

TECHNOLOGY WHITE PAPER

LEDs and Exterior Illumination

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Sol Inc.

Summary

Many manufacturers have started to use LED technology in their lighting fixtures. However, not all LEDs offer the same level of performance. The specific type of LEDs used is crucial to delivering the true benefits of LED lighting:

- High luminous efficacy
- Long useful life

Sol only uses High-Power LED technology that is designed to deliver 70% lumen retention even after 100,000 hours of operation. Manufacturers that have selected other types of LEDs, such as 5 mm LEDs, for their fixtures may require more fixtures (in some cases 6 times more) to provide the same maintained light levels as Sol fixtures.

Details

Not all LED are equal.

High-Power LEDs are designed by LED manufacturers for use in higher lumen level applications. These LEDs are good choice for general illumination since High-Power LEDs are constructed with features to support a long life of high lumen output. These LEDs have a larger die size (the physical size of the LED) and more robust mechanical construction for better thermal performance.

5 millimeter (mm) LEDs are an older LED technology designed for use as a signaling lamp. These LEDs are commonly found on automotive dash boards, telephones, and other applications where a blinking or solid LED indicates status. These LEDs were constructed for lighter duty applications where their light output was not as important as their longer life. Therefore 5 mm signaling LEDs operate very well over long periods of time at very low power levels. When used in higher power and higher lumen applications, as is the case in general purpose illumination, the light output and lifetime of these LEDs quickly diminishes to the point that they cease being a useful lighting source.

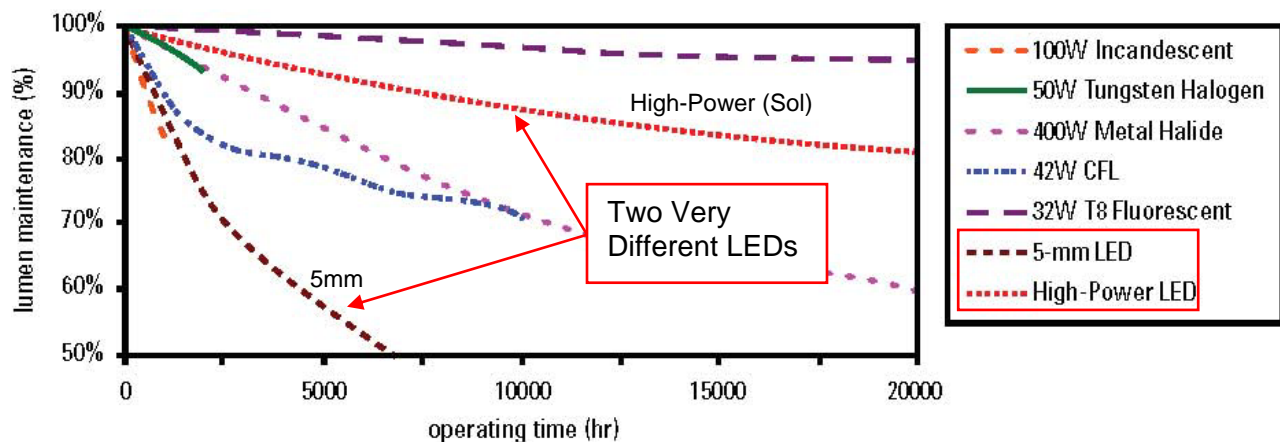
Lumen Maintenance

LEDs are chosen as a light source because they generate light efficiently over a long period of time. For general purpose illumination, it is important for a light to maintain a very high percentage of its starting illumination so that it does not need to be replaced frequently. High-Power LEDs deliver this benefit while 5 mm LEDs do not.

According to Rensselaer Polytechnic Institute and the United States Department of Energy's research on Solid State Lighting, High-Power LEDs and 5 mm LEDs have very different lumen maintenance performance:

As the following graph indicates 5 mm LEDs will maintain 70% of their light output until about 2,500 hours of operation; only 250 nights of bright light (10 hours of on-time per night). The light from 5 mm LEDs quickly diminishes. In contrast, High-Power LEDs maintain over 90% of their light output during that same 2,500 hour period and continue to deliver over 70% of their rated light out to 100,000 hours; 10,000 nights, or over 25 years.

Typical Lumen Maintenance Values for Various Light Sources



Source: Adapted from Bullough, J.D. 2003. *Lighting Answers: LED Lighting Systems*. Troy, NY: National Lighting Product Information Program, Lighting Research Center, Rensselaer Polytechnic Institute.

Which LEDs are being Used?

The benefits of LED lighting in outdoor applications; high luminous efficacy and long useful life are achieved by using High-Power LEDs. Lighting system manufacturers often indicate the type of LED being used.

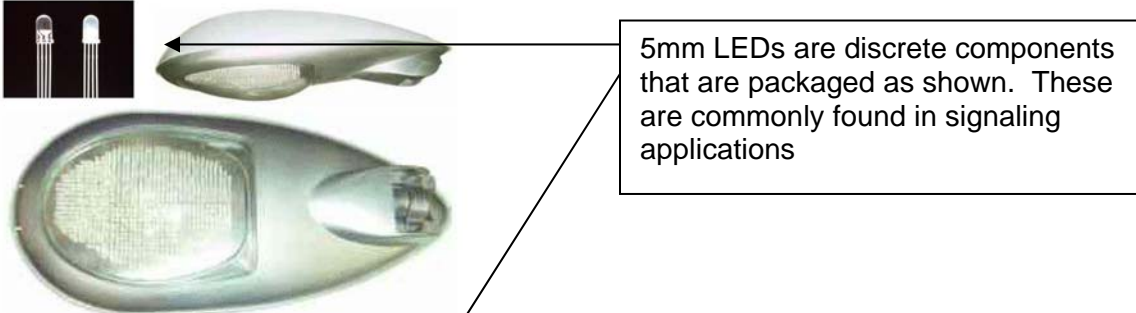
Sol only uses High Power LEDs. That means that a Sol lighting system maintains at least 70% of its rated light output up to 100,000 hours of operation. Manufacturers who use 5 mm LEDs achieve 2,500 hours of operation before their lamps decrease to 70% of rated light output. By 10,000 hours (less than 1 year) these systems require relamping. Unfortunately most of these systems are designed such that the LEDs are not easily replaced, in many cases large sections of the fixture assembly would need to be thrown out and replaced. Alternatively, a manufacturer that uses 5 mm LEDs could increase the number of fixtures required so that at the end of

whatever time period equates to the useful life of the fixture, the appropriate amount of light would be available.

The following images and data show how another exterior illumination company uses LED technology and the results they achieve. Sol's documentation and results follows.

5 mm LEDs

The following images and text are copied from Solar Illuminations' specification sheet:

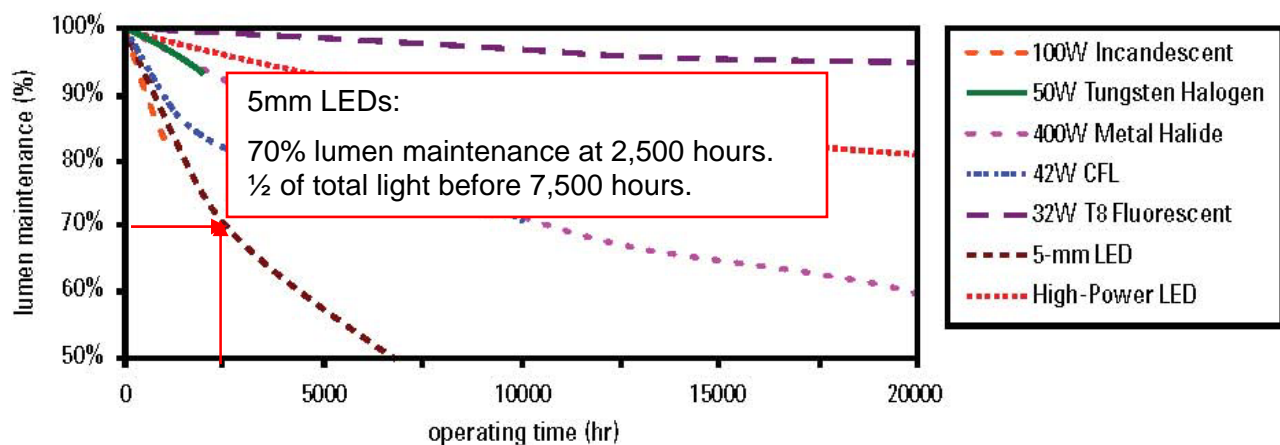


5mm LEDs are discrete components that are packaged as shown. These are commonly found in signaling applications

We use the very latest LED technology in all our solar street lights. We can use almost any type of LED in our solar street light and all have a typical life-span of up to 100,000 hours (approx. 20 years). For most applications we install multiple 5mm LED's with a color temperature between 3000k and 6000k. This offers the most desirable light color for street lighting and parking lot lighting. We install 744 or more LED's into our street light lamp which produces 4500 Lumens. Our 972 LED lamp offers an even greater light output of 6000 Lumens.

5 mm LED Lumen Maintenance:

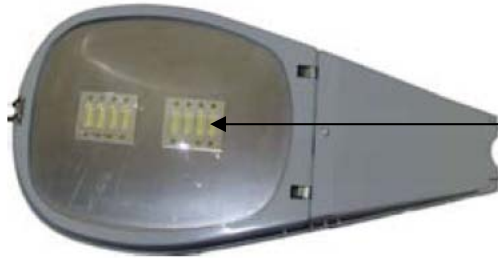
Typical Lumen Maintenance Values for Various Light Sources



Source: Adapted from Bullough, JD. 2003. *Lighting Answers: LED Lighting Systems*. Troy, NY. National Lighting Product Information Program, Lighting Research Center, Rensselaer Polytechnic Institute.

High-Power LEDs (Sol Inc.)

The following images and text are from Sol Inc's specification sheet:



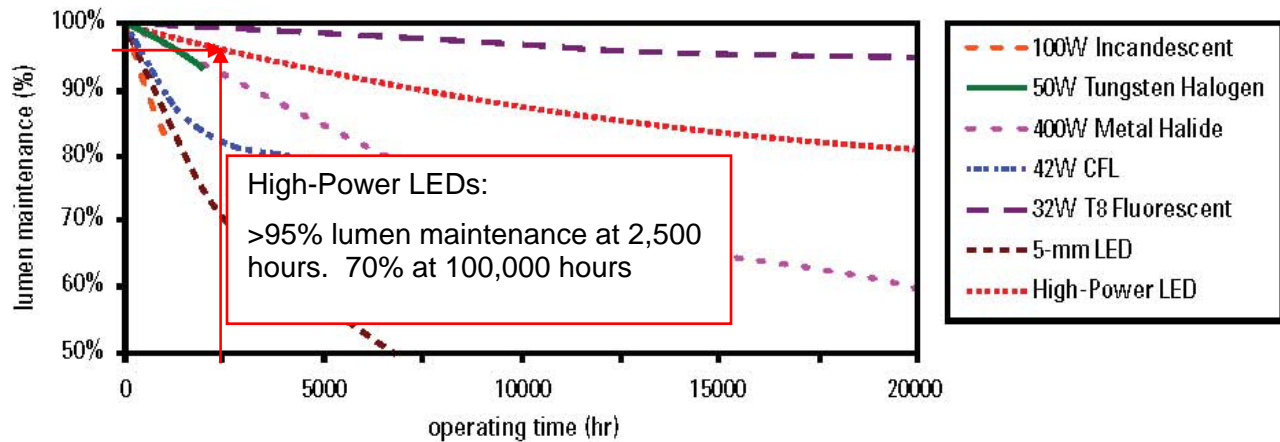
High-Power LEDs are packaged in clusters for better optical performance. In this case over 30 small High-Power LEDs are used per row in the fixture

DATA

LED Type	Strip Type / 100,000 Hours
LED Total Power	30 watts

High-Power LED Lumen Maintenance:

Typical Lumen Maintenance Values for Various Light Sources



Source: Adapted from Bullough, J.D. 2003. *Lighting Answers: LED Lighting Systems*. Troy, NY. National Lighting Product Information Program, Lighting Research Center, Rensselaer Polytechnic Institute.