A comparison of lighting technologies used for perimeter security applications

Outdoor lighting is an important security tool. A well-lit site – whether it is the entire site, a specific area such as a perimeter fence, or simply an entrance – is a less attractive target for would-be intruders than a site where they can hide under the cover of darkness. When used as part of a larger security system, outdoor lighting plays an even more important role, primarily by helping improve camera performance, which can mean the difference between identifying intruders and allowing them to get away scot-free.

But not all lighting is the same. There are a number of core technologies – Low Pressure Sodium (LPS), High Pressure Sodium (HPS), Metal Halide (MH), and Light Emitting Diode (LED). All have their advantages and disadvantages, especially when it comes to four of the most important factors of outdoor lighting as a security tool: Color Rendering Index (CRI), lumens per Watt (lm/W), color temperature, and lamp life.

This paper discusses the four most popular technologies used in outdoor perimeter lighting for security applications and highlights their advantages and disadvantages.

1. Low Pressure Sodium (LPS)

Invented in the 1920s, LPS uses a low-pressure tube filled with neon gas and sodium metal. Current runs through a neon gas filled tube in the way of an arc, slowly heating it until the sodium metal begins to vaporize. Once fully vaporized, the lamp is at its full light output and produces an orange monochromatic light (single wavelength/color). As a result, everything captured within the light has an orange hue.

LPS has the lowest CRI of the technologies but is the most efficient in terms of lm/W. This is due primarily to all of the power applied to it being used to produce a very specific light wavelength.

Advantages

- Most efficient lamp available

Disadvantages

- Turn on (5–10 mins)/cool down (15 mins)
- Lowest CRI value
- Light emitted is orange monochromatic (single wavelength)
- Shortest lamp life

Specifications

- CRI: 0
- Lm/W: 100–190
- Color Temperature: 1,800
- Lamp Life: 18,000 hrs

2. High Pressure Sodium (HPS)

Invented in the 1950s, HPS uses a high-pressure tube containing xenon gas, mercury, and sodium metal. The arc begins through the xenon gas, which gives it a sky-blue color, and continues to heat the tube until the mercury vaporizes. At this point the light shifts to a brighter blue until it further heats and the sodium metal vaporizes, emitting a similar but lighter orange color than LPS. With the addition of the blue light wavelengths from the xenon and mercury components to the orange light wavelength from the sodium, the light shifts to be more yellow in color. With power now used for multiple wavelengths, CRI is improved but lm/W efficiency is slightly decreased.

Advantages

- Higher CRI than LPS
- Good efficiency
- HPS lamps last 33% longer than LPS lamps
- More compact than LPS

Disadvantages

- Turn on (5–15 mins)/cool down (15 mins)
- Lower lumens per watt when compared to LPS
- Higher cost for high CRI variants

Specifications

- CRI: 20–60
- lm/W: 80–140
- Color Temperature: 2,100K
- Lamp Life: 24,000 hrs

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3. Metal Halide (MH)

MH lamps were invented in 1912 but did not become reliable until the 1960s. The initial arc is in a pressurized tube with argon gas which gives off a dim blue color. As it heats, the mercury deposits start to vaporize, resulting in a brighter blue color. As further heating occurs, halide salt deposits vaporize into different chemicals, causing the discharge to have multiple colors/wavelengths. This results in a high CRI and shifts the lamps from blue to white. The efficiency (lm/W) is lower than with other technology because only 25% of the energy is actually used to make the light (the remaining 75% is used to keep the lamp hot in order to maintain the halide salts in a vaporized state).

Advantages

- Compared to LPS/HPS, MH produces the fullest spectrum light
- Full spectrum light achieves a high CRI value

Disadvantages

- Lower lamp life than HPS/LPS
- Turn on (5–15 mins)/cool down (15 mins)
- Lower lumens per watt

Specifications

- CRI: 60–90
- lm/W: 65–115
- Color Temperature: 3,000 – 20,000 K
- Lamp Life: 20,000 hrs

4. Light Emitting Diode (LED)

Invented in the 1960s, LED lamps use semiconductor technology in which current runs through a p–n junction (sometimes referred to as a diode junction) with chemical compounds on it that cause light to be produced. This process is called electroluminescence – the phenomenon of a material emitting light when electric current is through a semiconductor with tiny holes, causing photos to be emitted. Advances in the last 10 years have increased the energy output to a level that makes it now suitable for indoor and outdoor lighting use.

Sample perimeter with LED-based security lighting

LED lighting has the inherent benefit of being lower power and cooler than any other lighting technology. This factor lead to a much longer operational life cycle and decrease maintenance and replacement costs. Because LED lighting is lower power and does not require high temperatures to vaporize elements, lamps and optical components can be made from plastics instead of typically fragile glass packaging. This makes the devices more durable, reduces manufacturing costs, and enables the creation of improved optic designs that are otherwise cost-prohibitive.

LEDs have an exceptionally long-life expectancy specification (based on when the light output is reduced to 70% of its initial specification). So, even when an LED is considered "dead", it is still at 70% of its initial brightness and will continue to function.

LEDs are a planar technology, meaning that all the light generated emanates from one plane and not 360˚. For outdoor lighting, there is a tremendous advantage in directional lighting. Traditional 360˚ lighting causes the illumination of areas outside of the targeted scope, resulting in wasted light that uses additional power and adds no value. This wasted light, termed “light pollution”, can also cause problems – it may be seen as a nuisance in urban areas and can have a negative impact on wildlife.

Advantages

- LEDs produce the widest full spectrum light
- Highest CRI value
- Highest lamp longevity

Disadvantages

- Slightly less efficient than LPS

Specifications

- CRI: 70–95
- lm/W: 28–150
- Color Temperature: wide spectrum
- Lamp Life: 50,000 – 100,000 hrs

Advantages and disadvantages summarized

This below table summarizes the advantages and disadvantages of the four lighting technologies. Red indicates poor performance, yellow indicates average performance, and green indicates the best performance.

	LPS	HPS	MH	LED
CRI	0	20-60	60-90	70-95
lm/W	100-190	80-140	65-115	25-150
Color Temperature	1,800	2,100	3,000-20,000	wide spectrum
Lamp life (hours)	18,000	24,000	20,000	50,000-100,000
Full light spectrum				
Warm up/ Cool down (mins)	5-10 / 15	5-15 / 15	5-15 / 15	instant / instant
Price	$$$	$$	$	$$

Summary

The four lighting factors discussed above – CRI, lm/W, color temperature and lamp life – play major roles in lighting. All lighting technologies on the market have different combinations of these factors, which is why it is important to research which technology best meets the requirements for the application being targeted.

For perimeter security applications, the right combination can improve performance and add efficiency to security systems, as each of these factors plays a critical part in its effectiveness. High quality lighting allows low cost cameras to operate at a higher performance level, and minimizes any breaks in the uniform light along the perimeter increasing the deterrent factor, all while keeping operating costs low.

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