U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Pedestrian Friendly - Outdoor Lighting - December 2013

Executive Summary

Nighttime outdoor lighting has most often been designed for the vehicle driver, rather than the pedestrian. Metrics such as pavement illuminance or luminance, illuminance uniformity ratios, vertical illuminance on objects or faces, and glare metrics such as Veiling Luminance Ratio or Glare Ratings from the Illuminating Engineering Society (IES) Luminaire Classification System (BUG) have been used as criteria. The U.S. Department of Energy GATEWAY Demonstration Program has followed two pedestrian-focused projects at sites where the pedestrian-scale lighting needed improvement: Stanford University in California and the Chautauqua Institution in upstate New York. The results from these projects reveal that pedestrians may have different criteria and priorities than drivers, especially in areas where cars are subordinate to bicycles and users on foot.

At both sites, an iterative process was used to evaluate luminaires; collect feedback from residents, homeowners, and/or campus facilities groups; and use that feedback to try other options. In both cases, it became clear that users

- cared about the daytime appearance of the luminaire
- found luminaire glare to be a significant factor in luminaire acceptability
- preferred luminaires that produced a soft-edged pattern of light on the ground
- found that horizontal illuminances could be at the low end of IES-recommended levels as long as luminaire glare was reduced.

Diffusion was an important characteristic of optical systems deemed less glaring. Light-emitting diodes (LEDs) or clear metal halide arc tubes exhibit high variation of luminance across the face of the luminaire, but diffusion from frosted refractors and flat glass panels was judged as less glaring, even when measured spot luminances were high. Smoothing out the luminance transition from high to low resulted in responses of greater visual comfort, even though glare metrics do not take this into account.

Traditionally, the outdoor luminaire's "glare" angles have been 75° to 90° from nadir. These projects gathered observations and responses that suggest that although pedestrians may be affected by glare from these angles when they are far away from a post-top luminaire, they are most uncomfortable when they are walking within the zone from 0° to 75°, that is, when they are closer to the luminaire and when the highest luminance elements are within or even above the field of view. This may be related to overhead glare that has been studied in interior applications, or it may be related to the fact that pedestrians

naturally glance around their surroundings as they walk, putting the luminaire in the field of view as their eyes look upward.

Every outdoor lighting project is different. The needs vary according to the project client, the users, and their activities, and therefore the best lighting solution will also vary from project to project. There are invariably tradeoffs that must be weighed among visual comfort, color, visibility, efficacy, and other factors. There is no glare metric that works reliably for pedestrian lighting, so full-scale mockups are an important step for gathering feedback from users. Not every neighborhood is suited for pedestrian-friendly approaches, but where communities are receptive, the following **may help mitigate glare, improve visual comfort and visibility, and make outdoor spaces more inviting**:

- lower lumen output luminaires and lower illuminances, if luminaire brightness can be controlled
- luminaires that spread luminance ("brightness") over a larger area
- luminaires with less optical punch and less sharp angular variation in candlepower
- luminaires delivering warmer color light, usually lower than 4000K, and often below 3000K correlated color temperature.

The problems of pedestrian lighting occur with all technologies, but LEDs offer unique optical options and opportunities to the industry. This report is meant to stimulate discussion among specifiers, users, energy specialists, and industry in hopes that new approaches, metrics, and standards can be developed to support pedestrian-focused communities, while reducing energy use.

http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2013_gateway_pedestrian.pdf

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