Street Lighting Technology Research

In conjunction with
Indiana Department of Transportation
Indiana Municipal Utility Group

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Modern Lighting Benefits

- Reduced cost (electric and maintenance)
- Increased reliability
- Whiter light than high pressure sodium.
- Energy savings → reduced emissions
- Improved safety
- Improved perception of neighborhood
- Reduced maintenance and longer life
- Light levels can be controlled by use and time of day or activity level
Iterative implementation process that considers the specific needs of a region

- INDOT / Energy Efficiency and Reliability Center (EERC) has been testing highway luminaires for ~2 years to assess luminaires that provide the most benefit.
  - Testing conducted in the laboratory at EERC and in the field (INDOT sites).

- There are reported successes and failures
  - Often the negative outcomes resulted from lack of a comprehensive design as well as use of equipment that was not designed for the particular application or was technically behind the current state of the art.
Modern Lighting Is Being Widely Implemented

- In the City of Los Angeles "Bright Lights, Safe Nights" program a total of 167,028 (March 2016) of the existing 210,000 street lights have been converted from principally HPS to LED.

- Crime statistics comparing 2009 to 2012, as reported by the local police, indicate < in Theft From Vehicles of 10.67%, a < in Burgulary-Robery-Theft of 6.40%, and a < in Vandalism of 10.90% for a total decrease in these categories of 8.9%.
• In shifting to an optimized white light, visibility is increased resulting in both increases in safety as well as the perception and enjoyment of the community at night.
• As stated by the Urban Age Institute, "It is however also becoming apparent that modern LED lighting increases citizens' sense of safety, makes cities more inviting for tourism, and increases productivity at our workplaces (without having to work harder)."
Virginia Tech Research Study Compared the lighting level to crash rate ratios for 83,000 crashes and 2000 miles of roadway lighting.

Source: Design Criteria for Adaptive Roadway Lighting, FHWA-HRT-14-051, July 2014
There isn’t a generic luminaire that can satisfy all needs.

Maximizing value requires consideration of luminaire design for a particular application.

The number of luminaire types can be controlled and most of the benefit can still be obtained.
High Mast Testing
“Favorite Failures”

Power Supply/Driver components
LED failures (shorts, connections, board)
Moisture ingress, corrosion
Power quality (surge, noise,..)
Materials-related lumen depr
Color shift (materials related)
Color shift (LED)
Sensors, controls
Thermal Testing
Driver Reliability Testing
Initial Lumen Depreciation
Lumen testing Results Example

Horizontal Illuminance Test Matrix Data

[Graph showing data points and lines on a 3D graph with axes labeled: Illuminance (Lux) on the y-axis, Test Point on the x-axis, and Day on the z-axis.]
INDOT Entrance Ramp Cobra Head Test
Identification of Test Problem

Spectra Comparison

Laboratory test data multiple duplicate data sets
4181 K

Data from last test site mid span
3875 K
INDOT High Mast Field Test
Perception of light quality

- White light improves perception of objects and ability to sense motion (human eye is the light sensor) when compared to monochromatic yellow light from HPS.
- Perception of glare can vary from person to person.
LEDs can cause glare, which may negatively impact adoption if not implemented correctly.
Impact on Neighborhoods

- Lighting assists in efforts to revitalize blighted or deteriorating neighborhoods.
- In street light performance tests conducted by the EERC in the field on city streets it has been noted that the white light of LED luminaires makes it easier to detect vehicles, detail and motion in the areas illuminated by LED street lights as compared to HPS light.
- It’s clear that LED street lights reduce safety concerns related to traffic during the data collection process.
- Transitioning to LED street lights substantially improves nighttime vision, safety, and security thereby helping improve neighborhoods as a whole.
- LED benefits contribute to revitalization of areas by improving both the quality and the penetration of lighting.
- Good road lighting contributes to a feeling of security by residents.
Opportunity to introduce new luminaires that have much higher efficiency and improved light quality as compared to HPS or mercury vapor.

- HPS luminaires are often not readily available as the technology is being displaced by LEDs.
- If sequenced in a consistent manner, a graded program over time will provide significant savings in energy and maintenance and overall improved value – Probabilistic Life Cycle Cost Analysis
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