TECHNOLOGY

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Next Steps: Five principles for responsible outdoor lighting

LED lighting hit the outdoor market in 2010 as the next generation of lighting to replace conventional HID sources. LEDs save money through reduced energy consumption and longer lifetimes—and unlike previous outdoor lighting technologies, LEDs offered a range of color temperatures and color qualities, greater control over the light distribution and instant On/Off/Dim capabilities.

We now know that the capabilities of LED as a light source require a deeper understanding of the relationships between the lighting conditions and the visibility and safety enabled by the lighting. While LEDs offer a broader range of performance, they also require more careful specification and selection by the lighting customer to make full and appropriate use of their capabilities. In many ways, the science, guidance and practice of lighting, particularly outdoor lighting, needs to catch up with the new set of capabilities offered by LED technology.

Outdoor lighting is provided at night for safe navigation, a sense of reassurance, detection of hazards, and enjoyment of spaces. However, human-created or "anthropogenic" light in the outdoor nighttime environment has negative impacts, including ecological disruptions, increased sky brightness, and impacts on specific at-risk animal species. This increased appreciation and understanding of the impacts of light at night has brought forth a challenge: balancing the intended function of light at night—typically, human visibility and safety—with these negative environmental impacts.

> The practice of outdoor lighting needs to catch up with the new set of capabilities offered by LEDs

Photo by Caroline Reilly, SSLS, Inc.

The light dome over Los Angeles, CA in December 2021 as seen from about 75 miles away at Channel Islands National Park.

Light at night has ecological consequences in cities and protected areas—the balance-of-function of the lighting and its consequences will be different depending on the setting. The roles of lighting in both types of settings need to be better understood to make more-informed lighting decisions, and with ongoing research our understanding will continue to improve over time. Though LED technology has been adopted for outdoor applications because of the energy savings it offers--and energy savings is a critical, global-scale consideration—careless use of LEDs at night is a growing concern.

Updated lighting guidance

and standards represent an obvious answer. In 2022, the IES combined multiple exterior lighting committees and launched the Outdoor Nighttime Environments (ONE) Committee, which includes lighting designers, manufacturers, practitioners, ecologists, animal scientists and technologists working together on the next generation of guidance and standards for light at night. Specifically, the committee was created to identify the topics surrounding anthropogenic light at night, remove redundancies, and fill gaps by seeking out research, science and subject-matter experts to help inform recommendations on outdoor lighting.

The committee currently writes and maintains IES standards covering the visual aspects of outdoor lighting for general pedestrian applications, inclusive of non-roadway areas, in an environmentally responsible way. However, as with any standards activity, developing consensus guidance can be slow, particularly when the underlying scientific understanding is evolving.

While still in its early days, the committee has begun updating lighting zone definitions to support appropriate target light levels in different settings. The committee has also worked on updating lighting practices for parks and protected places; developed a draft calculation to enable specifiers to evaluate the amount of uplight from outdoor installations; and created an ecological advisory group.

Agreement has been reached between the IES, the International Dark-Sky Association and the U.S. National Park Service on a set of general guidelines for the use of light at night. These are the "Five Principles for Responsible Outdoor Lighting," (**Table 1**). Lighting designers should ask themselves:

- **Is the light useful?** Before installing or replacing a light, determine if the light is needed in the first place. Does it add to the safety or enjoyment of the setting? Consider how the use of light will impact the surrounding area, including wildlife and the environment. Might reflective paints or self-luminous markers for signs, curbs and steps reduce the need for permanently installed outdoor lighting?
- **Is the light targeted?** Improved optical control enabled by LED technology can reduce the total amount of light necessary to achieve the intended light levels on a target while minimizing off-target light and eliminating upward-directed light. As we know, light that's directed upward is the biggest contributor to sky brightness.
- **Is the light level low enough?** More isn't better when it comes to light at night, and the light level should be the lowest required.
- **Is the light level controlled?** Controls, such as timers or motion detectors, can help ensure that light is available when it's needed, dimmed when possible, and turned off when unnecessary, or when there are seasonal ecological considerations.
- **What's the color of the light?** Use warmer colors of light where possible to mimic nature and circadian rhythms, and limit the amount of shorter wavelength light to the minimum necessary. But don't forget to take the other four principles into consideration. Animals can be negatively affected by all wavelengths of light and all wavelengths of light contribute to sky glow, so reducing the total amount of light and the On time of lighting should be the first priorities.

Looking forward, we need

more research on both the positive and negative impacts of light at night so we can guide users to an optimal balance between human needs and environmental effects in different settings. LED lighting can provide precision optical distributions and a range of spectral power distributions. We need to know the best options for human safety and visibility while also eliminating non-useful lighting and minimizing the total amount of necessary light in order to reduce environmental impacts. It is clearly possible, with intentional design, to simultaneously reduce the total amount of light used at night while also improving the safety and effectiveness of outdoor lighting.

The Five Principles can serve as a good starting point while the process of developing guidance in the form of standards and best practices continues. The energy savings and related carbon reductions with LED lighting technology have already had a massive environmental benefit. Now LED technology has enabled an additional opportunity to reduce the environmental impacts of light at night. We need to grab this opportunity with both hands to make the world a safer place for all those in it.

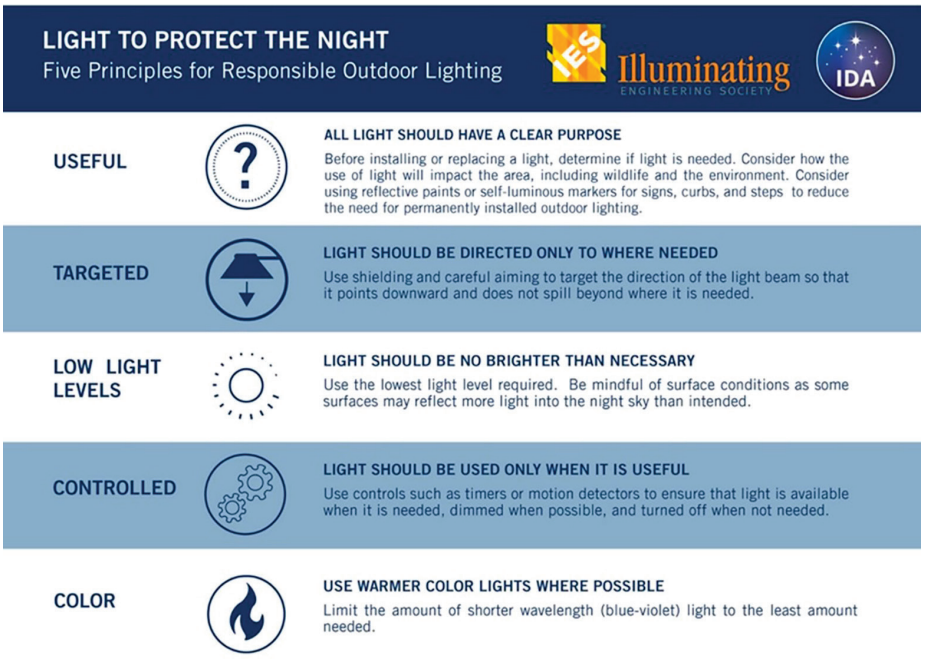

Table 1.

Morgan Pattison is the founder/president of Solid-State Lighting Services, Inc., providing technical, strategic and market expertise in the areas of LEDs, OLEDs, lighting, SSL, displays, optoelectronic materials and devices. Pattison is a senior technical advisor to the U.S. Department of Energy Lighting R&D Program and lead author of the DOE Lighting R&D Opportunities document. He currently serves as chair of the IES ONE Committee.

Rick Utting is the brand ambassador for Clanton & Associates, lighting design and engineering firm. Focused on pedestrian vision and the environmental sustainability of outdoor lighting, he currently serves as vice chair of the IES ONE Committee. Previously, Utting helped author two ANSI/IES lighting design standards for people in outdoor environments. From 2007 to 2019, he served as the director of lighting for Landscape Forms.