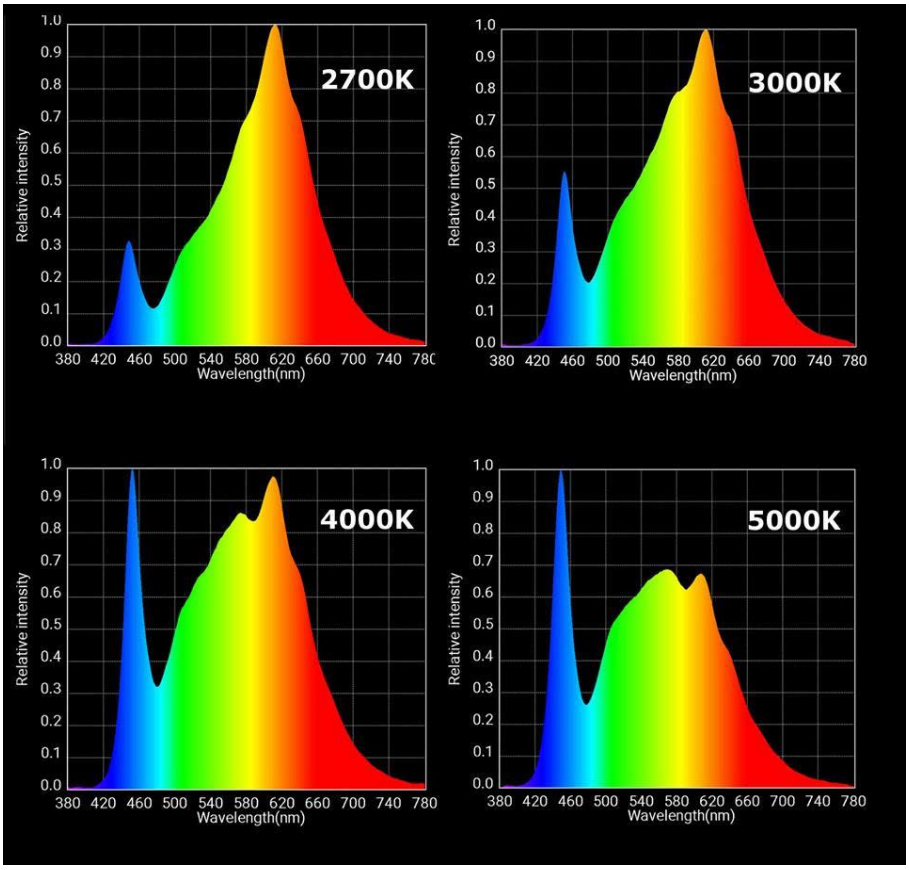
Outdoor Lighting Design Guide

The purpose of this document is to alert decision makers to important issues related to the installation of LED outdoor lights. These design criteria include color temperature, human health, flora and fauna, and people with light sensitivity disabilities.

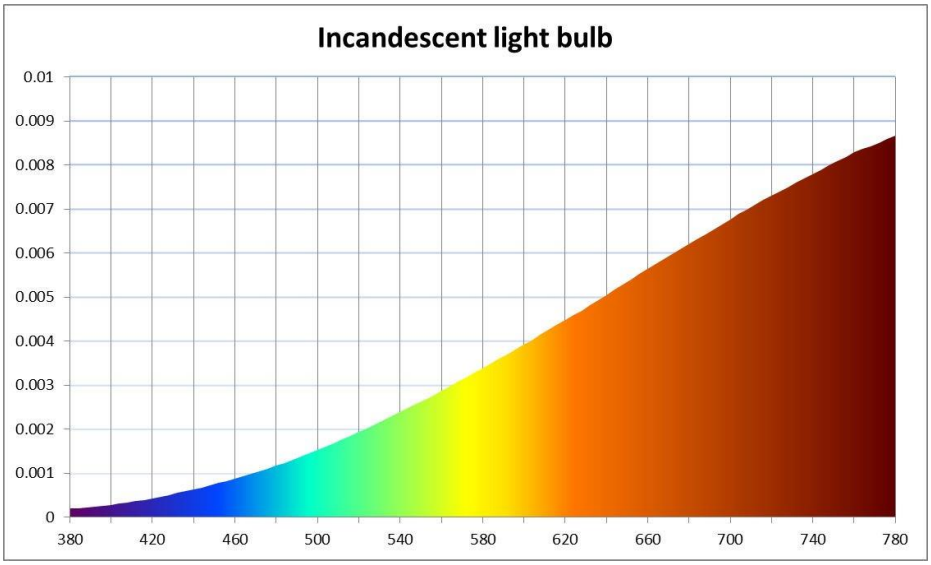
Color Temperature

Probably the most important criteria for lighting is color temperature. The advent of outdoor LED lighting has created a technology that can be unsafe for humans and for wildlife. This is because the main driver of LED emits blue wavelength light, which research has shown is dangerous when the blue peak is too high. Here is a chart showing the spike of blue wavelength light in different color temperature LEDs.



As you can see from the chart, the blue spike is far too large in comparison to the other wavelengths until about 2700K.

In comparison, below is a chart for a typical incandescent light.



Note how there is very little blue wavelength light, but a large amount of red wavelength light.

When outdoor LEDs first came out several years ago, there were very few options. Cities that were early adopters chose what was available, which was 5000K. Ever since, residents have been complaining bitterly to their city councils about these high glare lights. As technology has been refined, cities have been moving from 5000K to 4000K to 3000K and now 2700K, 2200K and 1700K.

The American Medical Association studied this carefully and released their seminal report in 2016. Their stated maximum for the time was 3000K. However, as new research has been released in the past 4 years, the AMA now recommends a maximum color temperature of "as low as possible."

The consensus now is that 2700K as the maximum safe, comfortable color temperature. This value matches the science, but it also matches personal feelings. Not all people react to high color temperature, but many do, especially those with light sensitivity disabilities.

Therefore, the maximum color temperature for an outdoor lighting project should be 2700 Kelvin.

Diffusion

LEDs produce visible light that is spread over a wide part of the visible light spectrum. Because LEDs focus light on a small area, the result can be injury to the eye. Therefore, any product that you select should have advanced optics that incorporate diffusion properties or external diffusers such as frosted glass to scatter the light source.

Shielding

Shielding is an important criterion to keep the light focused where it should go. There should be no uplight. Also, lighting should not trespass onto private property. The Illuminating Engineering

Society and the International Dark Sky Association just recently agreed to a strategic partnership to address the issue of light pollution. Below are the 5 Principles for Responsible Outdoor Lighting.

Sub-sensory Flicker

Some sensitive people can detect the switching between the DC LED and the A/C grid. This is known as sub-sensory flicker. This is typically caused by cheap driver electronics. Therefore, ensure that your vendor provides, in writing, a guarantee that there is no sub-sensory flicker.

Brightness

We tend to over light. As noted in the IES/IDA chart above, it is important to use the lowest lumens possible. Human eyes have cells for day vision and night vision. As we switch to night vision, our ability to see color is reduced, but our sensitivity increases. The high CRI of LED light will already improve our ability to see color, so it is important not to use a light that has too many lumens. Refer to IES Standard RP-8-18 for details, especially chapters 2 and 4.

Color Rendering Index

The CRI of HPS is typically less than 40. LED lights can utilize multiple blends of phosphor to achieve a specific CRI ranging from 65 to over 97 CRI. Therefore, any LED light utilizing this type of phosphor blend will have a vastly improved CRI versus HPS.

LED lights can also use single color dies, such as narrow band amber or red, which can have a CRI below zero, which means color rendering that is worse than HPS. However, there are numerous health and ecosystem benefits to using narrow band amber or red which outweigh the benefits of a high CRI. Therefore, CRI should be given a low priority compared to other design parameters.

Safety

There will be some residents that will be concerned that if an area is not super bright, they will not be safe. Their feelings may be valid, but the truth is that they will not be any safer with super bright lights. There are numerous studies about the safety of bright lights, but the results are ambiguous. In other words, safety comes from factors other than bright white lighting.

Studies have also shown that women, as a group, feel safer with a softer, warmer color temperature of 2200K or 2700K versus the harsh white color of a 4000K LED.

Time of Day

There is a considerable drop off in human activity later into the night. Therefore, if the design team plans on procuring devices that allow control of the brightness, then set up a system where the brightness can be controlled by time of night. For example, if a streetlight is normally operating at 500 lumens, perhaps 100 lumens would be sufficient after 11:00pm.

In addition, consider using motion sensors to further reduce the light to zero when not in use.

Bat Friendly

Research has shown that bat feeding is greatly impacted by lighting at night. Outside of city centers, use approximately 1000K red LED lighting. Here is an example of bat-friendly lighting in Worcestershire, England. Their studies have shown that there is no reduction in safety when using this color temperature of light.

Light Sensitivity Disabilities

A significant percentage of the human population is very sensitive to light. They can perceive light that neurotypicals cannot or their emotions are triggered in ways that neurotypicals are not triggered. We know that color temperatures exceeding 2700K can cause emotions of anger, agitation, thoughts of suicide, fear, and depression in highly sensitive persons. Strobing LED lights can be even worse.

The class of people with light sensitivity disabilities include those with autism, PTSD, epilepsy, bipolar disorder, highly sensitive persons, migraine sufferers, post-concussion sufferers, lupus, and others. The Americans with Disabilities Act protects this class of people. Therefore, the lighting design team must ensure that any lighting designs do not harm those with light sensitivities. In general, this means 2700K or less and no sub-sensory flicker. However, please check with your local disability rights group to ensure that all needs are met.

References

Safety
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