

The Revolution in Warehouse Lighting: LEDs and Intelligent Lighting Systems

SUMMARY

In a standard warehouse, lighting electricity can represent 38% of total operating expenses; 15% in a refrigerated facility. When grossly inefficient HID fixtures are used, the majority of that energy is wasted and turns to heat. HIDs also require frequent maintenance and offer little control. Fluorescent fixtures, although an improvement over HIDs, still leave a lot of room for improvement in terms of efficiency and control.

With the advent of LED light fixtures that are well suited to high-intensity applications, warehouse lighting is poised for a dramatic transformation from one of the leading energy users to a shining example of how a sustainable choice can improve the bottom line. But LED fixtures alone are not sufficient — LED fixtures incorporated into Intelligent Lighting Systems are the key.

This paper will outline how LED-based light fixtures and Intelligent Lighting Systems are converting warehouse lighting from a significant monthly energy expense to a strategic asset.

INTRODUCTION

It is 'game over' for traditional 'brass and glass' lighting in warehouses and large industrial facilities. In converting almost all of the energy used into heat and not light, the existing standard is simply not sustainable. Fluorescents, with modest increases in efficiency, offer some improvement, but are fraught with issues of their own — including lifetime and hazardous material content.

LEDs — ultra-efficient light-emitting diodes — change everything, especially when incorporated into Intelligent Lighting Systems.

Intelligent Lighting Systems, a fundamentally new approach to lighting, apply networking and software-based intelligence to multiply the energy-efficiency benefits of LED-based light fixtures. The result is a lighting platform that gives facility managers unprecedented levels of energy efficiency, improves the quality of the light delivered, and provides additional capabilities that continually enhance operational efficiency.

For industrial facilities, in particular, the dividends of Intelligent Lighting Systems are visible both in the work environment and in the monthly energy bill. With massive reductions in energy costs over high-intensity discharge (HID) fixtures and improved light levels, the benefits are visible to employees and managers alike. What do you need to know about Intelligent Lighting Systems to evaluate their suitability for your environment? This paper will address:

- Traditional industrial lighting sources — pros and cons
- The anatomy of an Intelligent Lighting System
- Factors driving rapid adoption of Intelligent Lighting Systems
- The business case for Intelligent Lighting Systems

If you are considering retrofitting an existing facility and/or constructing a new building, now is the time to familiarize yourself with the new lighting technologies and integrate them into your plans.

TRADITIONAL HIGH BAY LIGHTING

Inefficient. Expensive. Dumb.

The high bay lighting used in large industrial facilities — legacy fixtures including high-intensity discharge (HID) lamps and various fluorescent alternatives (T5 or T8) — is grossly inefficient. These fixtures have been in use for generations and are considered reasonably inexpensive to acquire with predictable maintenance requirements. From an energy-usage perspective, however, these fixtures are terribly expensive to run, driven by the inherent inefficiency of the underlying technology. Further, because they are usually left running for many hours a day, have no built-in intelligence, and have no native control capabilities, these legacy options cannot be managed to maximize efficiency and minimize energy usage.

The table on the following page provides an overview of traditional warehouse fixtures, reviewing the pros and cons of each.

Figure 1: Pros and Cons of traditional warehouse fixtures

FIXTURE TYPE	PROS	CONS
<p>HID (High-Intensity Discharge), including HPS (High-Pressure Sodium) and MH (Metal Halide)</p>	<ul style="list-style-type: none"> • Not affected by temperature of the environment • Lower initial costs • HPS are more efficient than MH • MH offers better CRI (Color Rendering Index) than HPS 	<ul style="list-style-type: none"> • Highest operating costs in class • No intelligence • 10-15 minute warm-up time required for full light output • Lumens (light output) depreciate rapidly compared to other light sources (at 40% of rated life) • Significant heat output – very inefficient for refrigerated or freezer environments • Requires shrouded arc tube for safety and fire prevention precautions • Noisy ballast operations • CRI (65) is low compared to other light sources • Energy inefficient (average 57 lumens per watt) • Minimal dimmability • Two-year re-lamping cycle • HPS: Yellow light with very low CRI
<p>HIF (High Intensity Fluorescent)</p> <p>T5 Fluorescent = (5/8" diameter tubular lamp)</p> <p>T8 Fluorescent = (8/8" diameter tubular lamp)</p>	<ul style="list-style-type: none"> • Instant ON capabilities • Consumes less energy and is more efficient • CRI (75-85) is better than HID • Longer life than HID • Less lumen depreciation (5-8% per year) • Operates cooler than HID • T5: Operates more efficiently at higher temperatures; not great for cold environments. (Highest light output at 35°C.) • T8: Operates more efficiently than T5 in colder temperatures. (Highest light output at 25°C.) 	<ul style="list-style-type: none"> • No built-in intelligence • Does not fully illuminate when first turned on • Lamps contain mercury – an issue in food processing environments and heavy manufacturing involving metals • Minimal dimmability • Two-year re-lamping cycle • Ballasts generally require 15 minute on time without cycling, minimizing true benefits from control • T5: Lumen depreciates rapidly in lower temperatures (freezing or below) • T8: Lumen depreciates rapidly in higher temperatures

The bottom line? Legacy HID and fluorescent leave a lot to be desired in terms of energy efficiency, which will only get worse should energy rates continue to increase. Neither of these choices gives facility managers what they really want:

Efficiency

- Energy-efficient light source
- Low heat output

Reliability

- Consistent performance in a wide temperature range — from deep cold to warm
- High-quality light that does not deteriorate over time
- Instant ON and OFF without shortening life of light source and at the full light level desired

Controllability

- Wide range of dimming options
- Easily matched with controls that allow users to tune the light level and usage to specific applications
- The ability to easily change control settings over time
- The ability to leverage controls and occupancy sensing to maximize energy savings without sacrificing usable illumination

ANATOMY OF AN INTELLIGENT LIGHTING SYSTEM

Integrated intelligence drives radical efficiency

Intelligent Lighting Systems take an integrated approach to delivering exceptional levels of energy efficiency along with high-quality illumination and new control capabilities. By incorporating LEDs, distributed intelligence and networking into a single system, Intelligent Lighting Systems transform lighting from a fixed expense to a strategic asset. They also provide operational insight and intelligence — reports, metering and third-party system integration — that can help you run your business even better. The elements of the intelligent lighting system are:

Intelligence — The core of an Intelligent Lighting System is a distributed control system, which combines sensor data and software-based ‘rules’ to determine where and when to deliver light within a facility. This intelligence has a profound effect on driving down energy usage, ensuring that lights are only consuming power when needed. System-wide intelligence also enables the harvesting and reporting of key operational data, which helps to improve overall facility management.

LEDs — LEDs are a semiconductor technology that has been in use for decades in a variety of applications. They offer unparalleled efficiency and reliability and are now being widely adopted for general illumination. In addition to commercial and residential applications, LEDs are now being installed in high-bay environments because they can deliver higher light levels, much lower energy consumption, long lifetime, minimal maintenance, and reduced heat generation. LEDs are also inherently controllable, which creates new opportunities for managing them.

Sensing — Intelligent Lighting Systems incorporate sensing devices as a mechanism for ensuring efficient light delivery. These devices provide the ability to identify occupancy or other environmental attributes; e.g., daylight, and tailor the delivery of light according to pre-defined software rules.

- *Software Rule Example 1:* Is the space occupied? Then turn the lights on in that area — either all at once or in a ‘domino’ sequence as the occupant progresses — to the desired light level (which can vary by shift).

- *Software Rule Example 2:* Is there other light present? Then reduce the amount of light delivered.

Networking — Bidirectional networking, which allows the fixtures to communicate with each other and with a centralized control device, is the fourth key element of an Intelligent Lighting System. Without it, the fixtures are standalone ‘islands’ that cannot work together to provide system-wide benefits such as zone-based control of fixture groups or detailed aggregate energy usage reporting.

The key to maximizing efficiency, however, is to have LEDs, sensing, intelligence and networking all integrated into a single system. Merely cobbling the various elements together does not make a scalable, efficient and cost-effective solution that meets the needs of high-performing facilities. Those ‘some-assembly-required’ projects often are characterized by limited functionality, higher costs and interoperability issues. In contrast, when these elements are optimized together, the resulting system can deliver radical improvements in efficiency and functionality.

Figure 2: Intelligence reduces power consumption

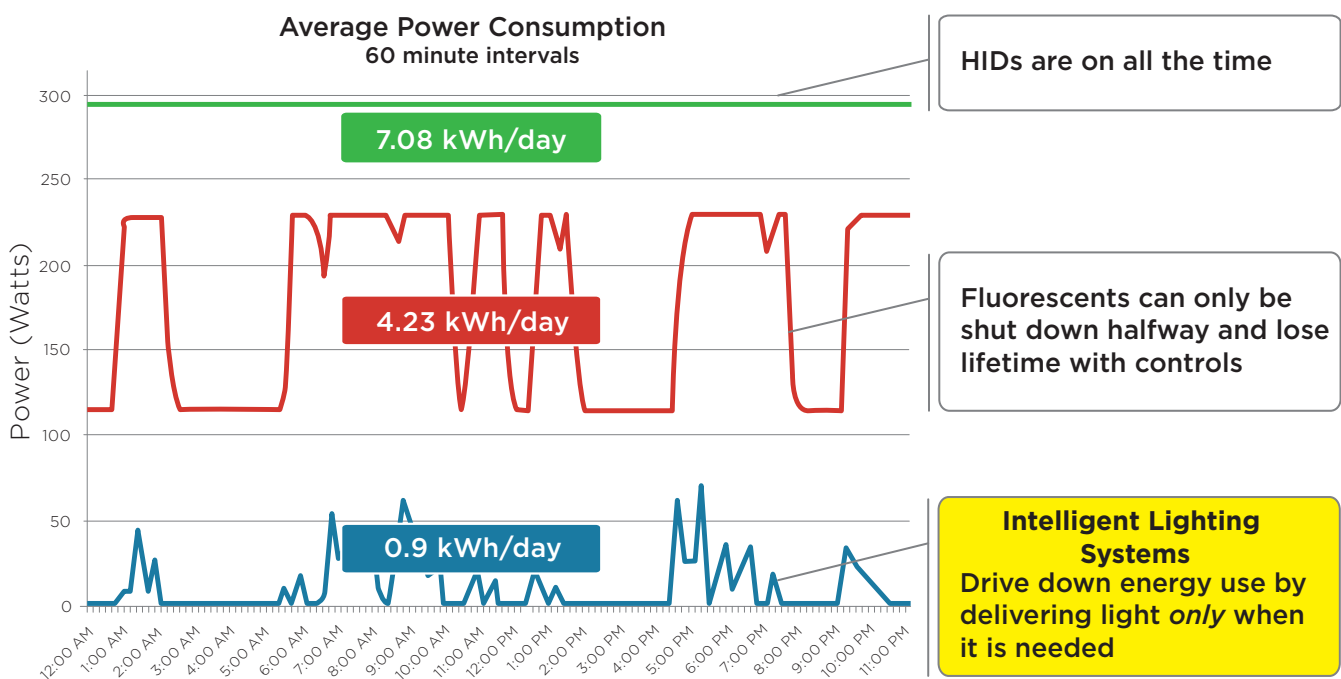


Figure 3: Pros and Cons of Intelligent Lighting Systems

FIXTURE TYPE	PROS	CONS
INTELLIGENT LIGHTING SYSTEMS	<ul style="list-style-type: none"> • Efficient — 90% or better energy reduction over HID • High light levels at target surface • Reduced maintenance — no re-lamping cycle • Lowest operating costs in class • Lowest lifetime cost of ownership • Enhanced sustainability • Lighting becomes a strategic platform 	<ul style="list-style-type: none"> • Higher initial purchase price

FACTORS DRIVING ADOPTION OF INTELLIGENT LIGHTING SYSTEMS

Major financial savings, improved light and operational control

Leading facilities are adopting Intelligent Lighting Systems because they are proven to deliver:

- **Massive energy reductions** — 90% and greater — by carefully managing the delivery of light only when and where it is needed and incorporating advanced LED technology, Intelligent Lighting Systems can drive down lighting costs by 90% compared to traditional HID alternatives. The reduced heat output also reduces chiller load in climate-controlled or cold facilities, offering additional savings that can be as high as 50%.
- **More light where it is needed** — The efficient and directional light provided by LED-based fixtures can dramatically improve the light levels (and uniformity of lighting) in a facility.
- **Long life, reduced maintenance** — With a lifespan of up to 100,000 hours, the LED light sources used in high-quality Intelligent Lighting Systems virtually eliminate ongoing maintenance and regular re-lamping schedules. When matched with an occupancy sensor and intelligent control, reduced run hours further extend useful life.
- **Improved operational control** — The ability to instantly update the lighting program, combined with the ability to gather detailed data about the facility’s lighting delivery, energy consumption, occupancy and more, mean that Intelligent Lighting Systems give managers better operational control of their resources and working environment.
- **Sustainability** — Corporations are embracing Intelligent Lighting Systems to reduce carbon footprint, document efficiency improvements, decrease the load on their utilities, and insulate themselves from future rate increases. As an added bonus, the radical energy savings driven by Intelligent Lighting Systems qualify some customers for substantial utility rebates.

As organizations evaluate how best to meet their ongoing lighting needs, while reducing energy bills and improving their green rating, these new solutions are an ideal fit.

INTELLIGENT LIGHTING SYSTEMS – THE BUSINESS CASE

Two-year payback

One of the top concerns for people considering LED-based solutions is cost. LED-based fixtures, whether ‘dumb’ or part of an Intelligent Lighting System, are more expensive than traditional alternatives. However, the intelligence built into Intelligent Lighting Systems maximizes energy savings, far exceeding the savings of dumb LED fixtures alone. When evaluating the business case for Intelligent Lighting Systems, it is important to consider:

- 1. Up-front costs** – What will it cost to acquire and install the new system? The equation: purchase price + installation costs, less any offsets* (utility rebates and tax credits, which can be substantial).
- 2. ROI (return on investment)** – How quickly will the energy and maintenance savings offset my initial investment? The ROI equation: savings per year divided by up-front costs. Or the payback equation: up-front costs divided by the annual energy savings, with an eye on when the anticipated savings cover the initial purchase price (time horizon).
- 3. TCO (total cost of ownership)** – What are the total costs, including installation, operation, and maintenance, across a five- or ten-year period? The equation: up-front costs less offsets, annual energy, maintenance, and cooling savings.

Analyzing the different scenarios for Intelligent Lighting Systems vs. HID and HIF will give you a detailed understanding of how the long-term financial benefits of Intelligent Lighting Systems mitigate the higher initial costs. When considering an investment in yesterday’s HIF technology, remember that even though payback periods will be similar, HIF will show a much higher TCO as the energy savings generated by HIF are much smaller.

Here’s a snapshot of a 500,000 square foot refrigerated cold storage warehouse that had 400W HID fixtures installed and retrofitted with an Intelligent Lighting System.

Figure 4: 400W HID, HIF and Intelligent Lighting System in a 500,000 square foot facility with 24 x 7 occupancy

	400W HID FIXTURE	HIF 8L-T8	INTELLIGENT LIGHTING SYSTEM
Wattage	465	302	165
kWh per Year	4,073	2,646	158
kWh Rate	\$.12	\$.12	\$.12
Electricity per Year per Fixture	\$489	\$318	\$19
Electricity per Year (650 fixtures)	\$317,850	\$206,700	\$12,350
Energy Savings per Year	\$0	\$111,150	\$305,500

Note: Savings number above is energy only and does not reflect maintenance, re-lamping or thermal load savings (for climate controlled or chilled facilities).

* Note: Many utilities offer substantial rebates to facilities undertaking a lighting retrofit if the energy savings will be significant enough. Additionally, Intelligent Lighting Systems, with integrated controls and built-in intelligence, gather actual kWh consumption data and occupancy data typically required by utilities for measurement and verification.

KEY CONSIDERATIONS WHEN EVALUATING INTELLIGENT LIGHTING SYSTEMS

Be a smart customer

When considering whether Intelligent Lighting Systems are appropriate for your facilities, here are some of the top-line questions you should ask any potential vendor:

- **Integration** — Does your system include LEDs, sensing, intelligence and networking in a single, integrated solution?
- **Light levels** — What light levels are delivered at the work surface? For LED-based fixtures, total lumens generated do not tell the whole story — focus on foot-candles (light output) delivered.
- **UL certification** — Is the fixture UL listed as a complete luminaire? A UL listed fixture gives you the greatest assurance that the system is designed for safe operation and insurance compliance.
- **Full testing results** — Do you have independent LM-79 and in-situ temperature tests for the lighting fixtures and LM-80 tests for the LED components used in the fixtures to document the light output and anticipated lifetime performance? Poorly designed LED fixtures will run too hot and won't deliver the light output over the fully claimed life.
- **Warranty** — What type of warranty protection is offered? What's covered? Term?

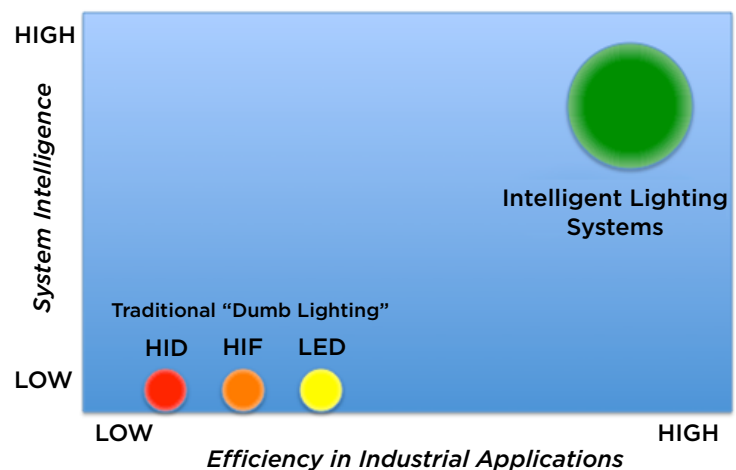
There are numerous other questions you should ask, but these are a good starting point that will help ensure that you are working with a reputable vendor.

CONCLUSION

Investing in intelligence pays dividends

If you are considering a retrofit or a new build project, developing a thorough understanding of Intelligent Lighting Systems and the opportunities they hold for greater energy and operational efficiency is a worthwhile investment. Lighting is often the largest energy user in dry storage warehouses, and the second-highest in refrigerated facilities (after chillers), but absolutely the easiest to address. Now is the time to get out your utility bill, sharpen your pencil and start to calculate

how much your current lighting is costing you each month, and how far you can reduce that number with an Intelligent Lighting System. Many customers are seeing lighting cost savings of 90% or more, with a two-year payback for their initial investment. No more 'dumb' lights, and that's an intelligent decision.



ABOUT DIGITAL LUMENS

A pioneer in developing and implementing next-generation lighting solutions, Digital Lumens is taking a game-changing approach to the industrial lighting market. With the introduction of the first Intelligent Lighting System, the company is combining LEDs, networking and software into a single, integrated system that reduces customers' lighting-related energy use by up to 90 percent, and transforming industrial lighting into a powerful platform for improved control, efficiency and operational insight. The company is distinguished by breakthrough technology, a management team of visionaries from the solid-state lighting and distributed networking industries, and proven results from real-world client deployments. For more information, visit www.digitallumens.com.



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