



Award Category

HVAC Retrofit

Green Features

Change from constant to variable air volume

Pneumatic system converted to digital control

Recalibration of required airflow for rooms and fume hoods

Occupancy sensor control for spaces and fume hoods

Load shedding enabled

Student-led occupant awareness campaign

Lowered greenhouse gas impact with fume hood recertification using nitrous oxide

Annual Energy and Cost Savings

3,853 MWh

372,821 therms

\$801,640

Size

185,000 ft²

Cost

\$9.03 million

Completion Date

May 2012

UC San Diego Pacific Hall Laboratory HVAC Retrofit

UC San Diego's chemistry and biology lab building was identified as one of the most energy intensive buildings on campus. With 230 continuously running chemical fume hoods and a peak electrical load of one megawatt, the building's HVAC system was an obvious candidate for an efficiency upgrade.

Built in 1993, six-story Pacific Hall houses offices and many laboratories, most with fume hoods. Prior to a 2012 HVAC retrofit, the entire building operated with constant air volume and was ventilated to achieve a minimum of ten air changes per hour (ACH) even when unoccupied. UCSD's Department of Environmental Health and Safety (EH&S) approved lower laboratory ventilation requirements of six ACH for occupied spaces, and four ACH for unoccupied spaces, providing the project team with the means to achieve significant energy savings.

To enable variable air volume (VAV) operation, supply and exhaust fan motors were updated with variable frequency drives (VFDs). In addition air control valves, specifically designed for laboratory and healthcare settings, were installed at each supply air terminal unit and exhaust in the building.



An HVAC retrofit at Pacific Hall yielded substantial energy savings. Photo: Rhett S. Miller, UC Regents.

The researchers at Pacific Hall frequently carry out experiments following irregular schedules, so the retrofit team could not use a typical workday schedule to predict occupied and non-occupied periods. They elected instead to install occupancy sensors to control both HVAC and lighting throughout the building. In each space, two to four room-level occupancy sensors that combine infrared and

ultrasonic technology detect general area occupancy. (Although ultrasonic sensors may pose problems with some lab animals, this was not a problem at Pacific Hall.) When all sensors in a space indicate that the area has been unoccupied for more than 20 minutes, the ventilation is reduced from six to four ACH, non-emergency lights turn off, and the HVAC temperature setpoints widen by four to eight degrees F. In unoccupied offices, airflow is reduced to zero. For laboratory rooms that may contain high risk chemicals, emergency override buttons were installed to trigger the HVAC system to the maximum airflow rate of ten ACH to ensure safety. Similarly, the building control system also incorporates load-shed programming while maintaining minimum safety requirements.

During a demand response event, the system will widen temperature setpoints and lower airflow in non-crucial areas, reducing campus demand by at least 100 kW.

Per EH&S's requirements, fume hood faces are required to have a minimum air velocity of 100 feet per minute (FPM) while in use. Prior to the retrofit, this was constant regardless of activity or occupancy. The project incorporated occupancy sensors that detect if a researcher is standing directly in front of each fume hood. If a fume hood is unoccupied the ventilation velocity now drops to 60 FPM.

Additionally, sash position sensors were installed to detect the position of the enclosure that separates the fume hood zone from the room. These sensors are linked to valves from Phoenix Controls that compensate for the varied sash openings to meet the required air flow velocity at each fume hood face. Prior to installation of these sensors, each fume hood had a ventilation bypass which allowed the full airflow volume to exit the fume hood exhaust. With the new sensors installed that bypass is closed, and the control valves immediately

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PowerSave Green Campus

More Information

<http://aps-web.ucsd.edu/FM/News/OurSpaceSpring2013.html>

<http://ucsdnews.ucsd.edu/video/2011fumehood.html>

<http://powersavecampus.ucsd.edu/projects.html>

react to the position of the sash, drawing only the minimum volume of air through the sash to maintain the required air velocity of 100 FPM when occupied.

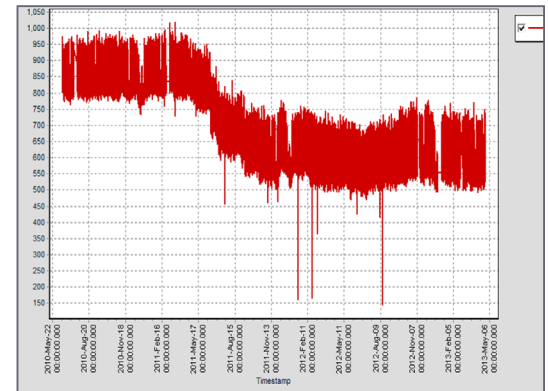
The sash position sensors are tracked on the central control system, allowing building managers to identify where occupants are leaving hoods open unnecessarily. Additionally, the campus's Powersave Green Campus program engaged student interns to develop an educational campaign to encourage the closing of sashes when not in use.

The retrofit required coordination with 44 researchers and their staff, and protection of sensitive equipment and organisms.

Harley Crace, one of the project managers of the Pacific Hall retrofit project, emphasized the challenge of coordinating a retrofit while researchers were doing experiments. "The most difficult part of doing a construction project inside an active lab setting was coordinating research schedules with the construction timeline," he said. The researchers were required to be displaced for a week in order for the contractors to install the new valves and sensors effectively. "Since the work we were doing was virtually invisible to the researchers, it was hard to get buy-in at first. For the most part, the occupants were amenable to the work going on and accommodated our time lines." On any given floor, the research schedules in different labs were staggered, and the construction team moved swiftly to retrofit one lab while keeping neighboring areas undisturbed, retrofitting the remainder of the spaces when research schedules allowed. The project team found this coordination to be crucial and it ultimately produced successful results.

Recertification of fume hoods is required anytime a fume hood is significantly modified, and managing this process was another key task. To help minimize the related green-

house gas emissions, the EH&S team worked with California Occupational Safety and Health Administration (Cal-OSHA) to modify a policy regarding recertification. In place of sulfur hexafluoride, a potent greenhouse gas typically used in such tests, campus received approval to use less harmful nitrous oxide. This alternative reduced the greenhouse gas impact of this step of the project by a factor of 100.



After the retrofit the building achieved over 30 percent energy savings. Image: Anna Levitt, UCSD.

LESSONS LEARNED

As UCSD had recently completed another lab HVAC retrofit on campus, Pacific Hall's smooth implementation was the result of learning from mistakes and reinstating best practices. The consensus was that planning well in advance with researchers was critical to a smooth execution, and technical issues were secondary to this coordination. Anna Levitt, Assistant Campus Energy Manager with UCSD Facilities Management, says, "We knew from the beginning that we had a great opportunity to achieve energy savings with this project. The real challenge was coordinating with all the different principal investigators who had different schedules and sensitive equipment." Maintaining good personal relationships and clear communication with occupants during the installation and commissioning process has paid off for the retrofit's execution.

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

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