

Bi-level LED Parking Garage Luminaires



PIER Buildings Program

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The Problem

Most parking garages use high intensity discharge (HID) light sources that operate continuously, regardless of lighting needs. This wastes energy, contributes to peak demand during the day, and contributes to light pollution at night. Light-emitting diode (LED) sources can drastically reduce parking garages' power consumption, even more so when combined with daylighting and occupancy-based control strategies.

The Solution

The California Energy Commission's Public Interest Energy Research (PIER) program sponsored the development of bi-level parking garage luminaires that integrate intelligent controls with bi-level electronic drivers or ballasts. These luminaires operate at a reduced level during vacant periods and at full light output upon occupancy. Many can also be combined with photocontrols for further energy savings.

Savings are achieved by combining broad-spectrum sources, such as LED lights, with fixture-integrated occupancy and daylighting controls. Adaptive lighting controls reduce light levels based on actual garage occupancy and general lighting conditions. The three case study demonstrations presented here measured energy savings of 68–84%; however, parking garage retrofit applications of bi-level LED luminaires generally achieve 40–70% savings over older technologies.

Products highlighted in this case study include: BetaLED's The Edge, the luminaire developed by PIER, CLTC and BetaLED; the BetaLED 304 series parking garage luminaire, a derivative product with an integrated occupancy sensor and two-level light control; and the Philips Wide-Lite VizorLED canopy luminaire, which comes equipped with an on-site programmable occupancy sensor, dimming power supply, and the first indirect LED light source. The VizorLED's Non-Direct View optics provide glare-free, uniform illumination. The Proximo occupancy sensor is fully programmable, allowing for on-site adjustment of high- and low-mode light output, occupancy timeout and other related controls.

FIGURE 1: POST-RETROFIT BI-LEVEL LED LUMINAIRES

Garage 1, California State University, Sacramento



Features and Benefits

- Bi-level light output based on garage occupancy
- Instant light level changes (no warm-up or hot restrike limitations)
- Reduced operating and maintenance costs with long-life light source
- Rugged, vandal-resistant design
- Field-tunable design allows for on-site adjustment of high and low light modes and timeout settings
- Improved lighting quality: good color rendering, high color temperature, high uniformity, white light

Technology Costs and Incentives

Replacement scenarios are generally one-to-one in retrofit applications, and installation is identical to other typical deck-mounted luminaires. Equipment costs, however, may be two to four times higher than common HID garage luminaires. This cost may be offset by energy and maintenance savings, and utility incentives. Many California utilities offer one-time incentives of approximately 5 cents per kWh saved, or \$100 per kW reduced. Other utilities offer incentives based on fixture type, source type and controls time. More information on current incentives can be obtained by contacting local utilities. Typical payback periods range from 3 to 10 years.

TABLE 1: ENERGY AND MAINTENANCE COSTS AND SAVINGS

Garage 1, California State University, Sacramento (Replacement LEDs: The Edge by BetaLED)

*Figures listed below are per fixture quantities unless otherwise noted

TECHNOLOGY	SYSTEM SIZE (W)	ANNUAL ENERGY CONSUMPTION (kWh)	ANNUAL ENERGY COST	ANNUAL MAINTENANCE COST	TOTAL ANNUAL COST	LIFE-CYCLE ENERGY COST	LIFE-CYCLE MAINTENANCE COST	TOTAL LIFE-CYCLE COST	TOTAL LIFE-CYCLE COST FOR ALL FIXTURES
HPS	189	1,656	\$212	\$18	\$229	\$1,693	\$140	\$1,833	\$55,003
LED	77 (Low) 165 (High)	906	\$116	\$0	\$116	\$926	\$0	\$926	\$27,794
SAVINGS		750	\$96	\$18	\$113	\$767	\$140	\$907	\$27,209

Annual hours of use: 8,760

Lifespan: 8 years

LED Lifespan: 70,000 hrs

Occupancy: 30%

Total Maintenance Cost: \$140

Time to replace lamp: 0.5 hr

HPS Lifespan: 24,000 hrs

Number of fixtures: 30

Cost of labor: \$100/hr

Energy cost: \$0.128/kWh

HPS lamp cost: \$20

Demonstration Results

California State University, Sacramento

In the winter of 2008 California State University, Sacramento (CSUS), in partnership with the Sacramento Municipal Utility District (SMUD) and the PIER program, retrofitted the third floor of the CSUS Garage 1 parking structure. Thirty high-pressure sodium (HPS) luminaires were replaced with The Edge LED parking garage luminaires from BetaLED. Integrated sensors switched light levels in the new luminaires between high and low modes based on garage occupancy. Incumbent HPS luminaires consumed 189W each. The LED replacements consume 165W in high mode and 77W in low mode. The luminaires have a lifespan of 70,000 hours.

Monitoring revealed that nearly all fixtures operated in low mode (77W) between midnight and 6 a.m., resulting in 78% energy savings compared to incumbent HPS technology during this time period. During daytime and evening hours, only about 30% of the LED luminaires operated in high mode, resulting in 5% energy savings compared to the incumbent HPS technology. Energy savings for this demonstration totaled 68%.

First costs for the CSUS demonstration totaled \$42,600, and simple payback for this demonstration was calculated at 16 years. It is important to note, however, that this was an early demonstration of an emerging technology, and since 2008 LED luminaire prices have declined significantly. Now most LED parking garage retrofits with similar economic factors can expect a simple payback period of 5 to 15 years. Project payback terms can vary widely depending on site-specific parameters, including demand size (watts) of existing technology, energy cost, garage occupancy rates, and regional variance in equipment costs.

FIGURE 2: POST-RETROFIT BI-LEVEL LED LUMINAIRES

Garage 1, CSU Sacramento

**FIGURE 3: BETALED THE EDGE PARKING STRUCTURE LUMINAIRE**

Installed retrofit technology at CSU Sacramento



TABLE 2: ENERGY AND MAINTENANCE COSTS AND SAVINGS

Parking Garage 2, California State University, Long Beach (Replacement LEDs: 304 Series by BetaLED)

*Figures listed below are per fixture quantities unless otherwise noted

TECHNOLOGY	SYSTEM SIZE (W)	ANNUAL ENERGY CONSUMPTION (kWh)	ANNUAL ENERGY COST	ANNUAL MAINTENANCE COST	TOTAL ANNUAL COST	LIFE-CYCLE ENERGY COST	LIFE-CYCLE MAINTENANCE COST	TOTAL LIFE-CYCLE COST	TOTAL LIFE-CYCLE COST FOR ALL FIXTURES
HPS	189	1,656	\$248	\$25	\$273	\$2,835	\$280	\$3,115	\$21,805
LED	16 (Low) 47 (High)	271	\$41	\$0	\$41	\$463	\$0	\$463	\$3,242
SAVINGS		1,385	\$207	\$25	\$232	\$2,372	\$280	\$2,652	\$18,563

Annual hours of use: 8,760
Lifespan: 11 years
LED Lifespan: 100,000 hrs

Occupancy: 48%
Number of fixtures: 7
HPS Lifespan: 24,000 hrs

HPS lamp cost: \$20
Time to replace lamp: 0.5 hr
Cost of labor: \$100/hr

Energy cost: \$0.15/kWh
Total Maintenance Cost: \$280

California State University, Long Beach

In the summer of 2011 California State University, Long Beach (CSULB), partnered with the PIER demonstration program to retrofit 7 HPS luminaires on the first floor of CSULB Garage 2. BetaLED’s 304 Series parking garage fixture is the second in the line of BetaLED luminaires designed for canopy applications in garages. It contains the functionality of BetaLED’s The Edge product, demonstrated at CSUS, and it incorporates a multi-level option that allows for field adjustability. As a result, light output for the high mode, low mode and the occupancy timeout can all be adjusted easily on each independent unit. The units installed at CSULB consume 47W in high mode and 16W in low mode. They have a lifetime of approximately 100,000 hours in their installed climate.

The installed luminaires were monitored for one month to determine usage patterns and energy savings. The garage was occupied 48% of the time. Using this percentage, researchers determined that the retrofit fixtures produced 84% energy savings compared with the incumbent HPS luminaires. This translates to 1,385 kWh saved per fixture per year. First costs totaled \$4,935, and simple payback was calculated to be 4 years.

FIGURE 4: POST-RETROFIT BI-LEVEL LED LUMINAIRES

Garage 2, CSU Long Beach



San Marcos Civic Center Garage

In the spring of 2011 the California Lighting Technology Center (CLTC), in partnership with the City of San Marcos and the PIER demonstration program, replaced 23 HPS luminaires on the second floor of the Civic Center Garage located in downtown San Marcos, CA. The incumbent HPS canopy luminaires, which consume 210W of electricity, were replaced with VizorLED parking garage luminaires, by Philips Wide-Lite. The new lights consume 70W in high mode and 7W in low mode. Perimeter units are connected to a photocell and operate only from dusk until dawn. Light level monitoring of the new LED luminaires found they operated in low mode an average of 47% of the time, resulting in 81% energy savings. First costs of the project came to \$24,426, and calculated payback was 6.1 years.

FIGURE 5: PHILIPS WIDELITE VIZORLED

Installed retrofit technology at the San Marcos Civic Center Garage



Product Availability

Philips Wide-Lite offers the VizorLED luminaire at www.widelite.com. Information on The Edge and 304 Series luminaires, manufactured by BetaLED, is available online at www.betaled.com. General Electric and Acuity Brands also offer LED canopy lighting solutions.

What's Next

CLTC continues to develop demonstrations of adaptive lighting technologies through the PIER-State Partnership for Energy Efficient Demonstrations (SPEED) program. SPEED is aimed at achieving widespread implementation of energy-efficient technologies.

Collaborators

CLTC, CSUS, SMUD, the California Energy Commission, and BetaLED collaborated on the CSUS demonstration. The CSULB project involved CLTC, CSULB and BetaLED. The San Marcos retrofit was a collaboration

between CLTC, the City of San Marcos, and Philips Wide-Lite. The demonstrations were sponsored by the CEC-PIER SPEED program, which is coordinated by the California Institute for Energy & Environment (CIEE) in partnership with CLTC.

For More Information

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TABLE 3: ENERGY AND MAINTENANCE COSTS AND SAVINGS

San Marcos Civic Center Parking Garage (Replacement LEDs: VizorLED by Philips WideLite)

*Figures listed below are per fixture quantities unless otherwise noted.

TECHNOLOGY	SYSTEM SIZE (W)	ANNUAL ENERGY CONSUMPTION (kWh)	ANNUAL ENERGY COST	ANNUAL MAINTENANCE COST	TOTAL ANNUAL COST	LIFE-CYCLE ENERGY COST	LIFE-CYCLE MAINTENANCE COST	TOTAL LIFE-CYCLE COST	TOTAL LIFE-CYCLE COST FOR ALL FIXTURES
HPS	210	1,840	\$235	\$25	\$260	\$2,688	\$280	\$2,968	\$47,488
HPS PERIMETER	210	920	\$118	\$25	\$142	\$1,344	\$280	\$1,624	\$11,368
LED CANOPY	7 (Low) 70 (High)	354	\$45	\$0	\$45	\$517	\$0	\$517	\$8,272
LED CANOPY PERIMETER	7 (Low) 70 (High)	177	\$23	\$0	\$23	\$258	\$0	\$259	\$1,809
HPS TOTAL		2,760	\$353	\$50	\$402	\$4,032	\$560	\$4,592	\$58,856
LED TOTAL		531	\$68	\$0	\$68	\$775	\$0	\$776	\$10,081
SAVINGS		2,229	\$285	\$50	\$334	\$3,257	\$560	\$3,816	\$48,775

Annual hours of use: 8,760
Lifespan: 11.42 years
LED Lifespan: 100,000 hrs

Occupancy: 53%
Cost of labor: \$100/hr
Time to replace lamp: 0.5 hr

HPS Lifespan: 24,000 hrs
Number of interior fixtures: 16
Number of perimeter fixtures: 7

Energy cost: \$0.128/kWh
HPS lamp cost: \$20
Total Maintenance Cost: \$280

About PIER

This project was conducted by the California Energy Commission's Public Interest Energy Research (PIER) Program. PIER supports public interest energy research and development that helps improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

Jerry Brown, Governor
California Energy Commission

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