Smart Buildings for Intelligent Savings

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When Bob Bechtold started along the path toward smart building a couple of decades ago, the term had yet to gain widespread popularity. Exploring his passion for renewable energy during the 1980s, he installed his first wind turbine and geothermal heating system, at his home. Later, he began to think that he could make the same kind of positive impacts at work with sustainable energy. As President and owner of HARBEC Inc., a company that fabricates precision plastic components in Ontario, NY, he began exploring that option.

He also had a few immediate concerns he wanted to address at work. During summers he says temperatures could approach "sweatshop conditions in the plant, making it stiflingly uncomfortable for employees." On top of that, he says, there had been "some problems with inconsistent power quality that had damaged some equipment." He began looking for a way to increase the quality and reliability of the electricity supplying his facility, and a means of keeping his workers cool. Generating power, heating, and cooling onsite, would provide a sustainable solution to both issues.

Finding Financing in a Learning Curve

Seeking to finance the investment in sustainable energy to achieve better control over conditions and quality, Bechtold presented his creative ideas to his potential financiers. But whenever he mentioned the terms green or sustainable energy, he says the banks tended to shy away, thinking he was "some kind of burnt out hippie." He decided he might have better luck if he could make a business case.

Reframing his intentions "as an economic issue," he went back to the banks, and the banks agreed to finance combined heat and power (CHP) and a wind turbine. Unfortunately, he says, the CHP system came in somewhat over budget, and he had to postpone the wind turbine construction. However, he had a partner in Automated Logic's WebCTRL system that been helping keep track of the Return on Investment (ROI) for his new investments in power generating capacity.

Within two years, he was able to document that the project made economic sense, and the bank released financing to continue the project by installing the wind turbine as initially planned.

Bechtold says Logical Control Solutions, local implementers for Automated Logic, played an important role. "They have a good handle on the product and how to make it work for your needs; they come in and figure out what gauges to put in, where to put them, how to implement them on the monitoring system, and how to demonstrate it on the graphics."

He says the company also brings a personal touch to servicing their software, for instance, "When we put our first wind turbine up, they didn't have an icon for a wind turbine. They had to build the graphic for a spinning wind turbine,

but they didn't just put a picture there—they made the turbine spin [when wind levels cause it to be operational]. So if you look at our website, it will show all of the details of everything through to the level of spinning wind turbines and all of what is happening at any moment in time."

In 2012, HARBEC management set a goal of achieving ISO (International Organization for Standardization) 50001 SEP (Superior Energy Performance) certification in order to achieve carbon neutrality the following year. That decision would mandate the collection of precise resource consumption and energy usage data—a task that would require the expanded use of its Automated Logic WebCTRL system.

The task presented a new challenge for HARBEC's WebCTRL system, "not from an automation standpoint, but from a monitoring and measuring standpoint," comments Jeff Eisenhauer, manager, energy systems, HARBEC. The project began with the company's acquisition of metering devices sourced through Logical Control Solutions Inc., which had installed the WebCTRL system in 2001. In 2012, Logical Control Solutions installed sub-metering systems on all electrical generation and major energy-consuming equipment, including the Capstone microturbines within its CHP plant, the Carrier air handling units and absorption chillers, and the two onsite wind turbines. Reporting capabilities were then integrated into the WebCTRL system.

In the year following the 2012 WebCTRL system upgrades, benefits proved to be dramatic. By increasing its operational efficiencies, primarily within the cogeneration plant, HARBEC was able to increase the overall efficiency of its HVAC systems, reduce natural gas consumption by 20%, reduce overall greenhouse gas emissions by 40% (calculated at 375 tons of carbon dioxide) and cut utility costs by 14%. By exceeding 15% energy savings over the entire reporting period (2009–13), HARBEC was designated a SEP Platinum Certified Partner.

The WebCTRL system now documents the plant's use of compressed air, natural gas, hot and chilled water as well as tracks all city water consumption at points throughout the facility. HARBEC is using the system's EnergyReports application, with its extensive trending capabilities, to track energy usage at the equipment level, allowing plant staff to monitor performance and meet benchmarked goals. Reflecting its commitment to accountable and sustainable operations, the company provides real-time public access to its energy usage data through its website [1]. With reporting options available in 3D bar, line, pie chart, and tabular formats, data is easily viewable according to Bechtold.

"We want to spread the word that it really works, and there is great opportunity to improve, both for the bottom line of the business and the good of the planet," he says.

A Building Teaches the Facts of Life

It can be a challenge to figure out where energy savings can be gleaned in a complex office building, but Hector Hernandez believes one of the best ways to find out is to ask the building itself. He says smart buildings are not just buildings that can turn switches on and off automatically, where everything just runs itself. For Hernandez, the definition of smart buildings are those that can answer important questions when asked.

Querying his customer's buildings Hernandez tries to "identify when a building is not working at an optimal level and where potentials for savings can be found. Then we create a strategy to bring the energy consumption down to realize those savings."

He says his company created a modeling software that, for example, models how a pump works and contrasts that with how it should work. "We model how their air-handler works, and how it should work, we model how the flow works, and how it should work."

With the help of software from CopperTree, Hernandez's firm, South Florida Analytics, deploys simulation software to model the buildings entire operations and systems. "We can trend it and determine actual operations cost," then compare the actual cost figures to those derived from simulations of the building based on equipment functioning at an optimized level. Comparing the optimized simulations to reality provides the customer with a clear understanding of how energy efficiency can result in savings.

"Once an owner has the projected values, he or she can decide how much they want to spend to reach a predetermined ROI," says Hernandez.

Before undertaking a retrofit and commissioning of the offices in the tallest tower complex in the southeast US, Hernandez, sought to prove to his client and building owner, Miami-based Millennium Partners, that the project would not only pay for itself through future energy cost savings, but that it would also generate a healthy ROI. According to Hernandez, energy savings can amount to a huge and valuable asset when figured into a major facility's bottom line. He says his company specializes in energy efficiency projects specifically designed to realize those values within a quick turnaround of a "one- to three-year payback."

Hernandez turned to CopperTree Analytics to study the building and identify which equipment, systems, and structures could have the most energy-saving impact to facilitate that anticipated payback.

South Florida Controls used CopperTree's CopperCube to extract current and historical trendlogs from the building automation system. To investigate the building and establish a baseline, trendlogs were then processed by CopperTree's Kaizen, a powerful analytics engine and logic builder. Using the Energy view product and demand charts then allowed them to view energy trends in the building, and CopperTree's customizable reports made it possible to pinpoint which equipment and systems could deliver the most impact. It also allowed them to build a model predicting return on investment of the renovation through the energy cost savings to be realized.

"Anybody has the capacity to turn equipment on or off," he continues. "Anybody can deliver 72-degree air, but very few companies can deliver savings, and even fewer can predict savings with confidence." And, he said that ability, fueled by the suite of analytical tools that CopperTree offers, has helped establish a solid market position for his firm.

Since deploying South Florida Control's retrofit of the office tower in Miami in mid-January 2015, the building owners and operators have seen a reduction in their electrical energy consumption of 64% per month.

CopperTree reports, the building now saves an average of $4,997 per month in electricity and is on track to save $59,970 this year. Furthermore, the savings predicted by the CopperTree solution were within 1% of the actual savings realized, which means the pilot model put together by South Florida Controls is reliable. With the verified model, South Florida Controls and Millennium Partners now have a proven tool they can use to project the ROI on future renovations in this and other buildings.

Hernandez believes truly optimizing savings requires something a lot more sophisticated than an educated guess. He has had conversations with building owners and managers who believe that they completely understand their facilities, and after a little probing he says he usually finds out, "They have no way of knowing" some of the most basic facts about how their building and its systems are being utilized.

"I don't blame them," he says. "For a long time, there just weren't any tools available that could track and monitor energy at the level of sophistication required for making informed decisions on how to fine tune operations for efficiency." But, "When I show them the pie charts [that CopperTree generates], their eyes light up."

Hernandez believes, "A true intelligent building is one that can give you the information you need to make the right decisions."

Being smart on the inside should not rule out also being smart on the outside, and that's something school kids sometimes learn at recess.

No Recess for Lighting Control

In school, we had an energy efficiency rule that we followed almost without question: the last one out at recess turns off the lights. Rules usually weren't fun, but we understood this would save energy, and recess was fun, so we obeyed. But sometimes we'd see really big lights on the playground at full blast right in the middle of afternoon recess…that raised questions.

Fortunately, kids are not the only people who notice strange things like this. Chris Mueller, Electrical Supervisor for Charlottesville Mecklenburg public school district says his school system considers lighting malfunctions that keep exterior lights on in the daytime an urgent priority.

"We never want outside lights burning in daytime," he says. But it's essential that they are on after dark, when exterior lighting performs an important role for both personal and facility security. Making sure the lights followed these simple rules consistently however, could prove a challenge.

"We used to use electromechanical automatic switches to turn the lights on and off as scheduled, but sometimes they'd lose their time, especially after a power outage," says Mueller. In a school district as large as Charlotte Mecklenburg, he says it would not be unusual to experience power outages affecting lighting sequences as frequently as once or twice a week.

With 170 schools under his supervision, he says callbacks for lighting were a drain not only on energy, but also were a near constant drain on maintenance personnel who would often need to respond—in person—to widely dispersed lighting malfunction calls, to repair, update, and reset the timers. He needed a smarter solution.

Intermatic's lighting controls offered an ideal solution with the ET 90215C controller. Mueller says the units are easy to program and feature both adjustable timing and astronomical programming that automatically adjusts to accommodate the annual shifts between Eastern Standard Time and Daylight Savings. But most important, they feature a built in capacitor that allows ET90215C to continue to keep time for up to 100 hours during power outages, maintaining proper scheduling once power has been restored.

In addition, ET90215C comes with the flexibility to override its built in astronomical sensor functions to switch individual lights off perhaps 15 or 30 minutes before sunrise, or to switch them on 30 minutes before dusk, assuring consistent illumination of public spaces on school grounds such as parking areas. According to Mueller, students, teachers, and staff have an increased feeling of safety and security now that the lighting remains constant throughout school campus areas.

Mueller says the District purchased 130 units, prioritizing replacements during service, maintenance, and repair calls. His crews have completed installation of about 50 of the devices.

He also reports that maintenance calls for timing devices have dropped almost to zero. If maintenance hours are figured at $40 an hour, eliminating most of those calls has already resulted in savings of $4,000. That's a significant savings and frees maintenance to take on other tasks.

College campuses essentially deal with the same issues of consuming power when, and where it's not needed, albeit while confronting wider challenges.

A Degree in Higher Education

One of the attractions of campus life for students suddenly free of their family environments is that no one tells you where to go or what to do, whether to turn the lights on or off, or how high to run the air conditioner. However, New York University (NYU), one of the largest private universities in the US, set an ambitious goal under mayor of New York City Michael Bloomberg's 2007 PlaNYC Climate Challenge, calling for a 30% reduction in greenhouse gas emissions per square foot by 2017. The university, that same year, signed on to the American College and University Presidents' Climate Commitment that set a long-term goal for institutions of higher education to achieve climate neutrality by 2040 through energy conservation and efficiency measures. Meeting these goals would probably require new guidelines.

Imposing a long list of rules on college students is usually not recommended, particularly regarding how they use energy. Students split their time between dorm room, classroom, campus activities, social events, and adventures, often without regard to time of day or any discernible or predictable schedule. That makes it difficult to gauge when any individual dorm room will be occupied or what measure of temperature control might be demanded at any moment. Both the reputation of the institution and the learning experience for the students depends to some degree on being able to provide young scholars with comfortable accommodations whenever they desire, while the future of the institution rests, in part, on managing the costs of doing so.

Colleges and universities spend $14 billion on energy every year. According to the energy management systems provider Telkonet, studies show HVAC and lighting costs represent two of the largest uncontrolled operating expenses in the education market. However, according to estimates by Telkonet, "a typical dorm room is vacant roughly 70% of an average day, suggesting that a considerable percentage of energy used to heat and cool is wasted on empty rooms."

NYU had been devoting 96.5% of its energy consumption profile towards heating, cooling, and powering buildings, and saw a real opportunity for efficiency gains by not operating air conditioning at full bore when no one was at home.

But they faced a challenge. The residence halls at NYU include a diverse portfolio of newer high-rise dormitories as well as converted apartment complexes and former hotels. Several different systems heat and cool each building, including packaged terminal air conditioners (PTACs,) fan coil systems, and water source heat pumps. With no centralized means of control, building managers at NYU's residence halls had to rely on student complaints for alerts about down equipment, and achieved energy savings only by shutting the system off for the entire building based on outside temperature.

NYU was faced with rising energy costs concurrent with its commitment to become a model for campus energy efficiency. It required an energy management system that would minimize energy usage, upgrade the dormitory experience for students, and provide ease-of-use for the maintenance department.

Retrofitting the heating and cooling equipment for energy efficiency demanded an adaptable solution.

Telkonet offered a technology that could strike a balance between energy efficiency and student comfort by intelligently controlling the temperature and plug loads in unoccupied rooms, with its EcoSmart energy management system. Over a period of four years, NYU installed Telkonet's energy management technology in 11 residence halls, encompassing 4,629 rooms. The system allows a residence hall to decrease equipment runtime and energy usage without a negative impact on occupant comfort.

With the installation of a networked energy management system, facility managers gain access to Telkonet's EcoCentral Virtual Engineer, which gives them the ability to view energy usage, remotely determine a room's occupancy status, and change temperature settings with the click of a mouse.

The company's EcoSmart technology deployed in each room generates considerable amounts of data about the status and performance of each controlled space. This data Telkonet says, is channeled to and displayed through EcoCentral Virtual Engineer.

Intelligent thermostats, occupancy sensors, door and window contacts, switches and outlets form a network that communicates information between rooms, floors, and buildings. Each device functions as a wireless repeater; the thermostats communicate with each other and aggregate data to a single EcoCommander server, the core of an EcoSmart network. In addition to providing facility managers with the capability to change HVAC settings room by room with the touch of a button on the virtual thermostat, System Status and System Alerts enable facility managers to do proactive monitoring in order to determine when repair or replacement of necessary components, such as batteries for wireless devices, might be required. This wireless "mesh" creates a robust, reliable, and self-healing network accessible from EcoCentral Virtual Engineer.

Further, the EcoCentral Virtual Engineer assists facility staff in identifying HVAC units that may be malfunctioning; often the problem can be fixed without having to physically send a staff member to a room, ensuring continuity of comfort and a positive experience for the occupant.

Dianne Anderson, Sustainable Resources Manager at NYU, appreciated the flexibility of Telkonet's technology. "The adaptability of both EcoSmart and SmartEnergy proved invaluable when it came to retrofitting multiple buildings with significantly different heating and cooling systems," says Anderson. "The technology itself is sophisticated, but Telkonet has made its operation incredibly simple and user-friendly."

"Now we have an intelligent system in place that maintains student's preferred temperature when they're in the room, yet within our own specified range," she says. "The centralized monitoring software helps maintenance staff react to problems, often before students know there's an issue."

In addition, with its Automated Demand-Response Capability, Virtual Engineer can design and preload profiles to pre-define how thermostats, outlets, and lights will respond to a demand-response request. Managers can schedule "events" in EcoCentral Virtual Engineer, and devices will switch to demand-response profiles at the appropriate time. Specifying the number of units to run concurrently, EcoCentral's Virtual Engineer will keep load at a constant level. Alternatively, management can specify the necessary kilowatt-hour reduction and let EcoCentral determine how to best set back thermostats.

"Not only are we committed to ambitious goals in reducing greenhouse gas emissions, but the campus is on track to be 40% larger by 2031, so we need to do everything we can to save every penny. Reducing energy costs with SmartEnergy, and later, EcoSmart, Telkonet's next-generation energy management technology, provided NYU with an option we could implement immediately," says Anderson.

NYU experiences an annual savings of 2,737,304 kWh and 5,066.2 Mlb. As a direct result of the EcoSmart and SmartEnergy installations, NYU saves $727,455 annually. Annual savings achieved by individual residence halls can be represented as part of the campuswide savings aggregate.

Buildings have been talking for a long time, but in the past they could only express, at most, the simple, yet extremely important, ideas such as "Help, I'm on fire," or "hurry, someone call the police." With buildings now able to convey ever more complex information, owners are finding that keeping the lines of communication open and secure is essential to the success of many of their infrastructure investments.

While today's smart building technology can keep tabs on the range of services from lighting, to plug in equipment, to ventilation, new ways of transforming day-to-day building operations into financial payback may soon become as commonplace as the alarm systems buildings have long used to tell us of their troubles. Pretty soon, in business it might be considered a compliment when someone says, "It feels like I'm talking to a brick wall!" BE

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