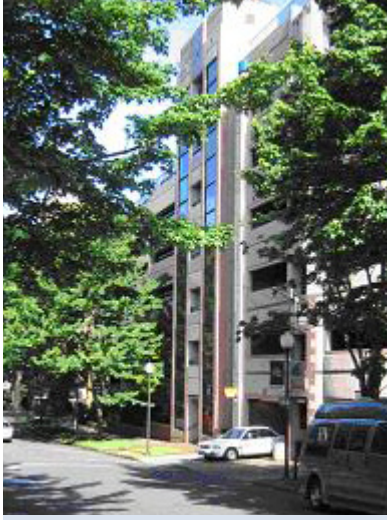
GATEWAY DEMONSTRATIONS

Lighting with LEDs: Area Lights for Commercial Garage

Providence Portland Medical Center, Portland, OR
Garage Lighting Report Brief



Outside view of PPMC garage.

Background

Parking lots and garages present a challenging environment for lighting. The illumination system must accommodate both vehicular and pedestrian traffic, endure harsh operating environments, and address public safety considerations as well as lighting quality issues, all in the most economical way possible. Excessive shadows in parking facilities can present safety hazards to pedestrians as well as drivers attempting to navigate various barriers and obstacles, and can also present security concerns. On the other hand—particularly at the low fixture mounting heights often found in parking garages—achieving the desired illumination distribution may require a large number of fixtures or may cause glare problems.

Most commercial garages use area luminaires for general illumination, typically with high-pressure sodium (HPS), metal halide (MH), or linear fluorescent lamps. HPS lamps are used because of their low cost, high efficacy, and long life. MH or fluorescent sources typically have shorter lives but produce a whiter light with much better color rendition.

A number of solid-state lighting-based (SSL-based) luminaires (products using a LED light source) have been recently introduced into the market because many inherent characteristics of LEDs coincide well with the needs of parking applications. Well-designed SSL-based fixtures have the potential to provide greater control of light distribution, better light color quality, longer life, and energy savings when compared to most traditional light sources.

This U.S. Department of Energy GATEWAY Demonstration project studied the applicability of LED luminaires for a commercial parking garage serving a hospital in Portland, Oregon. Participants in the project included the U.S. Department of Energy, Providence Portland Medical Center (PPMC), the Energy Trust of Oregon (ETO), and Lighting Sciences Group (LSG) Inc. Pacific Northwest National Laboratory (PNNL) conducted the measurements and analysis of the results.

Project Description and Results

The existing HPS area luminaires at the hospital were replaced with new LSG LED luminaires with quantitative and qualitative measurements of light and electrical power taken for both fixture types. Two versions of the LED luminaires were used in this demonstration: an existing version (Version 1), which had been available on the market since 2007 and a newer version (Version 2) introduced during the demonstration period, which has 30% more light output and uses about 8% less power than Version 1. Six Version 1 luminaires were installed in the below-ground parking Level A of the PPMC, replacing six existing 150W HPS fixtures spread out over two rows of parking spaces.

Illuminance measurements were taken at floor level on an approximately 60-ft x 40-ft grid. Version 2 of the LSG luminaire was installed in Level B of the PPMC parking garage. Onsite illuminance measurements were not taken for this second luminaire due to high traffic conditions; however, power and photometric measurements were obtained separately from an independent testing laboratory and used with commercial simulation software to develop illuminance estimate for the garage.

All three luminaires provide higher minimum illuminance levels than the minimum level recommended (1 fc on the horizontal surface) by the Illuminating Engineering Society of North America (IESNA). However, Version 1 of the LSG LED luminaires provided lower average illuminance levels across the parking spaces than the HPS luminaires they replaced. Version 2 of the LED luminaire, with its higher light output, is projected to provide slightly higher minimum illuminance levels than the HPS luminaires. Table 1 below contains a summary comparison of the illuminance levels.

This Report Brief provides a summary of a full Gateway Demonstration report available on the DOE Solid State Lighting website at: www.ssl.energy.gov/gatewaydemos.html.

Table 1. Illuminance comparisons between HPS and two versions of the LED luminaire.

	Existing HPS Fixture	LSG Low Bay V.1	LSG Low Bay V.2 (Projected)
Max Light Level (fc)	23.51	20.54	26.70
Min Light Level (fc)	1.49	1.46	1.88
Average Light Level (fc)	6.6	4.6	6.0
Average to Min	4.5	3.2	3.2
Max to Min	15.8	14.2	14.2

Maintenance and security personnel responses to the new light sources on Level B of the parking garage were next gauged with a written survey. Six of nine respondents felt the LED luminaires provided the same or more light than the HPS sources, and all respondents expressed a preference for the new fixtures when viewing the relamped area through a security camera. Respondents said the LED luminaires produced less glare, that they had a positive impact on visibility, and that they improved the overall appearance of the area.

Economic Performance

Economic performance was evaluated primarily by calculating the simple paybacks for the LED versus the HPS fixtures. To calculate simple payback, current energy, labor, and materials costs were used to calculate annual maintenance and energy cost. Two average electricity rates were used: a commercial rate local to Northeast Portland from Portland General Electric (6.5 cents per kWh – Rate Schedule 89) and an average national rate (11 cents per kWh). Under these rates, the LSG LED luminaires yielded annual energy savings of between $62 to $109 per unit when compared to the existing HPS luminaires, based on 24 hours of use per day.

Simple payback periods were calculated for retrofit and new construction scenarios for each of the rate schedules, all assuming 24 hr/day operation. The retrofit scenario assumes an operational HPS luminaire is already in place and, therefore, the full cost of the LED luminaire ($470) is figured into the payback calculation. Simple payback for the retrofit scenario is from 3.9 to 6.5 years depending on the price of electricity and the specific luminaire examined (i.e., Version 1 or Version 2, see Table 2). In a new construction situation, only the differential cost of the LED luminaire relative to the HPS luminaire need be taken into account. Based on this cost differential, the corresponding payback drops to between 1.7 and 2.6 years.

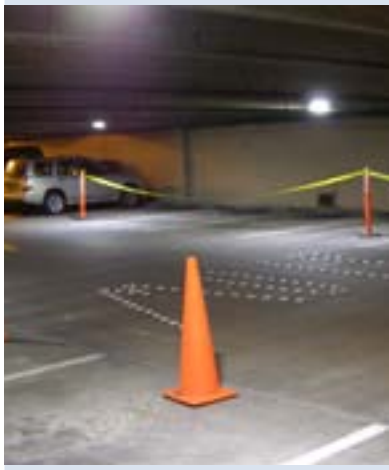
Table 2. Energy savings and simple payback for retrofit and new construction scenarios.

	Unit Cost	Luminaire Watts	Hrs/day Use	Annual kWh	Annual Cost of Lamps	Annual Operating Cost @ 6.5c/kWh	Annual Operating Cost @ 11c/kWh	LED Payback			
								Retrofit Existing		New Construction	
								Years @ 6.5c/kWh	Years @ 11c/kWh	Years @ 6.5c/kWh	Years @ 11c/kWh
LED V1	$470	82[1]	24	719		$ 46.75	$ 79.11	6.5	4.1	2.6	1.6
LED V2	$470	78[2]	24	683		$ 44.41	$ 75.16	6.3	3.9	2.7	1.7
HPS	$275	191[1]	24	1674	$10.50[3]	$119.32[4]	$194.66[4]				

[1]Measured
[2]Rated
[3]Incl. Labor
[4]Incl. Electricity and Replacement Costs

The manufacturer of the LED product investigated in this demonstration claims a useful product life of 50,000 hours (at least 70% of initial luminous flux is maintained). Actual field performance data do not yet exist to support the projected values. However, accumulated engineering knowledge and known performance of previous generations of LEDs indicate such long lives are well within possibility for well-designed luminaires. Economic and reliability claims used in this analysis are based on life and reliability information from the manufacturer. The manufacturer provides a 3-year warranty for the investigated products.

Original HPS garage lighting.



New LED garage lighting.

For Program Information on the Web:

www.ssl.energy.gov
DOE sponsors a comprehensive program of SSL research, development, and commercialization.

For Program Information:

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