LED WATCH

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TEST-BED STUDIES EXAMINE PoE

Will Power over Ethernet lighting systems become a truly disruptive technology?

As LED lighting efficacy has steadily improved, and as Power over Ethernet (PoE) standards have evolved to support larger loads, PoE has become viable for an increasing number of lighting devices and applications. As a result, a growing number of lighting manufacturers are introducing PoE lighting systems, making this a potentially disruptive technology. Such systems typically promise enhanced energy management capabilities—including accurate reporting of energy use—but we're in the early stages of adoption and there is still a lot we don't know. For example, how exactly is energy use being reported? Which system components are included in reported energy? Is energy loss in PoE cables and connections being reported? Do PoE lighting system architectures vary, and if so, how does that affect their energy use?

To answer these questions, the U.S. Department of Energy (DOE) is conducting a series of investigations in its Connected Lighting Test Bed (CLTB), designed and operated by Pacific Northwest National Laboratory. These investigations are intended to contribute to the understanding of the energy requirements of new technology (such as PoE) and new features, and to identify needs for industry standards, recommended practices and model specifications that reduce the risk that such systems may not deliver acceptable energy performance.

The first such study was published in February 2017. It peeled away the outermost layer of the onion, so to speak, by providing a brief background on the development of the various PoE technologies, ranging from proprietary to standards-based, and illustrating the convergence of PoE power-sourcing capabilities and LED luminaire power requirements. It classified PoE system devices in relationship to how they're used and described different PoE system architectures. Existing standards and specifications that address energy reporting were reviewed, along with existing test setups and methods germane to characterizing PoE system energy-reporting performance, and recommendations were made to accelerate the development and deployment of energy-reporting PoE connected lighting systems.

CABLE LOSSES

As indicated in its first PoE report, DOE wanted to take a closer look at how various components impact energy performance, starting with cabling (**Figure 1**). So testing was conducted in the CLTB to quantify energy losses in PoE cabling, exploring the impact of cable characteristics and verifying the usefulness of new industry-recommended practices. PoE lighting systems can offer improved efficiency relative to traditional line-voltage AC systems, because losses can be reduced by consolidating AC-DC power conversion among one or more PoE switches rather than distributing it among many smaller LED drivers. However, this reduction can be offset to some extent by increased losses (>10% in poorly designed systems) associated with increased voltage drop in the low-voltage Ethernet cabling.

Aspects of cable design that can affect cable energy performance include wire gauge, Category (e.g., 5e), fire rating and shielding. Among the findings of this study, published in November 2017, was that guidelines recently introduced by the American National Standards Institute (ANSI) C137 Lighting Systems Committee do appear to be effective in limiting cable energy losses to 5% in PoE lighting applications, provided that the average cable length on a project doesn't exceed 50 meters.

The next DOE study on cable energy losses in PoE connected lighting systems

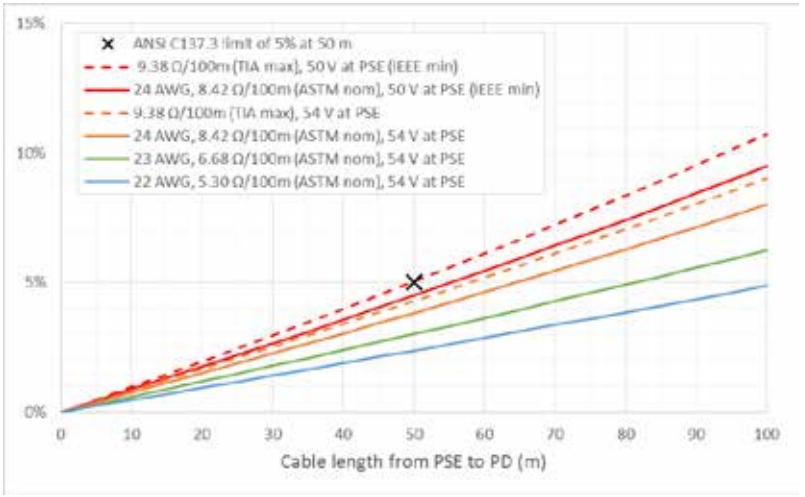

Figure 1. Range of expected cable losses for 51-W powered device at 20-deg C ambient in the first DOE cable study.

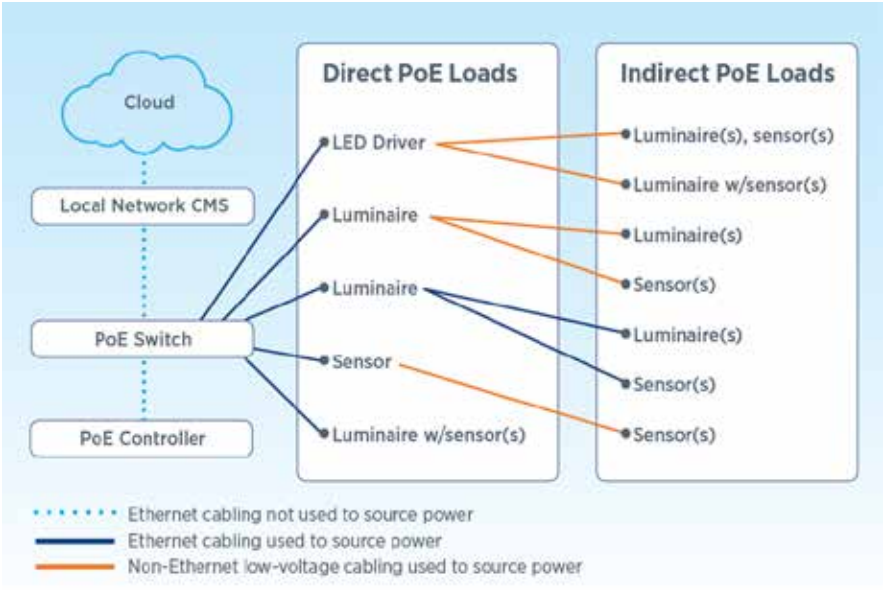

Illustration of different PoE lighting system architectures.

is peeling another layer of the onion by expanding coverage to shielded cabling and exploring the effect of installation practices on energy loss in shielded and unshielded cabling. Preliminary results indicate that energy losses are not substantially increased when cables are bent or bundled in open air, but that energy losses can increase when cables are bundled in conduit.

BETWEEN VISION AND REALITY

Connected lighting adoption is expected to continue to grow rapidly over the next decade. From an energy perspective, one of the most compelling potential features of connected lighting systems is the ability to report their own energy use. Lighting energy use has traditionally been estimated based on nominal input power multiplied by estimated operating hours. Systems that can report their actual operating hours, input power (accounting for any dimming control) and energy use could provide a much more accurate picture of lighting system energy use, facilitate data-driven energy management, and participate in transactive energy markets or ecosystems.

But between this vision and current reality lie many challenges, including a lack of appropriate standardized test methods for characterizing accuracy, classifications for specifying performance and information models for reported energy data. DOE is characterizing the system-level energy performance of connected lighting systems with different architectures and is exploring the impact of component choices. We'll continue to characterize PoE connected lighting system components that may affect energy performance. This includes Ethernet cables and relevant installation practices, which will be subjected to greater stress when IEEE standard 802.3bt is finalized (perhaps in 2018) and PoE switches are allowed to source as much as 90 watts per port. In addition, the energy performance of PoE switches operating under varying conditions will be explored. The results of our investigations will be used to propose common industry approaches to predict the energy performance of connected lighting systems.

To read more about DOE's work with connected lighting systems, visit *www.energy.gov/eere/ssl/connected-lighting-systems*.

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