Choosing the Right LED Product for Industrial Lighting Applications

DIGITAL LUMENS

INTRODUCTION

As the days of cheap and predictable energy costs rapidly recede, the impact of high energy prices on facility budgets is heightening demand for more efficient lighting solutions. And for good reason. Today, lighting-related energy use consumes upwards of 38%[1] of an industrial facility's total energy budget and with the ever-increasing cost per kWh of energy, that total bill continues to rise dramatically. As a result, energy efficiency is now a top priority at industrial facilities around the world and a key criterion for capital investment decisions.

It is this focus on efficiency that is at the heart of the rapidly growing adoption of LED-based lighting solutions within industrial facilities. LEDs are the most energy-efficient, cost-effective and safe illumination choice on the market today, with documented savings in the 50% to 90% range over legacy lighting alternatives.

History suggests that the value of a one percentage point reduction in energy use will continue to rise with each passing year, rewarding the ultra-efficient with significant bottom-line savings and a growing strategic advantage over less-efficient competitors.

The savings potential for industrial LED lighting solutions, however, varies widely by manufacturer, application, and facility-specific variables (hence the 50% to 90% range). This paper provides the basic framework for navigating the industrial LED lighting market and making the best choice to meet your project goals.

EFFICIENCY BY TYPE OF INDUSTRIAL LED LIGHTING

Industrial LED lighting solutions have varied savings opportunities, performance, reliability and lifetime characteristics, and fall into the following categories:

Basic LED Fixtures

These fixtures incorporate energy-efficient LEDs for illumination, but are otherwise functionally equivalent to legacy HID- and HIF-based fixtures. Dimming may be an option — sold separately — and must be manually configured light-by-light. After initial installation, lighting use is fixed. The only control available is an on/off switch or a circuit breaker.

Basic LED Fixtures with bolt-on sensors

This multi-vendor configuration couples basic LED fixtures with after-market occupancy or daylight sensors to achieve greater energy efficiency by turning lights on and off.

Intelligent LED Systems

These systems integrate intelligent LED fixtures (with occupancy and daylight sensors and a small computer) and wirelessly network them while providing a software management and reporting interface. They leverage the inherent capabilities of LEDs (for example, instant on/off and dimming) to maximize energy savings and provide facility management with unprecedented control and flexibility over how lighting is used throughout the lifecycle of the lighting installation.

Basic LEDs are a more energy-efficient illumination source that deliver one-time energy reductions versus legacy lighting — high-intensity discharge (HID) or high-pressure sodium (HPS). There is no opportunity for additional energy savings beyond the simple wattage reduction.

Adding sensors to basic LED fixtures can increase energy efficiency; however these add-ons (occupancy or daylight harvesting sensors) are single-purpose tools, typically with fixed settings that control the on or off state of a fixture or group of fixtures. For energy-savings purposes, it is important to note that most fixtures cannot accommodate both occupancy sensors, dimming and daylighting, too, nor are they adaptable to meet a facility's changing operational needs.

So while these aftermarket add-ons enhance basic LED lighting fixtures' functionality, the additional savings fall short of delivering maximum potential savings.

The most energy efficient category of industrial lighting, intelligent LED lighting systems, is the only category of lighting that routinely delivers savings of up to 90%. These fully integrated solutions leverage software controls, built-in occupancy and daylight harvesting sensors, and wireless networking, to provide facility managers and engineers with an unprecedented level of control and flexibility over lighting usage. And, these fixtures cost about the same as a basic LED fixture plus add-on sensor. The net result is dramatic energy efficiency savings throughout the lifecycle of a lighting installation.

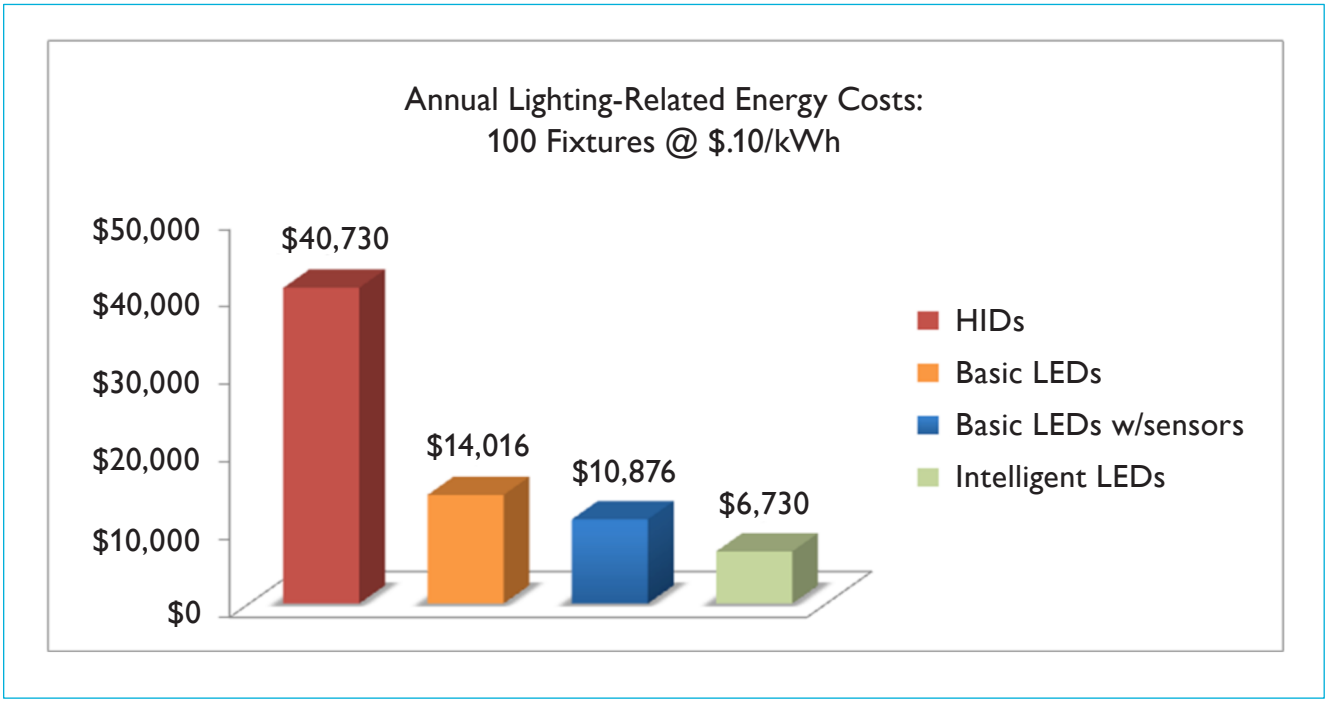

Figure 1: Comparing Energy Costs by Fixture Type

COMPONENTS OF EFFICIENCY

There are two parts to achieving the highest levels of energy efficiency and savings. First is the efficiency of the underlying illumination source and the overall design of the lighting fixture. By wide margins, a well-designed LED solution outperforms all other light sources in:

- **Energy efficiency and efficacy** of the lamp source because it requires fewer watts to produce high levels of light output;
- **Lamp life** because high-quality industrial LED fixtures have lifetime ratings of 50,000+ hours, compared to 20,000 or fewer hours for traditional sources;
- **Maintenance** because LEDs require little or no maintenance;
- **Thermal impact** because they run at lower wattage and are more efficient in converting electricity into illumination, they generate much less heat than conventional industrial lights, which is a crucial consideration in refrigerated, frozen and climate-controlled environments;
- **Cycling** because frequent on/off cycling only extends LEDs' useable lifespan.

The second part of the efficiency equation, which only intelligent lighting systems address, is the ability to control all variables to eliminate unnecessary use of light. Since lighting use is synonymous with energy use, it only makes sense that eliminating excess light is the single most important driver of additional savings. In simplest terms, the way to reach maximum energy efficiency is to use:

- Lighting only WHEN needed
- Lighting only WHERE needed
- Exactly the right AMOUNT of light (for example, no over-lighting to keep lights warm in a freezer or because of the inability to control each light individually)

This requires a lighting system with the flexibility to control the variables that drive when and where lighting is used, through occupancy sensors, daylight harvesting sensors, and the ability to schedule lighting to match needs of different shifts.

FLEXIBILITY AND ITS IMPACT ON SAVINGS

Achieving maximum energy savings requires a lighting system that provides maximum flexibility around all the elements that drive lighting use.

- Are the lights able to sense whether they should be on or off — based on activity in the area or available ambient light?
- Can lights be turned off or dimmed to any level in areas that aren't used?
- Can light output levels be customized so that on isn't necessarily 100% if that much light isn't required?
- Can lights be turned off when a space is unoccupied and instantly back on when needed?
- Can lighting settings be altered to meet specific operational needs (for example, facility cleaning or maintenance; differing work patterns based on shift, day of week or holiday schedules; or quickly changing system settings to manage an emergency)?
- Does the lighting system support ongoing lighting optimization?
- Can lighting settings be modified to ensure alignment between a facility's changing requirements as its business needs evolve?

Dramatic improvements in energy efficiency cannot be attained via a 30-foot scissor lift, manually changing the settings on hundreds of fixtures. Intelligent lighting systems solve this problem by providing locally intelligent luminaires and centrally managed software controls for fine-tuning system settings.

This level of flexibility cannot be attained via lights that require a 30-foot scissor lift to manually change the settings on hundreds of fixtures or, alternatively, add-on occupancy sensors. Facility personnel are simply too busy to make this a viable solution. Intelligent lighting systems solve this problem by providing locally intelligent luminaires and centrally managed software controls for fine-tuning system settings.

EFFICIENCY IN ACTION

Key drivers of energy savings are occupancy, fixture timeouts — the amount of time a fixture is left on after an area is vacated, and dimming. If lighting is used only when areas are occupied and lighting levels are matched to operators' needs, the energy savings are significant. Rather than leaving traditional high-intensity discharge (HID) lights on 24 x 7 at 100%, which costs $40,730 per year (100 fixtures & .10¢ kWh), that number can be driven down to $6,730 with an intelligent LED lighting system that is actively managing these variables (see *Figure 1*, previous page).

Occupancy

At most industrial facilities, occupancy levels are significantly lower than most people expect. This doesn't mean that a facility isn't busy; it just means that every square foot of the facility isn't necessarily occupied simultaneously. For lighting purposes, this means that the entire facility doesn't require 100% light levels all the time. The word 'occupancy' in this context is used to refer to how much a particular space is being used and therefore requires lighting. An alternative term is 'total lighting time.' At very busy facilities, space occupancy is rarely above 30% and frequently less than 10% (see *Figure 2*, below). So by turning LEDs off or dimming them when a space is vacated, facilities lock in significant energy and real-dollar savings due to lower overall total lighting time.

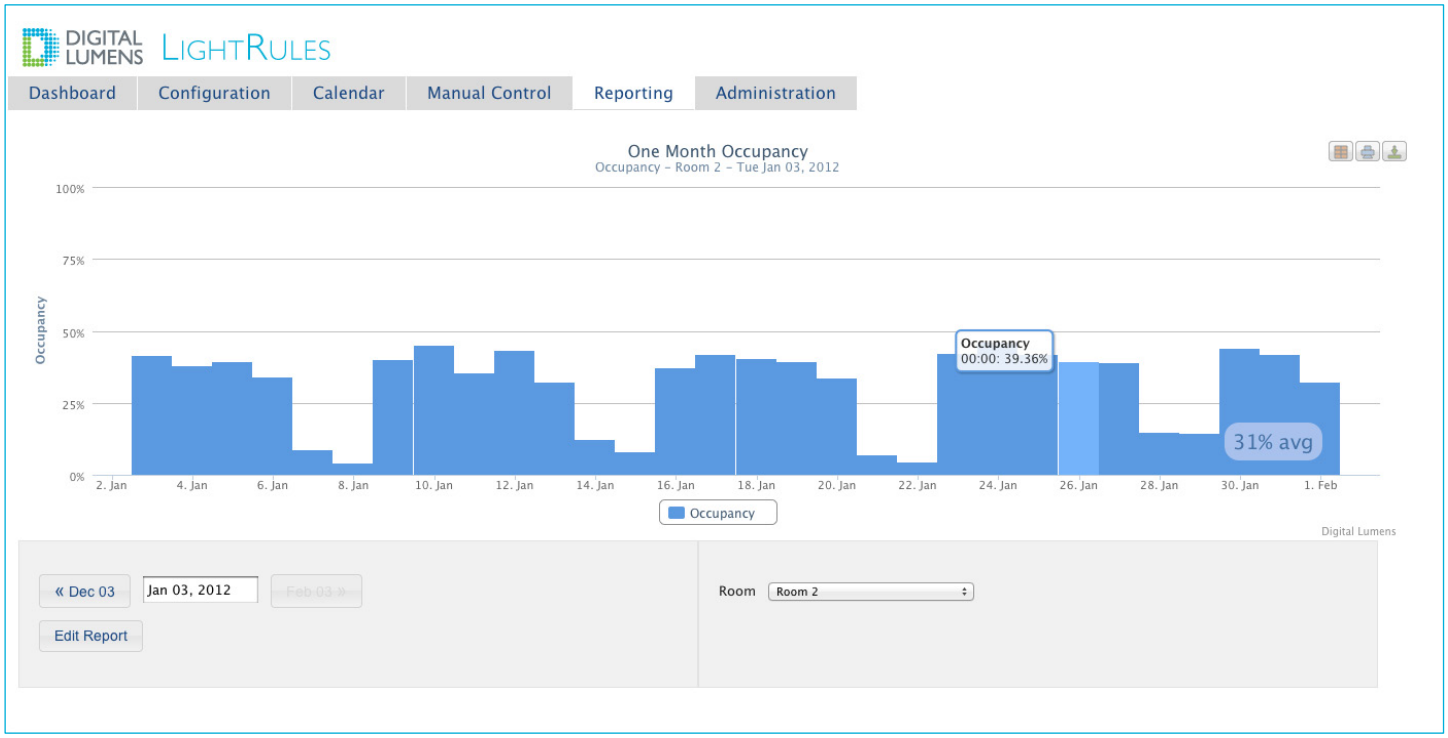

Figure 2: The LightRules Occupancy Report

Timeout Settings

Controlling the amount of time a lighting fixture remains on after an area is vacated may seem a minor point, but it can have a major impact on energy savings, as illustrated in the Timeout Settings Chart (see *Figure 3*) which shows the energy costs of a single light for a single year and how different settings drive different costs. Take those individual fixture energy costs and multiply by 100 fixtures and you'll see that the savings scale:

- 100 fixtures with 30-second settings will cost $3,500/yr
- 100 fixtures with 60-second settings will cost $5,700/yr
- 100 fixtures with 90-second settings will cost $7,300/yr

So the questions are: Exactly how long do lights need to be on after an area is vacated? Two minutes? Thirty seconds? And, how do you make changes where and when needed?

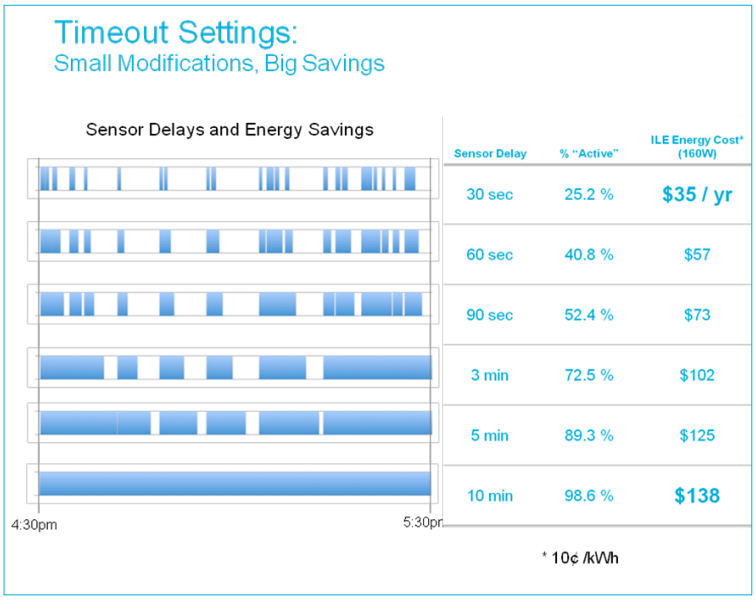

Figure 3: Sensor Delays and Energy Savings

Dimming

There are times and applications where turning lighting off completely is not ideal. For those situations, dimming provides a viable energy-saving alternative. "Off" in this sense may not mean totally dark, but rather "night-light" illumination levels of, say, 10% to 20% for individual fixtures or groups. Dimming strategies are typically used in locations such as cross-aisles and back corners for security and comfort. Since dim is always more efficient than fully on, managing illumination levels can also make a significant contribution to bottom-line savings.

A CLOSER LOOK: HOW FLEXIBILITY MAXIMIZES ENERGY EFFICIENCY

The facility diagram (see below, *Figure 4*) shows how having an intelligent lighting system with the flexibility to provide lighting based on occupancy, while controlling timeouts and dimming levels for 'active' and 'inactive' settings, drives energy costs and how they vary significantly. In this facility, lighting energy use for each area are as follows:

- **Dry storage** — 700 kWh per year
- **Cold storage** — 260 kWh per year
- **Refrigerated storage** — 1,000 kWh per year

Additionally, while not calculated into this scenario, the fact that the lights are only on when needed and run at a much lower wattage than conventional HID or HPS lamps, creates dramatic thermal savings for chiller operations.

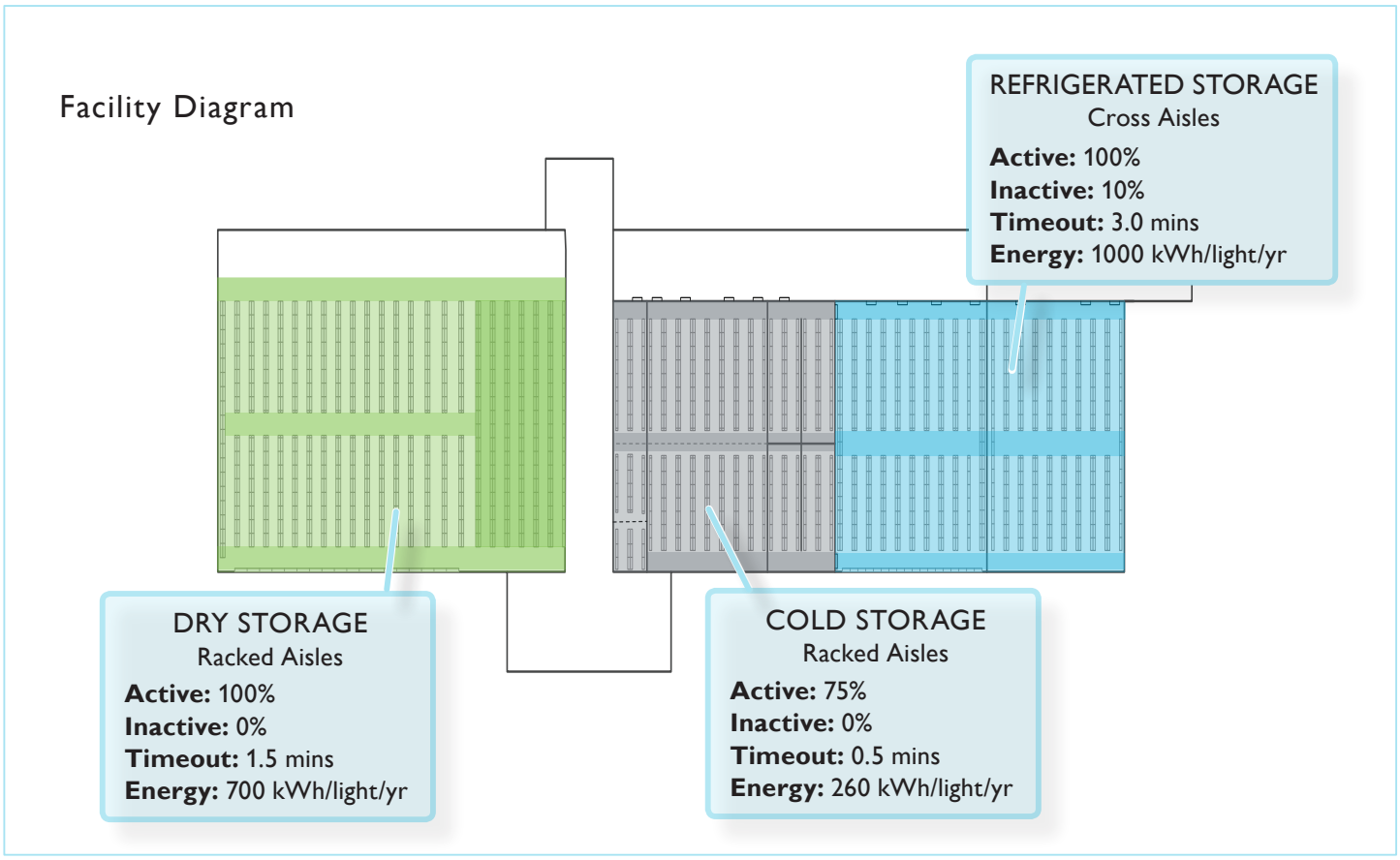

Figure 4: Intelligent Lighting Based on Occupancy

MEASUREMENT, VERIFICATION AND ONGOING FINE TUNING

A critical part of any energy efficiency initiative is measurement and verification, and lighting is no exception. You must be able to review and analyze the system's energy use at whatever level of detail is required, both for facility management and for utility partners. You should also be able to document lighting use on a fixture-by-fixture, group of fixtures, or facility-wide basis. Integrated intelligence and reporting enables facility personnel to review performance metrics without resorting to guesswork or manual observations, making it a key criterion for lighting system evaluations.

That same data is essential for ongoing fine-tuning, providing actionable intelligence on how a lighting system is performing, so that the team can determine and implement modifications that can further improve energy efficiency. The goal is to periodically review and update lighting settings to match changes in facility usage patterns. For example, when a facility first deploys a new lighting system, the tendency is to use very conservative timeouts and dimming levels, and gradually phase in adjustments. At initial commissioning, timeouts may be set to two or three minutes. But, over time those settings can be gradually reduced to 30 seconds to lock in savings once the operators in the facility are comfortable with the lights' behaviors. This provides a smooth transition for facility staff, without compromising safety, productivity or comfort and optimizes savings, as the following chart shows (see *Figure 5*):

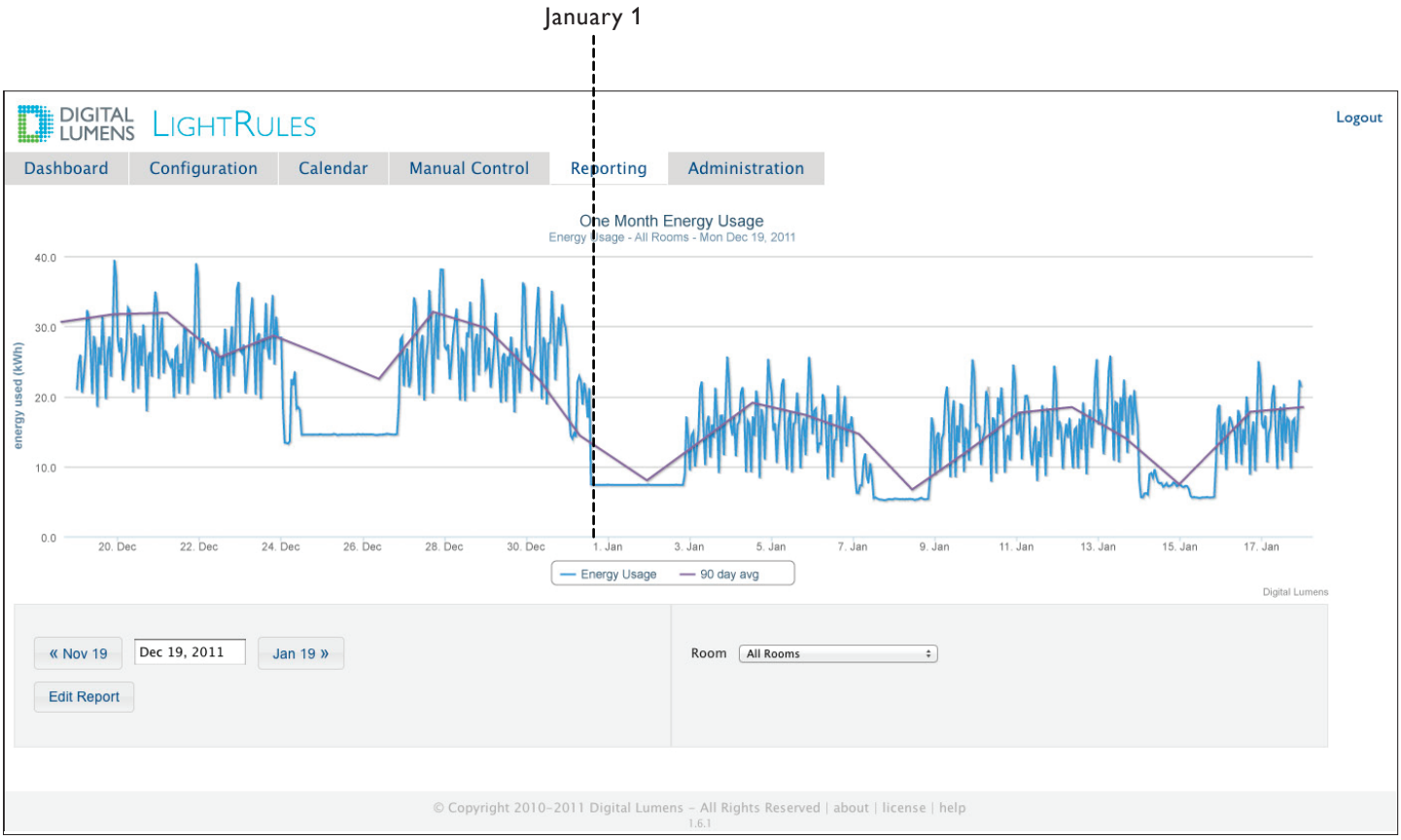

Figure 5: The LightRules One Month Energy Usage Report

Note the **January 1** date and how modest changes to sensor timeouts and dimming settings lead to substantial reductions in energy usage.

RELIABILITY: AN IMPORTANT CONSIDERATION/CRITERION FOR EVALUATIONS

There are several other important criteria for evaluating industrial lighting solutions that are critical with the switch to LEDs. They include:

- Fixture Longevity — With lifetime ratings in excess of 50,000 hours — more than twice that of alternative lamp sources — LED lighting fixtures need to be durable and designed with longevity in mind.
- Warranty — With LED-based systems, a five-year manufacturer's warranty is recommended, given the lifespan of these systems. Make sure that the warranty covers all of the hardware components of the system, as many lighting manufacturers only provide a pass-through warranty on key components such as the power supply and sensor, leaving the user with essentially no overall warranty.
- International Safety Certification — Best practice facilities are raising the bar on certifications, requiring not only component-level approvals, but UL/CE listing of the entire fixture as well. During evaluations, it is important not to assume that because one of these certifications exists, the others will be there as well. The highest quality manufacturers design their products to meet international standards of safety and quality.

SUMMARY

Choosing the right industrial LED lighting solution to meet your specific needs may seem daunting, but with a solid understanding of the LED options available, this process can be greatly simplified.

First and foremost, understand the range of LED offerings for industrial applications — from basic LED fixtures, basic LED fixtures with add-on sensors, to intelligent LED lighting systems. Then, identify which of these is most appropriate for the performance and energy-efficiency goals you have established for your organization. From an energy-savings perspective:

- **Basic LED solutions**, which improve upon legacy alternatives but perpetuate a simplistic and costly approach to lighting with fixtures left on all or most of the time, are at one end of the spectrum.
- **Basic LED fixtures with add-on sensors** are a reasonable mid-point, but still fall short of the energy-efficiency results set by intelligent lighting systems and carry double product and installation costs.
- **Intelligent LED Lighting Systems** maximize energy efficiency by marrying an energy-efficient illumination source with integrated intelligence and the ability to respond to the variables that drive lighting energy use. This approach is the easiest to deploy and operate, with similar first costs as basic fixtures with add-on sensors.

In short, Intelligent LED Lighting Systems provide the smartest, most efficient lighting alternative available to industrial facilities today. Currently in use in a wide range of demanding industrial applications, from temperature-controlled warehousing to manufacturing and retail, they are routinely delivering energy savings of 80% to 90% over legacy lighting solutions. They accomplish this by treating lighting as a managed asset that can be easily tailored to meet specific operational needs, providing the highest levels of efficiency and savings.

ABOUT DIGITAL LUMENS

Digital Lumens develops Intelligent LED Lighting Systems that are proven to reduce industrial customers' lighting-related electricity expenses by up to 90%. With this System — smart lights, wirelessly networked together and centrally controlled — the company is defining a new class of networked LED lighting that maximizes both delivered light and energy efficiency. Digital Lumens has been recognized as a 2011 World Economic Forum Technology Pioneer and a 2011 Global Cleantech 100 Company.

[1] Source: Energy Information Administration — CBEC Survey (2003).

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