UC Berkeley's University Hall wireless HVAC retrofit brings the campus one step closer to its climate neutrality goal

CASE STUDY SNAPSHOT

UC Berkeley's University Hall reduced annual energy costs 7% with a wireless HVAC retrofit using the Vigilent® Intelligent Energy Management System.

Building type: 7 story building with a mixture of office, administrative, and classroom space

Size: 152,000 square feet

Project area: 127,000 square feet

Annual energy savings: 93,100 kWh & 8,450 therms

Peak load reduction: 40.4 kW

Project cost: $176,000

Simple payback: 6 years

Benefits:

- Annual utility bill savings $21,500
- Greenhouse gas emission reduction of 73 metric tons of CO_2e annually
- Supply and exhaust fan speeds automatically controlled to meet space needs and minimize energy use
- Energy Management Dashboard shows real-time fan speed, zone temperature, and energy usage

Achieving climate neutrality is an ambitious goal, but the University of California, Berkeley is accustomed to setting high standards. The ventilation system retrofit at University Hall is one example of the many steps the campus is taking toward reducing its climate impacts. Through a campus-wide, monitoring-based commissioning effort, engineers discovered that portions of University Hall were frequently over ventilated, wasting both electricity and natural gas. To address these inefficiencies, the engineers recommended a Vigilent® Intelligent Energy Management System retrofit to increase the ventilation system's operating efficiency.

The Vigilent System saves energy by retrofitting a constant air volume (CAV) ventilation system to approximate a variable air volume (VAV) system using variable frequency drives and a wireless communication system to reduce fan speeds to match demand. Traditional VAV conversions are very costly and highly disruptive to a space, usually requiring full removal of all related ductwork. The Vigilent System does not require ductwork changes and retrofits are typically much less costly than a standard VAV retrofit.

Facility Profile: University Hall

Built in 1959, University Hall is a seven story building that houses UC Berkeley's School of Public Health, a small public health library and various campus administrative support services. Six air handling units serve the building's ventilation and heating needs. The building has no mechanical cooling and heating is provided by a hot water loop and heat exchanger fed by campus steam.

Vigilent Intelligent Energy Management System

The Vigilent System works by taking temperature readings throughout the controlled zones using wireless sensors and automatically modifying fan speeds via

energy upgrade™ CALIFORNIA
Energy Technology Assistance Program

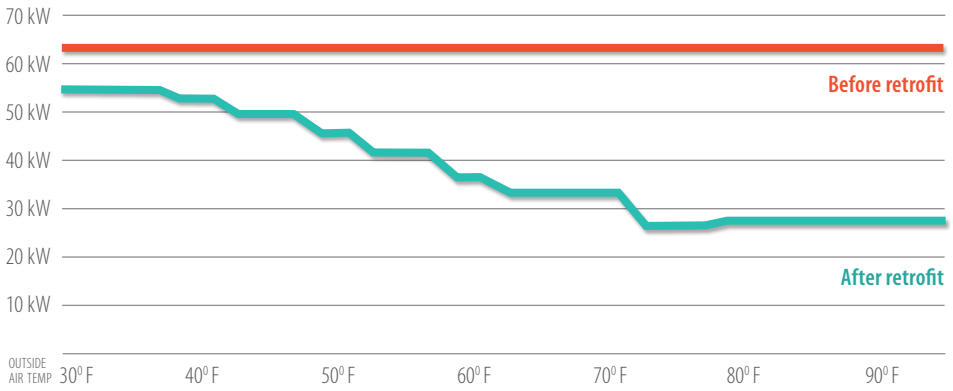
variable frequency drives (VFDs) to achieve desired space temperatures and ventilation rates. This approach is less costly than a full conversion to VAV and has been effective in other similar buildings on the UC Berkeley campus.

In University Hall, the Vigilent System was installed to control two air handling units (AHU-2 and AHU-6). AHU-2 is a dual-duct system with one supply (20 hp and 60,800 CFM) and one exhaust fan, both of which were outfitted with VFDs. The supply fan motor was also replaced. AHU-6 is a single duct system with reheat coils, three supply fans (50 hp and 129,800 CFM) and two exhaust fans. All five fans serving AHU-6 were outfitted with VFDs and new motors.

The project included the installation of 120 wireless thermal sensors placed throughout the two controlled zones and two wireless mesh gateways. The gateways collect signals from the sensors and transmit them to the Vigilent Artificial Intelligence Engine, a small server housed in a nearby building with other IT equipment. The Artificial Intelligence Engine receives temperature readings from the sensors and communicates through the building's existing Barrington Energy Management System to direct the VFDs to adjust fan speeds to match demand throughout the zones.

Vigilent's online Energy Management Dashboard controls the Vigilent System. This dashboard shows real time facility data and allows the system to be operated remotely. Bell Products performed the installation, programming and wiring of the VFDs and motors, and Vigilent installed the wireless sensors, gateway, and Artificial Intelligence Engine server. Vigilent also provided UC Berkeley facility operations staff with system operation training.

Average Electricity Demand Comparison University Hall HVAC Fans



▲ The Vigilent Intelligent Energy Management System wireless HVAC retrofits at University Hall are contributing significant electricity demand savings. Compared to the previous constant air volume (CAV) system, which consumed an average of 63 kW when operating, the retrofit allows the system to reduce fan speeds and thus electricity consumption to match need throughout the building. These savings peak when the outside air temperature is 72-76° F.

Energy Savings from Reduced Fan Speeds & New Motors

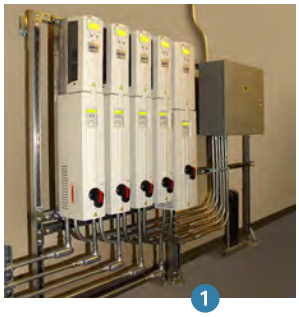
Prior to this retrofit, the constant volume ventilation system at University Hall was sized and commissioned to deliver sufficient cooling through ventilation for hot summer days. As a result, for most days of the year, air handlers AHU-2 and AHU-6 delivered far more ventilation than was necessary. As part of the project, minimum ventilation needs were determined based on square footage, use, and occupancy utilizing ASHRAE guidelines. The Vigilent System has been programmed to meet minimum ventilation needs and modulate fan speeds to stay within the desired temperature range. The Vigilent System saves electrical energy because the fans run at less than full speed for a large portion of most days, and heating energy is also saved because less air needs to be heated to supply the space.

The purchase of new premium efficiency motors for the fans, which was necessary to accommodate VFDs, also contributes to the energy savings from this retrofit project.

Project Costs and Savings

Estimated annual energy savings from the project are anticipated to be 93,100 kWh and 8,450 therms. This represents a 6%

▶ University Hall is home to the UC Berkeley School of Public Health. The building serves primarily administrative functions, with conference rooms, offices, small classrooms, and a small library.



1

2

3

Components of the wireless HVAC system

Variable frequency drives (VFDs) were installed to control the motors on both supply and return fans in the two air handling units.

120 Vigilent wireless temperature sensors were installed in University Hall.

Two Vigilent wireless mesh gateways relay communications between the temperature sensors and the Vigilent Artificial Intelligence Engine.

reduction in total building electricity use and a 9% reduction in building natural gas use. Energy savings from the new premium efficiency motors are about 4,000 kWh or 4% of the total project energy savings. Energy cost savings for University Hall are expected to be $21,500 annually, comprising 7% of the building's total energy costs.

The total project cost was approximately $176,000. Energy Technology Assistance Program rebates covered 10% of the total cost and the Pacific Gas & Electric UC/CSU Partnership Program covered 17% of the total cost. The remainder of project funding was borrowed as part of an energy efficiency bond initiative supported by the University of California Office of the President. The project's simple payback is approximately six years.

Lessons Learned

The total project cost for University Hall was relatively low because retrofitting the two zones (about 127,000 square feet of building space) only required the purchase and installation of seven VFDs and six motors. For buildings with a larger number of fans, a similar project may not be as cost effective, due to the need for additional VFDs. Installation of the VFDs, motors and Vigilent components at University Hall was quick, taking about one month. Commissioning the new system for performance, however, took considerably longer than initially anticipated. Several iterations of commissioning were necessary to fine tune the system to meet ventilation demand in all areas, due to the large number of rooms and the variety of uses in both zones.

PROJECT DATA

PROJECT SUMMARY

Site: University Hall
Location: UC Berkeley
Project area 127,000 square feet
Built: 1959

ENERGY INFORMATION

Annual building electricity use before retrofit: 1,558,900 kWh
Annual natural gas use before retrofit: 92,650 therms
Annual electricity savings: 93,100 kWh
Annual natural gas savings: 8,450 therms
Peak demand reduction: 40.4 kW

PROJECT ECONOMICS

Annual utility cost savings: $21,550 or 7% of previous annual utility costs
Total project cost: $176,000
Utility & CEC incentives:
- PG&E UC/CSU Partnership Program Rebate - $30,800
- Energy Technology Assistance Program Rebate - $16,800

Simple payback: 6 years

EQUIPMENT INSTALLED

Basic project components:
- 6 Baldor Super E Motors (20 hp, 15 hp (4x), 10 hp)
- 7 variable frequency drives (10 hp, 15 hp (4x), and 20 hp (2x))
- 120 Vigilent wireless temperature sensors
- 2 Vigilent wireless gateways
- 1 Vigilent Artificial Intelligence Engine system server
- 7 Vigilent wireless control modules for VFDs

Vigilent® Intelligent Energy Management Systems (www.vigilent.com)

Vigilent provides intelligent energy management systems for data centers, telecommunications facilities and large, commercial buildings. Vigilent energy management systems provide environmental monitoring, configuration and facility advisement, and dynamic closed-loop control to optimize temperature management. Vigilent systems can deliver reductions in energy costs while offering tenant comfort in large buildings. Vigilent is a privately-held firm located in El Cerrito, California.

"As UC Berkeley continues to implement projects that reduce our energy usage and greenhouse gas emissions, we will look to replicate the success of this project in achieving large savings through an approach tailored to the specific needs of the building."

Lisa McNeilly, Director, UC Berkeley Office of Sustainability

TAKING THE NEXT STEP

Additional case studies on the Vigilent Intelligent Energy Management System (previously known as DART)

- **PG&E DART Fact Sheet** (http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/rebatesincentives/DART_FS_Final.pdf)
- **PG&E Field Evaluation of Wireless HVAC Air Distribution Controls at Stanford University** (http://www.etcc-ca.com/images/stories/dart1.pdf)
- **PIER Draft Case Study on DART at UC Santa Barbara** (http://energy-solution.com/etap/wp-content/uploads/2011/03/DART_UCSB_Case_Study.pdf)
- **PIER Draft Case Study on DART at Cal Poly San Luis Obispo** (https://www.vigilent.com/downloads/case_studies/case_study_cal_poly_slo.pdf)
- **PIER Demonstration of Datacenter Automation Software and Hardware (DASH) at the California Franchise Tax Board** (https://www.vigilent.com/downloads/case_studies/case_study_ca_ftb.pdf)
- **Recovery Act: Federspiel Controls (now Vigilent) and State of California Department of General Services Data Center Energy Efficient Cooling Control Demonstration** (http://www.osti.gov/bridge/product.biblio.jsp?query_id=0&page=0&osti_id=1025751&Row=0&formname=basicsearch.jsp)

Applicable utility incentives

Contact your utility representative for information specific to your utility. Incentives for wireless HVAC controls projects may include:

- Customized incentive programs providing rebates based on documented kWh, kW and therm savings.
- Demand response (DR) programs paying incentives based on the amount of kW load a building can shed when called upon to do so.
- Automated DR programs providing additional incentives for customers that automate their equipment's response to a requested load shedding event.

Financing assistance

- California Energy Commission low interest loans for energy efficiency projects
- Utility on-bill financing
- Financing from energy service companies (ESCo)

ENERGY SOLUTIONS

Energy Solutions is an energy efficiency consulting firm working to create large-scale environmental benefits by developing and implementing innovative, market-based approaches to increase sustainability through energy efficiency, water efficiency, and renewable energy initiatives. Energy Solutions developed and implements the Energy Technology Assistance Program (2010-2012). Funding has been provided by the American Recovery and Reinvestment Act of 2009 and is administered by the California Energy Commission.