GATEWAY DEMONSTRATIONS

Outdoor Area Lighting with LEDs: FAA Technical Center Report Brief

As the focus of a U.S. Department of Energy (DOE) SSL Technology Gateway Demonstration, six high-pressure sodium (HPS) fixtures were replaced with six light-emitting diode (LED) luminaires mounted on 14-foot poles along a set of exterior walkways at the Federal Aviation Administration (FAA) William J. Hughes Technical Center in Atlantic City, New Jersey. The effort was undertaken as a team effort in December, 2007 involving DOE, the FAA and Ruud Lighting (and their wholly owned division, Beta LED). Measurement and analysis were conducted by Pacific Northwest National Laboratory (PNNL).

In this project, the SSL product demonstrated energy savings of more than 25% while maintaining illuminance levels and improving illuminance uniformity, compared to new HPS lamps installed in the existing luminaires at the site. The Beta LED product is modular, consisting of a series of "light bars" that each contain 20 LEDs. Adding (or subtracting) light bars from a given fixture increases (or decreases) light output, energy use, and final cost. The fixtures selected for this application used a 3-bar (60 LED) configuration designed to produce illuminance levels similar to the existing HPS luminaires. However, computer simulation determined that 2-bar (40 LED) luminaires would also easily provide the Illuminating Engineering Society of North America (IESNA) recommended minimum level of illumination needed for this application (0.5 fc), while going to the lower wattage luminaire would significantly improve the economic payback achieved.

Table 1 summarizes the energy savings for this demonstration project and shows that the SSL installation both saved energy and improved the lighting quality in this demonstration.

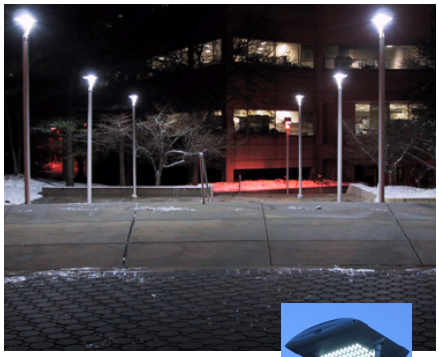
Table 1. Existing Lighting Data and Results from LED Replacement Luminaires

	Existing 70W* HPS	New 3-bar Luminaire	Optional 2-bar Luminaire
Average illumination levels	3.54 fc	3.63 fc	2.42 fc
Max/Min Ratio**	6.04:1	2.68:1	2.68:1
Minimum illuminance	1.25 fc	1.90 fc	1.27fc***
Total power draw****	97W	72W	48W
Energy consumption per luminaire	425 kWh/yr	311 kWh/yr	210 kWh/yr
Energy savings per luminaire	N/A	114 kWh/yr (26.8%)	215 KWh/yr (50.6%)

*Nominal wattage.
**Measurement of lighting uniformity; lower ratios indicate more uniformly lighted area.
***Calculated value
****Energy consumption for the HPS system is based on manufacturer-rated power levels for lamps and ballasts, multiplied by 4380 hours per year. Energy consumption for the 3-bar LED unit is based on laboratory power measurements multiplied by 4380 hours per year. Energy consumption for the 2-bar unit is based on manufacturer-rated power levels multiplied by 4380 hours per year.

Original HPS Luminaires

Close-up of Original HPS



New LED Luminaires

Close-up of 3-Bar LED

The focus of the DOE Gateway Demonstrations is to identify new SSL products that achieve three goals:

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: www.netl.doe.gov/ssl/techdemos.htm.

Tables 2 and 3 display the results of an economic analysis using 2-bar and 3-bar LED luminaires across a range of scenarios. The scenarios vary two important aspects of the situation: whether or not maintenance savings are included in the estimates and whether or not the original HPS fixtures are destined for replacement regardless of what they will be replaced with. The second factor means the LEDs are being compared against fixtures at both mid-life (Table 2) and at their end of life (Table 3- note that these values also apply to evaluation of a new installation). Payback ranges vary widely depending on how these factors are treated.

Table 2. Results of Economic Analysis for Replacing Fixtures at Mid-Life

Base Case	Alternative Case	Net Savings*	Savings to Investment Ratio (SIR)	Adjusted Internal Rate of Return (AIRR)	Simple Payback (Years)†	Discounted Payback (Years)†
HPS, existing fixture, energy only (no maintenance)	3-bar SSL	($804)	0.14	-5.57%	—	—
HPS, existing fixture, including maintenance	3-bar SSL	($68)	0.93	2.66%	18	—
HPS, existing fixture, energy only (no maintenance)	2-bar SSL	($478)	0.39	-1.17%	—	—
HPS, existing fixture, including maintenance	2-bar SSL	$258	1.33	4.29%	13	16

*Net Savings is the Life Cycle Cost (LCC) of the Alternative Case subtracted from the LCC of the Base Case.

†A blank space indicates that payback is not achieved within the design lifetime of the LED (23 years or 100,000 hrs). 4380 hours per year. Energy consumption for the 2-bar unit is based on manufacturer-rated power levels multiplied by 4380 hours per year.

Table 3. Results of Economic Analysis for Replacing Fixtures at End of Life

Base Case	Alternative Case	Net Savings*	Savings to Investment Ratio (SIR)	Adjusted Internal Rate of Return (AIRR)	Simple Payback (Years)†	Discounted Payback (Years)†
HPS, replace fixture, energy only (no maintenance)	3-bar SSL	($224)	0.36	-1.45%	—	—
HPS, replace fixture, including maintenance	3-bar SSL	$513	2.46	7.14%	7	7
HPS, replace fixture, energy only (no maintenance)	2-bar SSL	$103	1.51	4.87%	10	12
HPS, replace fixture, including maintenance	2-bar SSL	$839	5.16	10.67%	3	3

*Net Savings is the Life Cycle Cost (LCC) of the Alternative Case subtracted from the LCC of the Base Case.

†A blank space indicates that payback is not achieved within the design lifetime of the LED (23 years or 100,000 hrs).

In sum, both the original lighting and the replacement 3-bar LED luminaires (sized to match original levels of illumination) provide significantly more light than the IESNA recommended minimum for exterior walkway applications (0.5 fc average). Such "over-lighting" directly translates into higher costs than necessary, both in terms of energy used and in fixture capital costs. For this reason, a 2-bar LED luminaire could be considered for installation at this site. However, either the 2-bar or the 3-bar luminaires can potentially meet a payback criterion of 10 years or less, depending on what they are being compared against.

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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