BEST PRACTICES 2012

San Diego State University Wireless HVAC Controls Retrofit

An intelligent wireless control system allows an existing constant air volume system to perform much like a variable air volume system, resulting in substantial and immediate energy reductions. Incentives increased the cost-effectiveness of the retrofit, which reduced annual energy use by 30 percent.

Award Category
HVAC Design/Retrofit

Green Features
Sufficient outside air exchanges ensured

Wireless sensor network with advanced software controls

Variable frequency drives

Fan speeds modulate down to 25 percent of full capacity

Secondary energy savings from conditioning less air

Size
76,000 ft^2

Annual Energy and Cost Savings
Electricity:
268,000 kWh (18%)

Natural gas:
9,300 therms (55%)

Total energy: 30%

$38,000

Cost
$103,500
(before incentives)

Completion Date
June 2011

The Aztec Recreation Center (ARC) is one of the most utilized buildings on the San Diego State University campus, serving 775,000 students and visitors who exercise and train there year-round. Open 24 hours most days, the building's systems work hard to condition a wide variety of fitness and office spaces. However, until last year these systems were working much harder than necessary. Built in 1997, the 76,000-square-foot facility was equipped with four constant air volume (CAV) air handlers, designed to provide the same amount of conditioned air required to meet comfort and ventilation requirements on the hottest and busiest days, even during low load conditions.

Because of the excessive fan and cooling energy used by the building, the ARC was selected for near-term energy improvements by the SDSU Associated Students' Sustainability Advisory Board. The association manages five campus buildings, and in 2011 the association's advisory board adopted ambitious long-term sustainability goals that included a commitment to reach zero net energy for the operation of their buildings by 2020.

A cost-effective control system retrofit at the ARC set the association well on its way toward these goals. The system from Vigilent includes 23 sensors, a wireless mesh network, control software and a dedicated server. The project team also added variable-frequency drives (VFDs) to all air handlers. The HVAC system is now able to serve partial-load conditions efficiently, approximating the performance of a variable air volume (VAV) system, at a significantly lower installed cost. With numerous sensors monitoring indoor conditions, the new control system interfaces with with the building energy management system and adjusts supply air volumes based on zone conditions using a sophisticated algorithm.

The student group's sustainability advisor had learned about this control strategy at a UC/CSU conference in 2010. Seeing a major opportunity to implement the technology at ARC, he met with the facilities team and created a project plan, bolstered by incentives from San Diego Gas & Electric's UC/CSU/CCC Partnership Program and funds from the American Recovery and Reinvestment Act.

The intensively used Aztec Rec Center provides a variety of spaces for personal and group exercise. Image: Energy Solutions.

Previously running constantly at full speed, supply fans now modulate to the minimum required for ventilation, down to 25 percent of full capacity.

Lower fan speeds are common during most of the morning hours and at night, and ramp up steadily throughout the day with increasing outdoor temperatures and internal loads. Because of the building's size and wide variability in occupancy patterns throughout the day, this greater level of control produced immediate and dramatic energy savings — 18 percent less electricity and 55 percent less natural gas compared to the previous year, amounting to $38,000 in energy cost savings annually. Even on the hottest days of the year

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Project Team

Campus: Associated Students Association, Campus Sustainability, Facilities

Control Software and Sensor Network: Vigilent

Variable Frequency Drives: Drive Solutions

Utility Partner: San Diego Gas & Electric

Energy Technology Assistance Program (ETAP) Implementer: Energy Solutions

More Information

http://energy-solution.com/etap/wp-content/uploads/2012/04/ETAP_SanDiegoState-WirelessHVAC_CaseStudy.pdf

in July 2011, energy use was measured at 30 percent below that for July of the previous year.

The VFDs and the wireless sensors are essential to achieving high energy savings at such a low cost. A key benefit, however, is the intelligence of the system, which is able to process and respond automatically to a large number of sensors. Glen Brandenburg, the student group's sustainability advisor, drew an analogy to more advanced vehicle climate controls, "In a newer car, you don't keep adjusting the fan from high to low, cool or warm, you just set the temperature to 72 and the system figures the rest out."

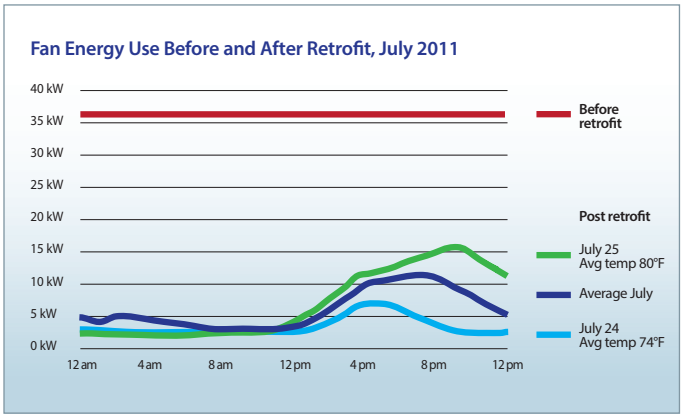

Chart showing energy savings from reduced fan power before and after controls retrofit. Data source: Energy Solutions.

Wireless sensor networks provide the ability to retrofit control systems without the need for costly wiring.

While the primary energy savings come from reduced fan operation, the team discovered additional savings from reductions in the energy required to heat and cool the great volumes of air that had coursed through the building. Overall, the energy savings exceeded projections for the project by 55 percent, and state and federal rebates were enough to cover the full project cost. Without the incentives, simple payback would have been just under two years.

In addition to these favorable economics, the ability to control air delivery in a way that matches the actual needs of the spaces minute-by-minute also gives the facilities personnel insight into indoor environmental conditions. It will give building managers real-time and historical trend data if they choose to use it. Quieter and more efficient operation likely means more effective staff service and lower maintenance costs. Moreover, the project implementation was non-intrusive and has had no negative impacts on comfort. It avoided the long procedures, costs, disruptions and other potential problems, such as asbestos removal, that can come with upgrading to a VAV system, which would have likely achieved similar performance results.

LESSONS LEARNED

This project demonstrates how well informed staff can lead to seizing major efficiency opportunities. The ease with which the project was implemented was also an exercise in good teamwork between the associated students and facilities managers, who both saw the "win-win" opportunity for the SDSU students and the university.

The fact that the ARC is large and occupied for the most part by transient, non-sedentary people offered a particularly good application for the Vigilent system. However, the system can be installed easily in buildings of any size and vintage, and will work with any common cooling equipment.

Based on the successes of the Aztec Rec Center retrofit, the students' association has moved on to implement the Vigilent system at SDSU's 12,000-seat Viejas Arena.

Best Practices case studies are coordinated by the Green Building Research Center, at the University of California, Berkeley.

The Best Practices Competition showcases successful projects on UC and CSU campuses to assist campuses in achieving energy efficiency and sustainability goals. Funding for *Best Practices* is provided by the UC/CSU/IOU Energy Efficiency Partnership.