UC Berkeley
Energy Use in Buildings Enabling Technologies

Title
Case Study: Adaptive LED Wall Packs

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ADAPTIVE LED WALL PACKS

University of California, Davis

Post-retrofit network-controlled LED wall packs line the Thermal Energy Storage building at UC Davis

OCCUPANCY RATE
20%

ENERGY & CO_2E SAVINGS
89%

LIFETIME MAINTENANCE SAVINGS
$233 per fixture

LIFETIME ENERGY COST SAVINGS
$753 per fixture based on UC Davis rate of $0.075/kWh

In 2012, UC Davis upgraded its exterior lighting as part of the university's Smart Lighting Initiative. Wall packs on campus, like other exterior lighting fixtures, were retrofitted with dimmable LED sources, motion sensors, and wireless controls. This allowed the units to be incorporated into an adaptive campuswide lighting control system. The system offers an intelligent, networked approach to lighting and energy management, with improved lighting quality and optimal energy efficiency.

"We used to have a single on/off switch for these lights," says David Phillips, director of UC Davis Utilities. "Now we have a coordinated network with programmable, independent, fully dimmable switches. We turn them on, and they all start chattering. They ask, 'Where am I?' 'When should I light up, and how much?' With support from CLTC, UC Davis Design and Construction Management, and our colleagues across the campus, we've answered those questions. And we'll be able to continually update the programming to make improvements over time."

The retrofit also put UC Davis in compliance with California's 2013 Title 24 lighting code. Under the code, all outdoor lighting installed 24 feet above the ground or lower must use motion-sensitive lighting controls or a centralized lighting control system, in addition to daylight controls.

PROBLEM

Wall packs typically employ high-intensity discharge (HID) light sources, such as high-pressure sodium (HPS) and metal halide (MH) lamps. These sources are only moderately efficacious, contribute significantly to light pollution, and their light generally measures poorly on the color rendering index (CRI). Moreover, because wall packs operate during off-peak hours, they often waste energy lighting unoccupied spaces at full illuminance levels for hours at a time every night. Replacing inefficient sources with LED or induction technologies and adding photocells, occupancy sensors and controls to wall packs dramatically reduces this energy waste. Incorporating these fixtures into a networked control system further maximizes energy savings and provides other benefits, too.

SOLUTION

For each wall pack installed at UC Davis, an LED source was combined with a motion sensor and a wireless control unit, creating a fully programmable and dimmable luminaire capable of on/off and bi-level switching, as well as 0–10V dimming. These adaptive wall packs provide efficient white light that measures 4100K, with a CRI of 70. These full-cutoff fixtures also minimize light pollution.

A wireless lighting control module was added to each wall pack via a NEMA twist-lock receptacle. The module serves as the point of communication between each luminaire and the lighting control network. The network gateway serves as a central communication point for the control modules on the network while also providing network access for users to adjust operations.

These adjustments include setting the luminaires to automatically turn on and off at preset times (or defer to integrated daylight sensors), changing dimming schedules, modifying bi-level functionality, and sending commands to luminaires within the system. The wireless control system also allows administrators to create luminaire groups, event schedules and control profiles, monitor energy use patterns, and receive automatic alerts from the fixtures when a maintenance issue is detected.

DEMONSTRATION RESULTS

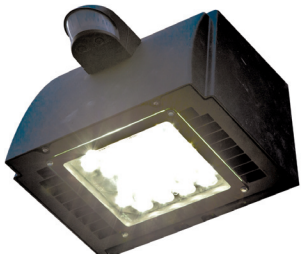
The SPEED program and CLTC partnered with other UC Davis entities, including Facilities Management, the campus Utilities unit, and Design and Construction Management, to install 101 LED wall packs on 13 different buildings across the UC Davis campus. The project team chose LED wall packs from Philips Day-Brite. Lumewave, Inc. produces and maintains the TOP900 wireless control units, radio frequency (RF) network and LumeStar system software used to incorporate the luminaires into the UC Davis adaptive campus control system.

The LED wall packs replaced 56 HPS wall packs and 45 MH units that had an average system wattage of 189W. The LED luminaires are on for an average of 12 hours each evening, operating at 20% of full light output until a motion sensor is triggered, at which point the corresponding wall packs switch to a higher illuminance level. The wall packs allow for top-end trimming, meaning high mode can be programmed to be 80% (for example) instead of 100% of full power, and settings are easy to adjust thereafter.

PROJECT TECHNOLOGIES

LED WALL PACK

WTM-40W wall pack by Philips Day-Brite, available at **daybrite.com**



OUTDOOR MOTION SENSOR

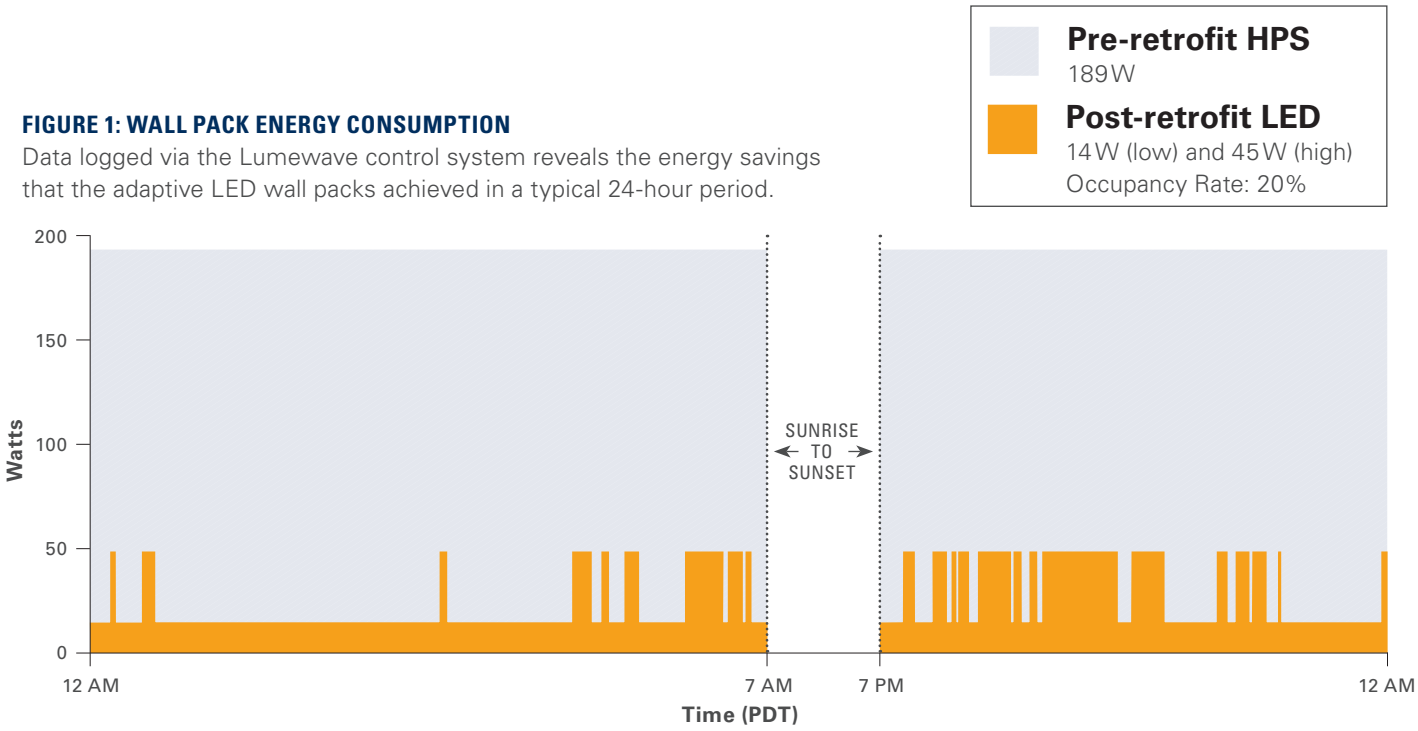
EW low-voltage outdoor motion sensor by WattStopper, available at **wattstopper.com**

NETWORKED CONTROLS

TOP900-TL wireless lighting control module by Lumewave, available at **lumewave.com**

FIGURE 1: WALL PACK ENERGY CONSUMPTION

Data logged via the Lumewave control system reveals the energy savings that the adaptive LED wall packs achieved in a typical 24-hour period.



The wall packs installed at UC Davis use just under 14W in low mode and 45W in high mode, less than one-third of the electricity used by the original luminaires.

During a six-week monitoring period, occupancy rates averaged 20%. The wall packs remained in low mode for an average of 9.6 hours total each night and operated in high mode for about 2.4 hours total each night. They were off during daylight hours. This resulted in energy savings of 89%. Based on this data, each LED wall pack will save about 741 kWh annually. At UC Davis' exceptionally low electricity rate of 7.5 cents per kWh, annual energy and maintenance cost savings total $986 per fixture. Facilities that pay higher rates can expect greater economic returns.

ECONOMIC EVALUATION

The networked control system installed on the UC Davis campus was a first-of-its-kind, best-practice solution; as such, it increased both the benefits and the costs of the retrofit project. Facilities with limited funding or lower electricity rates may find installing local controls provides a more cost-effective solution (see table 1 and figure 2). This option does not provide all the features of a networked system, but still provides deep energy savings.

An incentive from the UC/CSU/IOU Energy Efficiency Partnership (www.uccsuiouee.org) reduced project costs by $178 per fixture, shortening the payback period by 20%.

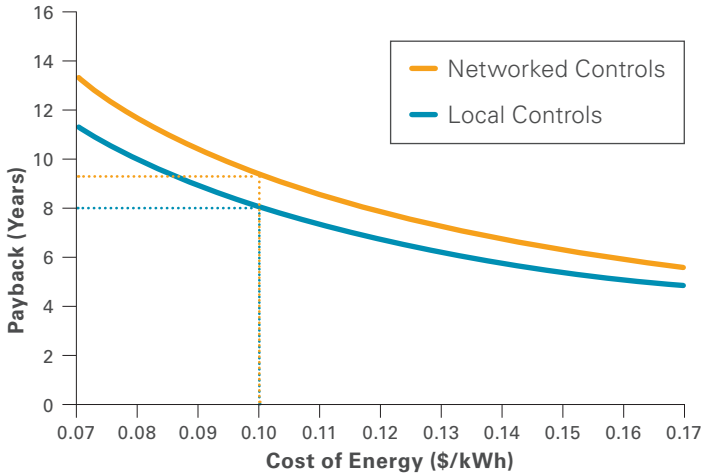
TABLE 1: PROJECT ANALYSIS WITH INCENTIVES

	UC Davis Networked Controls*	Networked Controls at $0.10/kWh	Local Controls at $0.10/kWh
Project Cost per Fixture	$550	$550	$420
Payback**	12.8 years	9.6 years	8.2 years
ROI	0.4	0.8	1.1
IRR	4%	8%	11%

* Lumewave system savings at UC Davis rate of $0.075/kWh

** Payback periods do not include maintenance savings

FIGURE 2: SIMPLE PAYBACK BASED ON ELECTRICITY RATES



Electricity rates for UC and CSU campuses vary widely. As figure 2 illustrates, simple payback periods without maintenance savings for the Philips Day-Brite LED wall pack fixtures with the Lumewave networked control system range from 5.7 years to 13.7 years. Simple payback periods for the same LED wall packs with local controls range from 4.8 years to 11.7 years, depending on electricity rates. Maintenance savings reduce payback periods by roughly 23%.

Costs for this project were partially offset by a utility rebate based on annual kilowatt-hours saved. California utilities offer a wide variety of rebates and incentives for energy efficiency improvements and participation in demand response programs. Facility managers should contact their local utilities for more information. Other incentives, including tax deductions, may also be available.

COLLABORATORS

UC Davis Facilities Management handled installation of the wall packs on the UC Davis campus. Funding was facilitated by the UC/CSU/IOU Energy Efficiency Partnership. PG&E provided rebates for energy savings.

TABLE 2: PROJECT COSTS & SAVINGS SUMMARY

	BEFORE	AFTER	SAVINGS
Technology	HID Wall Pack (HPS and MH lamps)	Philips Day-Brite LED Wall Pack	
Fixture Wattage	189W (System) 150W (Lamp Only)	45W (High) 14W (Low)	
Annual Energy Consumption	828 kWh	87 kWh	**741 kWh**
Annual Energy Cost	$62	$7	**$55**
Annual Maintenance Cost	$17	$0	**$17**
Total Annual Cost	$79	$7	**$72**
Lifetime Energy Cost	$849	$96	**$753**
Lifetime Maintenance Cost	$233	$0	**$233**
Total Lifetime Operating Cost	$1,082	$96	**$986**
Total Lifetime Cost for All Fixtures	$109,282	$9,696	**$99,586**

Metrics listed are per-fixture quantities unless otherwise noted.

Number of Fixtures	*101 fixtures*	**Pre-retrofit Lifetime**	*12,000 hours*
Installation Cost	*$162*	**Post-retrofit Lifetime**	*60,000 hours*
Cost of Labor	*$65/hr **	**HID Lamp Cost**	*$15*
Time to Replace Lamps	*0.5 hours*	**Annual Hours of Use**	*4,380 hours*
Energy Cost	*$0.075/kWh*	**Lifespan**	*13.7 years*
Occupancy Rate	*20%*		

* Cost of labor for UC Davis campus

ABOUT THE STATE PARTNERSHIP FOR ENERGY EFFICIENT DEMONSTRATIONS (SPEED) PROGRAM: The SPEED program is supported by the California Energy Commission and managed through the California Institute for Energy and Environment (CIEE). SPEED demonstrations are coordinated by the CIEE in partnership with the California Lighting Technology Center and the Western Cooling Efficiency Center, both at the University of California, Davis.

Any questions about this project, including technology costs, can be directed to:

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For more resources and information, including technology catalogs, business case studies and demonstration maps, visit PARTNERSHIPDEMONSTRATIONS.ORG.

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