BEST PRACTICES 2012

UC San Diego HVAC Controls Retrofit at Geisel Library

Instead of replacing the constant air volume air delivery equipment in this heavily used library, a digital controls retrofit and new variable frequency drives allow significant fan speed reductions and better control, resulting in lower retrofit costs and immediate energy savings of 23 percent.

Award Category
HVAC Design/Retrofit

Green Features
Variable frequency drives (VFDs) installed on 32 fans

New motors installed where needed

Advanced software controls

Sufficient outside air exchanges ensured

Primary savings from fans operating at 70% of maximum speed

Secondary energy savings from heating and cooling less air

Size
422,000 ft^2

Annual Energy and Cost Savings
Electricity:
1,580 MWh

Natural gas:
103,300 therms

$280,000

Cost
$1.1 million

Completion Date
February 2012

Since the Geisel Library opened in 1970, its 22 air handlers have been running full speed, 24 hours a day and 365 days a year. Such excessive fan use in this large building made Geisel an obvious candidate for helping UC San Diego meets its campus-wide commitment to save 12 million kWh in 2012 alone.

The iconic library is one of the most heavily used buildings on campus, serving 1.4 million students and visitors annually. Its inverted pyramid tower, designed by William Pereira, hides a vast area of subterranean stacks and reading rooms that were added during a 1994 renovation. In recent years, the building became the site for a consolidation of library resources after budget cuts forced several other facilities on campus to close.

The iconic Geisel Library is now the destination for almost all library resources on campus. Image: UC San Diego.

Ordinarily, Geisel's HVAC system would be a clear candidate for an upgrade to a modern variable air volume (VAV) system. However, due to the high demands placed on the building, service interruptions from a major construction project would have been challenging to manage. Instead, the campus turned to a new HVAC control solution by Vigilent, which allows the air handlers to behave more or less like a VAV system, but with few interruptions to users and substantially lower cost. The project is on track to achieve approximately 60 percent of the savings it would have achieved with a full VAV retrofit, but at 30 percent of the cost.

The addition of VFDs and new controls put Geisel on par with the national average for energy usage in libraries, reducing energy intensity from 134 to about 100 kBtu/ft^2.

As with a VAV retrofit, the key to large energy savings is the installation of variable frequency drives (VFDs) on all supply and return fan motors. At Geisel, motors also had to be replaced on many of the fans, which were incompatible with the new VFDs.

Many older building management systems (BMS) are not compatible with BACnet, the open-source communication protocol developed by ASHRAE, that allows different programs to speak a common language. This was the case at Geisel Library, so the project team upgraded the BMS so that it could communicate with the new system.

Because the Vigilent system is designed to work in buildings without digital controls, it is commonly installed with a network of wireless sensors. Fortunately, the retrofit team was able to take advantage of the existing digital sensors that had been installed with an earlier BMS upgrade during the 1994 expansion. Campus energy managers will now be able to easily install additional sensors if they need greater control granularity in the future.

When the new control system went live, the library's energy use immediately dropped by 23 percent. This included savings not only in fan use, but also from a 14 percent reduction in chilled water, and a 23 percent reduction in hot water use. This is because the reduction in air volume translates to less simultaneous heating and cooling with the dual-duct system.

2012

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Project Team

Control Software: Vigilent

Electrical Contractor: Baker Electric

Controls Contractor: Johnson Controls

Commissioning Agent: EnerNOC

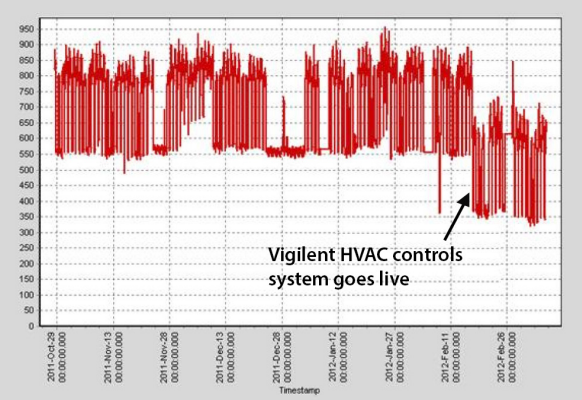
Energy Technology Assistance Program (ETAP) Implementer: Energy Solutions

More Information

http://www.universityofcalifornia.edu/news/article/28033

http://libraries.ucsd.edu/about/geisel-building.html

In all, the project is saving the university nearly $280,000 annually including total savings from electricity and natural gas. Altogether, the Geisel retrofit alone is likely to save 1.6 million kWh, or 13 percent of the university's 2012 energy saving goal.



With the new system, savings from fan energy reductions were immediately apparent. Image: UC San Diego.

The new control system also offers improved load management. At Geisel, the system is programmed so that zones go into "unoccupied mode" during demand response events, reducing demand for the entire campus by a projected 130 kW. This mode of operation widens the temperature setpoint range from 70°F for heating and 74°F for cooling, to 66°F and 78°F respectively, while also lowering fan speeds further.

To leverage the investment in the Vigilent system, energy managers spent time ensuring robust communications between the new controls technology and existing digital IT infrastructure.

In Geisel, the minimum fan speed is set to 70 percent, and the energy managers continue to work with the building staff to reduce fan speeds further. A challenge with temperature controls in library spaces is the importance of keeping humidity levels low to protect the book collection from mold, something that was an initial concern of the librarians. To address this, humidity sensors were installed throughout the building to provide detailed monitoring and control of moisture levels. High humidity has not been an issue since the system was installed.

LESSONS LEARNED

As a controls retrofit, it was not necessary to put together a large design and engineering team. Still, facilities management and library staff worked closely with consultants and contractors to ensure a smooth delivery process. Because there were already plans in place to commission the building, the campus hired a monitoring-based commissioning (MBCx) agent to work with facilities staff through every stage of the process, from construction through commissioning the system.

Given the vintage of the existing BMS, the team needed to verify that control communications were sufficiently robust to accommodate the additional software and functionality. For example, IT firewalls can become problematic if a Vigilent server is used for multiple buildings. Similarly, the age of the existing motors required quite a few equipment replacements, which had to be coordinated with the library facility staff to minimize interruptions during operating hours.

The achievement of substantial energy and cost savings with few disruptions to operations is a useful and replicable strategy to consider for any CAV, non-lab building on any campus (labs require faster response than this system provides). Considering current budget challenges, such streamlined digital control upgrades make sense for California campus buildings.

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.