MARCUS J. MOLINARO
COUNTY EXECUTIVE

EOIN WRAFTER, AICP
COMMISSIONER

COUNTY OF DUTCHESS
DEPARTMENT OF PLANNING AND DEVELOPMENT

November 14, 2019

To: City Council, City of Beacon
Re: Referral ZR19-382, LL: Amend Sub. B of Section 223-14 Re: Exterior Lighting

The Dutchess County Department of Planning and Development has reviewed the submitted referral for countywide and intermunicipal impacts as outlined in General Municipal Law (Article 12B, §239-l/m).

ACTION
The City is seeking to modify its exterior lighting provisions. These provisions will now apply to residential and industrial properties.

COMMENTS
We are pleased to see that the City is revising its lighting standards and suggest the Council may want to incorporate certain specific standards or guidelines so that residents and developers can reference the standards prior to developing a site lighting plan or purchasing a fixture.

For LED lighting we generally recommend: color temperatures between 2,400 – 3,000k, light be distributed uniformly across a site, BUG (Backlighting, Uplighting, and Glare) ratings be on the low end of 0-5 range, and that the Color Rendering Index be within 80-100. Regarding site lighting in general, we recommend parking lot and pedestrian areas not exceed 1.0 footcandle and that adaptive controls such as dimmers and motion sensors shut off lights when they are not needed.

Please see a recent article from the Dutchess County Planning Federation, attached.

RECOMMENDATION
The Department recommends that the Board rely upon its own study of the facts in the case with due consideration of the above comments.

Eoin Wrafter, Commissioner
By
Jennifer F. Cocozza
Deputy Commissioner

Plan On It

DUTCHESS COUNTY PLANNING FEDERATION

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Understanding LED Lighting for Site Plan Review

Robert Wills, RA, NCARB, Senior GIS Project Coordinator

Lighting is an important component of site plan review by our local boards. But the expectations you may have from your review versus what is eventually built don't always correspond. Obscure references on the plans to lighting science and photometric charts can be confusing. The unfamiliar technology of light emitting diodes (LEDs) can further complicate your evaluation. So, what's different about LEDs that we need to concern ourselves with? Let's discuss the basics of traditional lighting, and what's unique about LED sources. Then we'll look at which aspects of LED lighting are important when reviewing lighting plans.

Traditional Technologies

In traditional light sources such as incandescent, electricity is used to get the filament so hot it gives off visible light, but this process wastes a lot of energy in the form of heat. Gas-discharge lamps such as fluorescent or sodium vapor waste less energy as heat, but all of these sources have other issues:

- **Non-directional**: What characterizes each of these sources is non-directionality of the light waves; they go all over the place and require a well-designed fixture to direct the light to its intended destination.
- **Color**: They each have a distinctive color that may be objectionable to some, such as the orange glow of sodium vapor lamps.
- **Inefficient**: Although they seem bright when staring at the source, they don't throw all that much light a long distance; the ratio of light to heat that they produce is low, making them inherently inefficient.

Newer LED Technology

Light-emitting diodes, as a source of general illumination, are revolutionizing the lighting industry. Along with advantages in flexibility, adaptation, quality and quantity of illumination over traditional lighting, LEDs significantly reduce energy usage and toxic waste generation. LEDs create light in a fundamentally different way than the incandescent, fluorescent, and gas-discharge lamps that were the standard in the past. Light emitted from LEDs is due to the movement of electrons between two substances, very similar to how modern integrated circuits work.

Single LED (grain of rice) | LED Tape (10mm wide) | LED Light Engine (4" diameter) | LED Array (12"x12"x4")

Individual LEDs are tiny. These bulbs are grouped together in a variety of ways to create usable LED light sources.

LEDs are very tiny, the size of a grain of rice. In order to make useable area lighting, single LEDs are nested together into what is referred to as an array or light engine. Things to keep in mind regarding LEDs:

- **Uni-directional**: The light source is uni-directional, meaning it comes straight out of the device, similar to sunlight. By emitting directional light, the LED array lights the intended surface more evenly, reducing the occurrence of glaring hot spots. Further, it is easier to control the throw of light from LEDs through their fixture or "luminaire." By doing so, the fixture can help minimize glare.
- **Dimmable**: The intensity of the LED light can be changed with the use of electronic controls. Unlike regular dimmers, computerized control can alter the brightness of all the lighting in an area or customize the brightness to selective areas.
- **Color**: The color of the LED light can be changed. By altering the materials of the LED, or by encasing the LED in a phosphor-coated capsule, any color can be generated. In fact, color can be altered after installation at the whim of the user, through special interfaces with the lamp.

Color, control, and distribution are three aspects of LED lighting where innovation can make for great designs that both look appealing and provide safety at night without the negatives of light trespass and sky glow. Let's explore these characteristics more closely to see how they relate to a lighting plan.

Color and Perception

We've all experienced the color of light emitted from various sources as being quite different. "Color is only a pigment of your imagination," said Dr. Carl Ingling in 1977. Because color perception can depend on the viewer to some extent, an objective reference is used to describe the color of light emitted by a light source, called the Chromaticity Index. This was developed by the International Commission on Illumination in 1931. Color is expressed as a temperature, in Kelvin degrees or "K," and ranges from a low of 1,500K (red, or warm) up through 10,000K (blue, or cool). This is the Correlated Color Temperature (CCT), and it describes the dominant tone of white light sources from warm to cool. In light fixtures, a CCT below 3,200K is considered warm, whereas a source above 4,000K is considered cool.

The range of colors shown here are pegged to their temperature, or K value, illuminated beneath each lamp. A standard incandescent bulb would fall around 2,700K – 3,000K. [Image credit: The Lighting Practice]

Color temperature is an important component of a lighting specification. A very cool source, especially at night, appears bright, stark, and with lots of glare, no matter how bright or dim the light is. This is of special concern with LEDs, because we are seeing many specified for outdoor and parking lot lighting in the 5,000K–6,500K range, or very cool.

Further, recent scientific studies have shown that light sources in the cool (blue, or ultraviolet) range may upset both the normal sleep patterns of humans (circadian rhythm) as well as wildlife behavior and their patterns of migration. Therefore, ask for a warmer CCT (color temperature), in the range of 2,400K–3,000K.

Color of Objects Lit by LEDs

In addition, the way a light source renders the colors of objects is important. The Color Rendering Index (CRI) is a 0-100 scale that rates a light source as to how close it renders the color of objects as "natural" (a score of 100), or in this context as close to the way an incandescent source would light an object. By choosing judiciously, lighting designers can specify LEDs that render a warm, appealing light, close to the temperature of incandescent lights. The CRI should be requested if it is not a part of the documents you are reviewing. Also note that some LED light engines are comprised of three colors of LEDs: red, green, and blue, to make its mixture of projected light appear white to human eyes. Although a positive is that the color of emitted light can be changed to any color of the rainbow through electronic control, there may be detrimental effects like multi-colored halo around lit objects. The CRI is important to understand how these sources render objects. A CRI above 80 is mandatory for an "Energy Star" rating. When reviewing plans, ask for lighting that approaches the top of the scale: 80 or above.

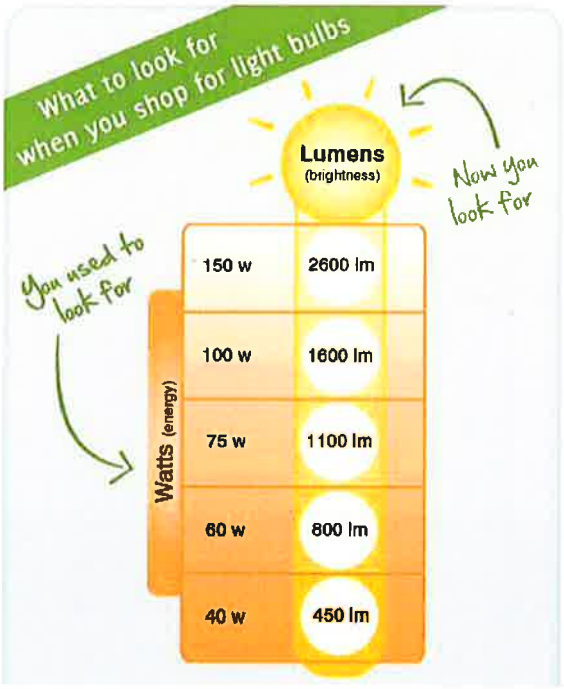
Control and Distribution

Because of the nature of LED-generated light, fixture design accommodates the increased brightness and linearity of their emitted light. The techniques of control and distribution are the same with either LEDs or traditional sources. As with traditional exterior lighting, a number of factors determine the number and placement of LED fixtures to adequately light an outdoor space. Keep in mind that ***illuminance*** is the measure of light hitting a horizontal or vertical surface. It is measured either in lumens per square foot (footcandles), or lumens per square meter (lux). Let's look at some LED-specific issues, starting with brightness.

Brightness and Perception

We are used to equating wattage with brightness, and our experience with incandescent light may tell us that a 40-watt bulb might be great for a table lamp but not for a workshop light, where a 150-watt bulb would be more appropriate. However, the wattage only tells you how much energy the bulb uses, not how bright it is. Because LEDs are so much more efficient at producing light, lumens (a unit of brightness) are used to specify these light sources.

The footcandle measurements shown on a standard photometric plan will help you determine whether the proposed lighting is of a reasonable brightness. Dutchess County's Greenway Guide on lighting recommends an average of just one (1) footcandle for parking lots and pedestrian areas. High-security areas may need up to 5 footcandles, but anything higher is a waste of electricity and source of glare and light pollution.



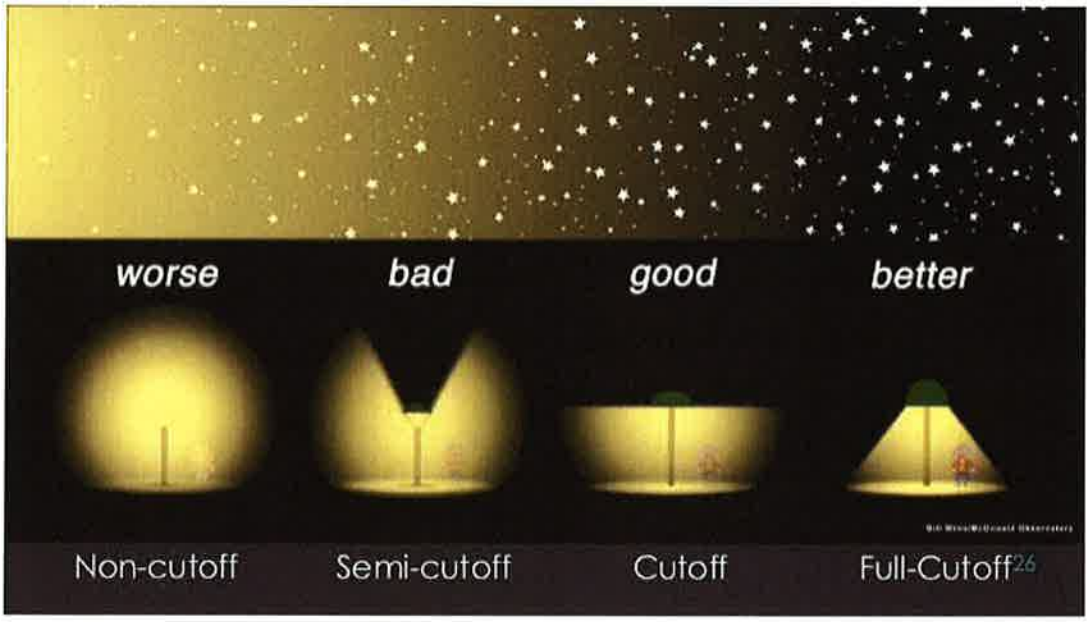
As a reference point, this chart shows the number of lumens produced by common incandescent bulbs. [Source: Federal Trade Commission]

Uniformity

Both through the linear nature of the emitted light and the multi-source design of the light engine, LED outdoor lighting for parking applications provides a more evenly distributed light pattern than traditional sources. There should be less variance in the amount of light measured directly under the luminaire to that hitting areas farther away from the source, and less of the "bright spot effect" directly under the luminaire inherent in traditional lighting. This is described by the ***uniformity ratio***, which compares the footcandle level at the brightest areas versus that at the most dimly lit areas. This is a definitive measure of the perception of safety in a parking lot; when reviewing photometric plans you may see ratios as high as 20:1, which is too high. Ratios approaching 5:1 are more appropriate. Also, understand the relationship between light source, fixture design, pole height, and area to be lit. All are affected by each other and may be a source of negotiation with your applicant to achieve appropriate footcandle levels and a good uniformity ratio.

Blinded by the Light

Light emanating from an LED fixture can be blinding because of its brightness and glare. Glare is categorized as "excessive and uncontrolled brightness," according to the Lighting Research Center. As with traditional lighting design, the same designations for the way fixtures control emitted light are used with LEDs. Because of the intensity of LED arrays, it is especially important that the shielding of the light engine provide a full-cutoff of emitted light.



This illustrates the importance of full-cutoff fixtures. [Image credit: Bill Wren, McDonald Observatory]

You may also see reference to a newer specification standard for outdoor lighting called the "BUG Rating." BUG stands for Backlighting, Uplighting, and Glare, and it is a complicated metric comparing the way any fixture directs light up, out, and down. Not all manufacturers and specifiers provide this information, and guidance for understanding it is difficult to come by. For reference, the ratings can range from 0-5, with 0 being the best and 5 being the worst. A fixture's BUG rating would be notated as, for example, "B1 U2 G1." See the information section at the end of this article for resource links on BUG ratings.

Summary

Understanding the many variables of outdoor LED lighting can be difficult, and the information provided in photometric plans and lighting spec sheets doesn't always shed light on the subject. Given the details available in a typical Planning Board packet, remember to consider the following guidelines when evaluating proposed lighting for any project, and consider adding them as lighting standards in your zoning code:

Lighting Parameter:	**Specific Guideline:**
Correlated Color Temperature (CCT)	Warm; color temperature within 2,400K–3,000K range
Color Rendering Index (CRI)	High; within 80–100 range
Footcandles (illuminance)	Low; average of one (1) footcandle in most pedestrian and parking lot areas
Uniformity Ratio	Low; ratios approaching 5:1
Fixture Design	Full cut-off
BUG Rating	Low end of 0–5 range
General Guidelines:	
Avoid fixtures that aim light up and/or away from the intended surface	
Mind the lumens, not the wattage	
Ask for adaptive controls like dimmers and motion sensors to shut off lights when not needed	

More Information

Lighting Research Center at Rensselaer Polytechnic Institute

Pennsylvania Outdoor Lighting Council: Municipal Lighting Resources and Model Outdoor Lighting Ordinance

International Dark Sky Association: Outdoor Lighting and Light Pollution

CNet article on understanding the Color Rendering Index (CRI)

EnergyStar overview of basic light quality parameters

BUG Rating: What is a BUG Rating? (1000Bulbs Lighting Blog), and The BUG System—A New Way to Control Stray Light From Outdoor Luminaires (International Dark Sky Association)

McDonald Observatory's Dark Skies Initiative

Click here to view past issues of *Plan On It*.

This newsletter was developed by the Dutchess County Department of Planning and Development, in conjunction with the Dutchess County Planning Federation.