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GATEWAY Demonstration: LED Lighting in a High-Temperature Environment



High-flux lighting applications in high-temperature environments present a formidable challenge for LEDs. The higher the luminous flux from a luminaire, the more difficult it can be to properly dissipate the heat, to prevent damage to the

electronic components and LED packages; and this is made even more difficult by high-temperature environments. To learn more about how this type of environment affects LED lumen and color maintenance, luminaire efficacy, and luminaire component lifetimes, DOE's [GATEWAY](#) program is documenting the LED retrofit of the incumbent quartz metal halide (QMH) area lighting along a 7.2-mile stretch of the Yuma (Arizona) Sector Border Patrol Area between the U.S. and Mexico, where temperatures at sunset can exceed 100° F. Although a border lighting application is unique, high-flux and high-temperature applications are not, and in the U.S. they include high-security exterior lighting (e.g., correctional facilities and military bases) and, more generally, street and area lighting.

The Yuma Sector retrofit is a DOE [Federal Energy Management Program](#) (FEMP) Energy Savings Performance Contract (ESPC) ENABLE project administered through the General Services Administration (GSA). Through the ESPC ENABLE process, an energy service company (ESCO) was selected for the retrofit, and Eaton's Cooper Lighting Business designed the lighting system and manufactured the luminaires. The goal was to achieve a minimum energy savings of 50% while maintaining existing light levels, and the application also presented an opportunity to improve lighting quality.

The specific area of interest was between the primary fence marking the U.S.-Mexico border, and a secondary fence set back 125' from the primary fence. This spacing between the primary and secondary fences, coupled with 180' pole spacing, required each LED luminaire to cover roughly 11,250 square feet with an approximate average illuminance of 25 lux (lx) at a 40' mounting height.

The ESPC ENABLE process required an investment-grade audit, which was conducted in February 2014. Two LED luminaires were installed on each of three sequential poles as a trial demonstration of the proposed design solution for U.S. Customs and Border Protection (CBP) approval, prior to the task award. A [new GATEWAY report](#) presents the initial findings from this trial demonstration and is the first in a planned series that will document the installation of LED luminaires throughout the Yuma Sector. The final system design and luminaire selection by CBP are ongoing.

In the trial demonstration, the new LED system was found to equal or better the QMH system in terms of both uniformity and illuminance, when comparing the initial output of the LED system and the maintained output of the QMH system, which had been operating for an unknown number of hours. The average illuminance of the two systems was comparable, with the LED system exceeding the QMH system for all horizontal illuminance measurements taken between the primary fence and the pole, and for vertical measurements taken on the primary fence. The vertical illuminance on the primary fence increased by more than 100% with the LED system, relative to the QMH system. The average horizontal and vertical illuminance on the secondary-fence side of the pole was slightly lower with the LED system than with the QMH system.

Night is when the most activity occurs in the Yuma Sector Border Patrol Area, so it was important to ensure that the lighting system would help the agents perform their duties. The LED lighting system installed for the trial demonstration confirmed LED technology's ability to reduce energy consumption and improve lighting quality. That lighting system had been on the market less than two years, yet at the time of installation, an upgraded system that incorporated a newer-generation LED package was due to come on the market within the next several months. That upgraded lighting system provided improved efficacy and optical distributions, requiring lighting system design modifications that resulted in an expected energy savings of 69%.

The expected annual maintenance cost savings include considerable reductions in maintenance visits required by the contractors as well as savings in CBP staff time and resources. The retrofit includes a 24' reduction in pole height, which increased

projected energy savings due to a reduction in lumen output required at a lower height, and decreased expected annual cleaning costs due to reduced lift and labor costs. The advanced optical system of the selected luminaires improved the uniformity of the lighting system, despite the reduction in pole height. The combination of the optics and lower pole height reduced stray light considerably.

The Yuma Sector Border Patrol Area lighting retrofit trial demonstration displayed the potential of LED technology to improve lighting quality and reduce energy consumption. DOE plans to continue to track the progress and performance of this installation over the coming months. If high-flux LED technology performs well in a region with high ambient temperature and solar radiation, it can perform well in most outdoor environments.

For details on this project, see the full report, which is available on the [DOE website](#).

As always, if you have questions or comments, you can reach us at postings@akoyaonline.com.