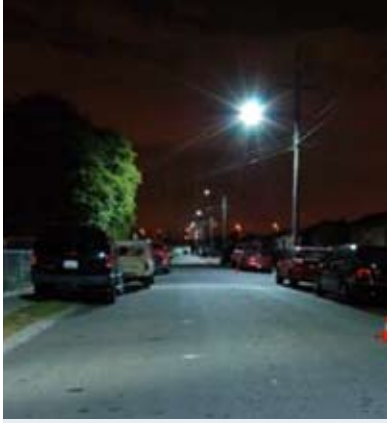
GATEWAY DEMONSTRATIONS

Outdoor Lighting with LEDs:

City of Oakland, CA Street Lighting Report Brief



Background

Recently, a number of LED products intended for outdoor applications have come on the market. The interest in this new class of products is high because of LEDs' long life and corresponding reduction in maintenance and operational costs, good color characteristics, and potential for high energy savings. Outdoor and street lighting applications typically use high-intensity discharge (HID) sources, including high-pressure sodium (HPS) or metal halide (MH). HID lamps are typically very efficacious, but have other performance drawbacks, including long restrike times, low color rendering abilities in the case of HPS, or in the case of MH, poor lumen maintenance as well as visible color shifts over time. LED-based luminaires are emerging as a viable alternative for outdoor applications.

Project Description and Results

The Oakland Street Lighting Demonstration Project was a joint project of the U.S. Department of Energy (DOE), Pacific Gas & Electric (PG&E), and the City of Oakland. For this project, the City replaced fourteen 121 Watt HPS luminaires (100 nominal Watts) with fourteen 78 Watt LED luminaires (60 nominal Watts) on three public streets in Oakland. Quantitative and qualitative light and electrical power measurements were taken on all three streets. Economic costs were estimated and qualitative satisfaction gauged with a resident survey. A preliminary parking lot installation of LED luminaires was also performed to assess the likelihood of any negative safety impacts prior to street installation.

To allow for a variety of comparisons, one of the test roadways was illuminated with relamped HPS luminaires on the eastern half and LED luminaires on the western half. An adjacent, parallel road was illuminated exclusively with LED luminaires, while a third adjacent road was entirely relamped with HPS luminaires. All luminaires have mounting heights 28.5 ft above the road surface, with spacing between poles of approximately 110 ft, 120 ft, or 165 ft. Measured illuminance levels for both the HPS and LED luminaires are shown in Table 1. The new LED luminaires drew roughly 35% (43 Watts) less than the HPS luminaires. At about 4,100 annual hours of operation, annual electrical savings are estimated to be approximately 178 kWh per luminaire replaced.

	Average Illuminance (fc)	Minimum Illuminance (fc)	Avg. to Min. Uniformity Ratio	Max. to Min. Uniformity Ratio
HPS Luminaires				
110' Spacing	1.00	0.19	5:40:1	19.00:1
120' Spacing	0.80	0.09	8.66:1	40.00:1
165' Spacing	0.47	0	>10.16:1	>60.00:1
LED Luminaires				
110' Spacing	0.58	0.19	3.11:1	6.50:1
120' Spacing	0.53	0.09	5.68:1	16.00:1
165' Spacing	0.35	0	≥7.47:1	≥26.00:1

HPS lamps are large point sources, so that even with good optical design, the area below the luminaire tends to have significantly more illuminance than points farther away. This area is often over-lighted. This over-lighting is compounded because the initial installation must also account for the future lumen depreciation of the source. Thus, the lower average illuminance levels measured under the LED luminaires do not denote inferior light

Projects investigate SSL applications that:

1) save energy relative to the incumbent technology;

2) match or better the existing illumination and visibility produced by the incumbent technology; and

3) offer economic value to users.

Visit the DOE Gateway Demonstration site at http://www.netl.doe.gov/ssl/techdemos.htm.

This Report Brief provides a summary of a full Gateway Demonstration report available on the DOE Solid State Lighting website at: http://www.netl.doe.gov/ssl/techdemos.htm.

performance. In fact, the LED luminaires maintained minimum light levels across all spacings while significantly increasing overall uniformity. Improved uniformity means that the minimum illuminance levels of the installation can be achieved with fewer, more effectively used lumens. As LEDs have a much flatter lumen depreciation curve over their lifetime in comparison with traditional light sources, the need for initial over-lighting is also reduced.

A survey of residents indicated a strong and consistent preference for the new streetlights. Much of this appears to be attributable to improved visibility for drivers and pedestrians and the overall positive effects of the new streetlights on several aspects of the neighborhood's overall appearance and nighttime safety.

Economic Performance

The LED luminaires yielded an annual combined energy and maintenance savings of $42 per luminaire when compared to HPS luminaires maintained under a spot replacement scheme, and $33 per luminaire under a group replacement scheme. The LED luminaires were assumed to have zero regular maintenance cost over the course of their useful life. In a new construction setting, where these luminaires are installed instead of HPS luminaires, the simple payback periods for the LED luminaires (based on their current cost) is between 12 and 15 years, depending on the maintenance scheme. In a retrofit setting where the LED luminaires are installed in place of HPS luminaires, the corresponding simple payback range from 20 to 26 years. A range of simple payback values for new construction based on the assumed maintenance savings are graphically illustrated in Figure 1.

Because the expected useful life of LED products corresponds to several years, empirical data does not yet exist to support the projected values. Economic and reliability claims are therefore based on the best available information from the manufacturer and DOE reports. The payback periods in this particular case study correspond to a range of roughly 50,000 to 100,000 hours of operation. It should be noted that the manufacturer provides a 5-year warranty (20,500 hours of operation at 4,100 hours per year), although a much longer useful life is anticipated.

Conclusions

The potential for energy savings from LED street lights is very large. Although the results of this assessment estimated a relatively long payback period for this specific LED street light product under current conditions, other performance attributes combined with operating cost savings may be such that longer payback periods are acceptable. These could include various benefits from improved visibility, as highlighted by a survey of residents on the new LED lighting.

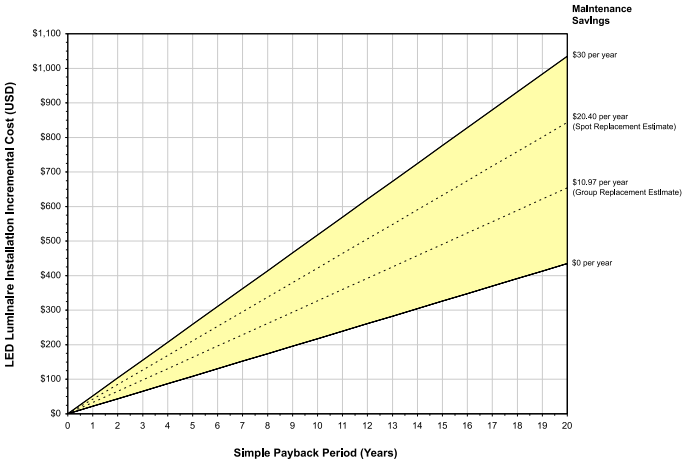


Figure 1: Estimated New Construction Luminaire Payback

For Program Information on the Web:

http://www.netl.doe.gov/ssl DOE sponsors a comprehensive program of SSL research, development, and commercialization.

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