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LED Street Lighting – Summary and Recommendations

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What is the issue?

Currently, most street lighting has used high-pressure sodium (HPS) technology that emits an orange yellow light to improve night visibility for vehicles and pedestrians. This type of street lightening is gradually being replaced with light emitting diode (LED) street lightening systems due to cost and energy savings compared to HPS lighting.

Concerns over this change centers around the fact the LED street lightening systems typically emit more short-wavelength light (termed "blue light" or "blue spectrum light") than HPS technology and the potential health and safety impacts associated with this technology. Therefore, to address this concern, the following sections will focus on the discussion and explanation of the blue light spectrum emissions from LED lamps.

What is "blue light" and why the concern?

"Blue light" describes a range of wavelengths that have been defined slightly differently dependent upon the literature source used as reference; typically falling between 424 nm to 500 nm. Currently, the most common white LED light sources utilize LED chips that emit light within this wavelength range but then passes through a phosphor layer that converts the majority of the output into longer wavelengths. This conversion into longer wavelengths produces emissions that are typically in the green, yellow, orange, and red part of the light spectrum; it is the mixture of these colors produces the white light perceived by the eye. Despite the conversion and mixture there would be some output that would remain in the shorter wavelength spectrum.

Due to the lack of consensus, the term of "blue light" can be misleading; therefore, more attention should be given to both the actual wavelength range emitted by the light source and the spectral power distribution (SPD) of the source. The SPD determines how the light source affects the appearance of objects illuminated by the light and the potential scattering characteristics within the atmosphere; whereas wavelengths in "blue light" range included in the formation of the white LED light can adversely influence melatonin production. Both the SPD and the wavelength of the emitted lighted can affect

visibility and safety, environmental light pollution, disruption of wildlife environments, and potential human health effects associated with the “blue light” wavelength range.

What are the associated health impacts of the “blue light” range?

Any potential health affect derived from exposure, environmental or otherwise, is dependent upon the duration, frequency, and intensity of the exposure. The proper amount of exposure to short-wavelength light is an essential component of a number of human physiological processes including the circadian rhythm (the “biological body clock”) that controls sleep/wake cycles. In this specific case, the concern centers around exposure to short wavelength light during the night that, dependent upon the level of exposure, could disrupt this circadian rhythm. The potential result of this disruption is an increased risk of a variety of associated adverse health effects such as sleep disturbances, reduced quality of sleep, impaired daytime productivity and functioning, thermoregulation, blood pressure, and obesity due to suppressive effect of melatonin levels.

However, it must be noted that these potential health impacts are not unique to LED light sources but other exposures that lead to the disturbance of the circadian rhythm have also had similar reported health implications. For example, similar impacts have been observed from exposure to lighting conditions during evening/night employment and excessive levels of screen time to electronic devices and cellular phones.

Another concern is the potential increase in glare following the installation of LED light sources as street lighting due to the concentration of light and emissions in the shorter wavelength range. The higher the emission of light in the blue light spectrum the greater the potential for worsening glare that results in pupillary constriction. The ultimate result is decreased visual acuity that could threaten driver and pedestrian safety.

What are the benefits of LED streetlights?

The use of LED white light street lighting systems provide economic and energy savings due to higher energy efficiency and longer life. The use of this technology provides greater control over where the light is directed for illumination, visibility, and safety purposes compared to the HPS street lighting system that has limited directional control of the emitted light. In other words, the LED system can meet the same illumination requirements as conventional streetlights while emitting less light – reducing exposure to short wave light content and less reliance of fossil fuels to power these systems. The LED systems can also be adjusted to allow only the level of illumination needed at any given time to be provided in a specific area. In addition, these systems provide a high degree of control over the pattern and the evenness of illumination in comparison to conventional streetlight systems that emits light in all directions. Each of these factors allows the LED systems to increase visibility and potential safety and limit light pollution and glare if designed and managed appropriately.

Recommendations

The potential health impacts associated with LED street lamps is not unique to this specific light source and may result from any source of excessive exposure to light during nighttime hours. However, the potential risk for the disruption of human circadian rhythms and disruption of wildlife environments must be acknowledged. This information should be used to guide the design and management of any LED street lightening system to ensure that they are appropriate for the community to improve visibility and safety but minimize potential risks to community and environmental health.

Several recommendations from the literature, including those published by the American Medical Association (AMA), provide insight into strategies that could be incorporated into community LED street lighting systems that would capitalize on the benefits of this technology in economic and energy cost savings but guard the health of the community. These are shown below:

a.) LED lighting should be properly shielded in order to minimize glare and light pollution into the surrounding environment including the improvement of stellar visibility (or sky glow).

b.) Minimize the amount of emitted light in the “blue light” wavelength spectrum from the LED light source by the selection of the most appropriate lighting technology for the intended area of illumination and appropriate management processes for light emission.

c.) Provide only the level of illumination needed at any given time to a specific area by the focusing the direction of the emitted LED light and dimming the light output during off-peak hours in order to decrease exposure to shorter wavelength emissions, reduce the amount of energy consumed, and increase the life of the light source.