major buildings on the SCSU campus and is now integrated into the switchgear of all new building and renovations.

"Lites Out" Committee:

Based on initial data from the new system, University President Michael J. Adanti established a new executive level advisory group, the "Lites Out" Committee, to develop energy conservation programs, recommend cost-saving energy projects for implementation at the school, and support new projects. Designated participants in the University's "Lite's Out" Committee include:

Chairman: Executive Vice President

Associate Vice President of Capital Budgeting and Facilities Operations

Director of Engineering, Environmental, Health and Safety

Chairman of the Academic Computing Center

Director of Residence Life

Outside Consultants

Faculty and Staff Representatives

Sub-Meter Installation – The Practical Side

Sub-meters are installed on the secondary side of the switchgear in a building or facility. Besides having a lower cost, secondary sub-meters are much easier to install. Electricians can install them in about three hours while performing cleaning and maintenance of load centers or as a separate job. Additionally, the meters facilitate electricity monitoring without necessitating major interior changes in the building. Installation is simply a matter of hooking three current sensors around the electrical feeds and adding the three potential taps. The meter can be mounted anywhere. Average cost to purchase and install a sub-meter connected to the DDC system is approximately $3,000.

Performance and Benefits

The sub-metering of individual buildings helps to evaluate performance and to identify problems, it makes it easier to identify energy saving measures and to quantify benefits, and can be implemented at various scales and levels of process integration.

The sub-metering also provided information as to where older, obsolete equipment needed to be replaced. New high performance equipment was installed along with DDC controls to maximize energy savings. Rebates were applied for and received for these projects. In some cases, the rebate paid up to 87% of the up-charge from standard performance to high performance equipment. Some examples are listed below:

Project	Initial Operating Performance	New Operating Performance	% Reduction in Energy	Rebates	Pay Back Years
Replace 300 chillers in science building	0.80 Kwh/ton	0.51 Kwh/ton	36 %	Up-charge, $32,000, rebate received, $26,500	0.3
Replace 600 ton cooling tower	2 – 15 Hp single speed fans	2- 5Hp VFD drive fans	70%	UP-charge $12,000, Rebate $6,000	2
Install new 600 ton chiller complex	Initial design, 0.60 Kwh per ton, part load performance 0.59 Kwh per ton	0.51 Kwh per ton full load, 0.34 Kwh per ton part load performance with VFD drives on chiller	30%	Up-charge $98,000, Rebate $85,000, Calculated annual electrical saving, $22,500 (2002 Dollars)	0.6

* *Up-charge*: The difference in pricing between a “standard performance equipment” and a ”high performance equipment”.

Projects and Savings Identified by “Lites Out” Committee

“Pick the low hanging fruit first”, advises Patrick Norton, Director of Facilities Engineering, Environmental, Health and Safety at Southern Connecticut. “When an energy conservation program is first implemented, you will find many cost savings measures that are easy and relatively inexpensive to implement. The savings generated by this low hanging fruit can be the source of financing to pick the next round of measures. This is how SCSU implemented its program”.

The following is a listing of some of the projects identified by the “Lites Out” Committee. The total payback in years is based on an average.

Project	Annual Savings	Cost	Rebates	Net Cost	Payback, in Years
Install Occupancy Detectors in remaining areas	$261,000	$449,000	$250,000	$240,000	1.0
Behavior Change Programs	$38,000	$20,000	0	$20,000	0.5
Set Computer to Auto Shutoff	$446,000	$13000	0	$13,000	0.03
Consolidate classes during off peak and close one building	$24,000	0	0	0	0
Energy saving contest in residence halls	$61,000	$4,500	0	$4,500	0.1
Install Compact Fluorescents in remaining lamp fixtures	$108,000	$29,000	$14,000	$15,000	0.1
Complete T-8 retrofits	$138, 000	$237,000	$118,000	$119,000	0.9
Misc. Projects	$251,000	$384,500	$97,000	$249,000	
TOTALS	$1,289,000	$1,177,000	$479,000	$701,000	0.5

Executive Vice President, James E. Blake established a revolving fund for energy improvement projects to start the program implementation. As rebates were received and savings gained, additional funds then became available to fund the next round of projects.

Most of the projects described above have been completed, most by University staff. In addition, SCSU was able to engage students by holding energy conservation contests in the residence halls. The residence hall achieving the greatest reduction in energy was given a pizza party. One semester, when two dorm halls tied, SCSU gave a party to both.

For Further Information

Patrick R. Norton, Director of Facilities Engineering, Environmental, Health and Safety, 203-392-6053, Norton@southernct.edu
Association of Higher Education Facilities Officers (APPA) at http://www.appa.org

ENERGY STAR® - Sub-Metering Energy Use in Colleges and Universities: Incentives and Challenges http://www.energystar.gov/ia/business/higher_ed/Submeter_energy_use.pdf

Other Sub-metering Programs

The following list of schools presents a good starting point for someone interested in reviewing some effective sub-metering programs.

Duke University: Robert Friedman at 919-660-4257 or Bob.Friedman@duke.edu
Kent State Tom Dunn, Associate Director of Campus Environment and Operations at tdunn@kent.edu
University of Virginia: Tony Motto, Energy Program Manager at 434-982-5893 or awm3g@Virginia.edu