Energy-efficient LED Downlights

The Problem

Recent studies estimate more than 800 million recessed downlights are in operation in the United States, split nearly equally between residential and commercial applications, with about 83% still using incandescent lamps. Inexpensive compact fluorescent lamp (CFL) downlights are commercially available, but most of these units are not dimmable, which is a desired attribute for many downlight applications. Therefore, energy-saving CFLs often are overlooked in lieu of the functionality of incandescents.

This conflict creates a significant market opportunity for an energy-efficient, dimmable light source designed for the recessed downlight market. Significant energy savings potential exists for long-life LED replacements, as much as 81 trillion watt hours (TWh).[1]

The Solution

Eaton's Cooper Lighting business and the California Lighting Technology Center (CLTC) partnered on this PIER-sponsored project to create an LED recessed downlight suitable for both retrofit or new construction markets that met ENERGY STAR requirements, provided high-quality, broad spectrum light, and could successfully dim on standard analog dimmers. The culmination of this partnership venture was the successful launch of the HALO® LED downlight offered by Eaton's Cooper Lighting business.

Features and Benefits

- The HALO LED recessed downlight is the first ENERGY STAR-rated LED downlight and exceeds the high efficacy requirements set by California's Title 24 energy regulations
- High color rendering and warm white color temperature: 80 CRI at 3045 K
- Delivers light equivalent to many standard incandescent sources used in recessed downlight applications
- Dimmable to 15% of total light output with standard AC incandescent dimmers, 5% with low-end trim adjustment

FIGURE 1: HALO® LED DOWNLIGHT POST-RETROFIT
Bidwell Mansion Visitor Center, Chico, CA

- Up to 25 times longer lamp life than incandescent lamps, lasting up to 68 years in most residential applications and 15 years in typical commercial applications[2]
- Multiple trim options available designed to minimize glare and increase aesthetic appeal, including those for wet applications

Technology Costs and Incentives

Installation of LED downlights in retrofit and new construction situations is almost identical to typical incandescent or CFL recessed downlights. The exception is that many LED downlight housings—for example, the HALO product by Eaton's Cooper Lighting business—can be in direct contact with insulation. Replacement scenarios are generally one-to-one in retrofit applications. Equipment costs range from $100–300 depending on the manufacturer and distributor, but costs may be offset by maintenance savings and utility rebates.

Many California utilities offer one-time incentives ranging from 5–24 cents per kWh saved, plus up to $100 per kW reduced, as compared to incumbent technologies or state energy regulations. More information on incentives can be found at www.fypower.org.

[1] DOE, Energy Savings Estimates of Light Emitting Diodes in Niche Lighting Applications, prepared by Navigant Consulting, September 2008.

[2] Residential applications assume two hours of use per day. Commercial applications assume nine hours of use per day.

Demonstration Results

The HALO LED module, including dedicated H750I-CAT housings, were successfully demonstrated as part of PIER's State Partnership in Energy Efficiency Demonstrations (SPEED) program. Two demonstration sites were selected for initial product evaluation and demonstration: the lobby at the Bidwell Mansion Visitor Center in Chico, and a conference room at the California Department of Public Health in Richmond. In total, 39 units were installed, resulting in an average of 61% energy savings and equivalent or increased light levels as compared to pre-retrofit downlight technologies.

Bidwell Mansion Visitor Center

The entrance lobby to the Bidwell Mansion Visitor Center (BMVC) was renovated with 27 new LED modules and housings provided by Eaton's Cooper Lighting business (Figure 1). This demonstration project replaced existing 10" bi-pin CFL recessed downlights with the new LED product. Lighting renovations consisted of a one-to-one replacement of existing luminaires with new LED luminaires.

The retrofit resulted in 50% energy savings compared to incumbent CFL downlights (Table 1).

Light levels and uniformity were maintained throughout the space, and increased lamp life is expected to result in additional cost savings for the facility.

California Department of Public Health

This demonstration project replaced 12 existing 5" incandescent recessed downlights with the HALO product. Lighting renovations consisted of a one-to-one replacement of existing luminaires with LED luminaires.

The LED downlights consumed 75% less energy than the existing luminaires (Table 2).

In addition, lamp lifetime increased from 1,000 hours to 50,000 hours, resulting in reduced maintenance costs. Average light levels were maintained, while energy consumption decreased.

Product Availability

LED downlights currently are available from multiple manufacturers. In particular, some now offer ENERGY STAR-rated products, including Eaton's Cooper Lighting business, Philips Lighting, Juno Lighting, EEMA Lighting Group, Elite LED, Intematix, Lithonia Lighting, Neo-Neon International Ltd., Prescolite, Inc., and Renaissance Lighting, Inc.

TABLE 1: TOTAL PROJECT ENERGY ANALYSIS
Pre- and post-retrofit technologies at Bidwell Mansion Visitor Center

	LUMINAIRE TYPE	QTY.	WATTS PER LUMINAIRE	TOTAL LOAD (W)	FIXTURE EFFICIENCY	TOTAL DELIVERED LUMENS	ANNUAL ENERGY CONSUMPTION (kWh)	SAVINGS
EXISTING	10" fluorescent downlight	25	28	700	45%	15,300	1,417.5	
	3" T12 strip	1	80	80	70%	1,400	162.0	
NEW	HALO LED downlight	27	14.8	400	99%	17,508	809.19	
SAVINGS							**770.31**	**49%**

TABLE 2: TOTAL PROJECT ENERGY ANALYSIS
Pre- and post-retrofit technologies at California Department of Public Health

	LUMINAIRE TYPE	QTY.	WATTS PER LUMINAIRE	TOTAL LOAD (W)	FIXTURE EFFICIENCY	TOTAL DELIVERED LUMENS	ANNUAL ENERGY CONSUMPTION (kWh)	SAVINGS
EXISTING	Gotham 5" incandescent downlight	12	60	720	58%	5,558	1,136	
NEW	HALO LED downlight	12	14.8	178	99%	7,781	280	
SAVINGS							**856**	**75%**

For more information on specific ENERGY STAR LED downlights, please visit www.energystar.gov and follow the links to solid-state residential lighting products. LED downlights generally can be purchased at contractor or electrical supply centers.

What's Next

CLTC continues demonstrations of energy-efficient LED downlights as part of the SPEED Program and is seeking new demonstration partners for this technology. Please contact CLTC for more information.

Collaborators

This research project is a collaboration between California Department of Parks and Recreation, California Department of Public Health, California Energy Commission, California Lighting Technology Center, Eaton's Cooper Lighting business, Lighting California's Future (LCF), Public Interest Energy Research (PIER) Program, and State Partnership in Energy Efficiency Demonstrations.

For More Information

Cori Jackson, Senior Development Engineer
California Lighting Technology Center, UC Davis
cmjackson@ucdavis.edu, cltc.ucdavis.edu

- To read more about the LED downlight, visit cltc.ucdavis.edu/publication/energy-efficient-led-downlights
- More information on PIER demonstrations is available at partnershipdemonstrations.org
- More information on the HALO LED recessed downlight is available at cooperindustries.com/content/public/en/lighting/brands/halo.html

FIGURE 2: HALO LED DOWNLIGHT

FIGURE 3: HALO LED DOWNLIGHT POST-RETROFIT
Department of Public Health, Richmond, CA

TABLE 3: ENERGY AND MAINTENANCE COST AND SAVINGS

TECHNOLOGY	ANNUAL ENERGY CONSUMPTION (kWh)	ANNUAL ENERGY COST	ANNUAL MAINTENANCE COST	TOTAL ANNUAL COST	LIFECYCLE ENERGY COST	LIFECYCLE MAINTENANCE COST	TOTAL LIFECYCLE COST
CFL	72.8	$9.32	$3.77	$13.09	$179.20	$72.50	$251.70
LED	34.48	$4.93	$0.00	$4.93	$94.72	$0.00	$94.72
SAVINGS	**34.32**	**$4.39**	**$3.77**	**$8.61**	**$84.48**	**$72.50**	**$156.98**

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.

04/2014