Assessing Sky Glow — It Depends...

Sky glow, the brightening of the night sky by outdoor lighting, can be undesirable. The amount of sky glow depends on the characteristics of the sensory apparatus evaluating it. Thus, the methods used to quantify sky glow must take the spectral, spatial and absolute sensitivity of the detector into account for a meaningful assessment.

Should the same visual criteria be applied to both of these scenes?

Do you want to resolve individual stars or experience the entire Milky Way?

Our visual system is often used to evaluate sky glow, but the visual system is not a single detector. Rather, the visual system employs different eye-brain channels to perform different visual tasks. The channel responsible for high spatial resolution by cones in the fovea, used to thread a needle or count the stars in a constellation, has a photopic spectral sensitivity similar to that used in conventional light measurement devices. The overall impression of the night sky brightness, however, depends upon a different, whole-retina channel with a scotopic spectral sensitivity representing the rod photoreceptors that are much more sensitive to short-wavelengths than cones in the fovea. Thus, in assessing the impact of sky glow for human visual assessments, it is necessary to employ a detector, virtual or real, that accurately reflects the characteristics of the relevant visual channel.

Relative contributions to sky glow for different design specifications and detector characteristics*

Measurement Direction	Light Source	Lighting Design Criterion	Scattered Radiant Flux	Scattered Photopic Flux	Scattered Scotopic Flux
Zenith	HPS	Photopic illuminance (base case)	1.00	1.00	1.00
	6500 K LED	Photopic illuminance	1.78	1.20	3.63
	6500 K LED	Brightness illuminance equal to brightness illuminance of HPS base case	0.96	0.65	1.96

* Table is for clear sky conditions.

Do you want to thread a needle or feel safe and secure in a parking lot?

Whole-retina brightness perception, important for feeling safe in an illuminated parking lot, is dominated by short wavelength sensitive cones, so “cool” light sources, like 6500 K LEDs, with relatively more energy at short wavelengths than high pressure sodium (HPS) can achieve equal parking lot brightness at reduced power levels. The ability to thread a needle using our fovea, however, will be reduced for cool sources when equally bright. If the design objective is aimed at making people to feel safe and secure in a parking lot at night, the total amount of radiant power emitted by “cool” light sources will be less than that emitted by “warm” light sources and less radiation will reach the atmosphere to be scattered. However, the amount of scattered light in clear atmospheres depends upon the spectral content of the light source. Even though less radiant power would be sent to the atmosphere if the parking lot was designed for brightness rather than for threading a needle, relatively more light will be scattered in clear atmospheres because the spectrum is dominated by short-wavelengths. The table, left, shows how different parking lot design criteria affect sky glow evaluated with the fovea, one star at a time (photopic), or with the entire retina (scotopic). For atmospheres filled with relatively large aerosol particles (e.g., hazy, cloudy), there is little to no difference in scattered light for different light source spectra and designing by the brightness illuminance criterion will always reduce sky glow.

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Reference

Rea MS and Bierman A. 2014. Spectral considerations for outdoor lighting: Consequences for sky glow. *Lighting Research and Technology,* doi 1477153514556127, first published on October 23, 2014.

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