

ECHELON'S EFFICIENT CONNECTED LIGHTING SOLUTIONS

FOR INDUSTRIAL & COMMERCIAL APPLICATIONS

EXECUTIVE OVERVIEW

Echelon Corporation is a leader in connected, Internet of Things (IoT) lighting solutions. They give enterprises, governments, parking operators, and anyone who deals with large-scale lighting solutions the ability to provide their constituents with cost reductions as well as safer and more comfortable living and working environments.

Historically, lighting is something we all take for granted. Installed lights surround us both inside and outside, and many of us hardly notice. Today, the transition from incandescent and fluorescent bulbs to LED technology is one of the fastest-growing changes in unit volume we have ever seen.

We are on the verge of being able to drastically change how lighting effects our daily lives. Installing digital, connected lighting solutions such as those offered by Echelon can greatly reduce energy consumption and maintenance, directly affecting a corporation's bottom line. These same solutions can provide real benefits in terms of safety, productivity, and health for employees, customers, and the general public.

THE LIGHTING TRANSITION FROM ANALOG TO DIGITAL

LED or solid state lighting (SSL) has been around for many years, but the transition from traditional incandescent and fluorescent fixtures began slowly. Today—driven by great strides in reducing costs, continued improvements in brightness, and the significant energy efficiency of SSL—we are seeing not only rapid growth in new installations but also a significant market for replacement in fixtures and lamps. Figure 1 forecasts LED penetration through 2022.

FIGURE 1: GLOBAL LED LAMP PENETRATION SHIPMENTS 2014-2022
(SOURCE: STRATEGIES IN LIGHT)

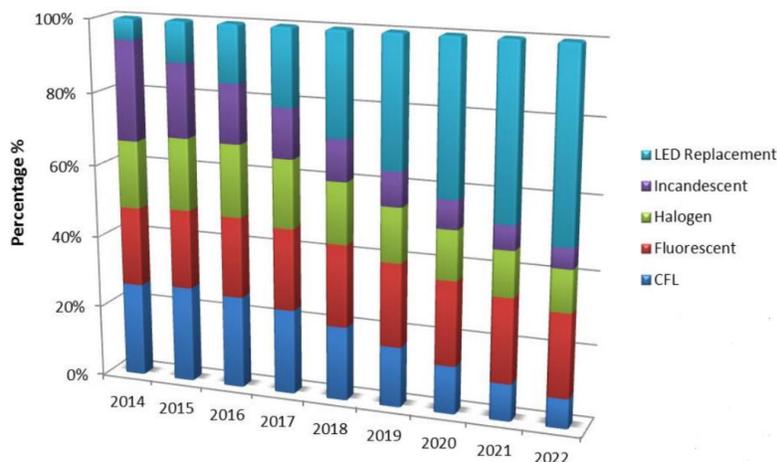


Table 1 illustrates one of the simplest reasons for the changeover. LED lights last so much longer than current installations that the cost doesn't need to be equivalent, only competitive.

TABLE 1: LIGHTING TECHNOLOGY LIFETIME

Technology	Lifetime (hours)
Incandescent	3,000
Fluorescent	10,000
LED	50,000 to 100,000

THE EFFECTS OF LIGHTING ON LIFE & WORK

Other than longer lifetime hours, what are the main benefits? MI&S believes that LED lighting has the ability to both **reduce costs** and make our work and life environments **more productive** and **safer**.

LED saves so much power over alternatives, per focused or directed unit of illumination, that including sensors and communications in lighting comes almost for "free" in terms of lighting wattage budget. While you pay more for the LED luminaire, the longer life and the ability to monitor performance also means lower maintenance costs. Deploying lighting-based sensors—and gaining useful insight from them—can lead toward net neutral costs or operational savings over time. LED lighting offers economic, environmental, and productivity benefits.

ECONOMIC & ENVIRONMENTAL BENEFITS

- **Energy efficiency** Energy efficiency is perhaps the greatest advantage of LED lighting. A properly-designed LED circuit will approach 80% efficiency, meaning that 80% of the energy is converted to light, and only 20% is lost to heat. Incandescent bulbs operate at about 20% efficiency. This huge increase in energy efficiency of LEDs reduces costs and heat, and it increases their lifespan.
- **Longer life** A longer lifespan means reduced carbon emissions. LED luminaires last up to 10 times longer than other types of lights, reducing the requirement for frequent replacements. This results in using fewer lights, and hence fewer resources for maintenance, manufacturing, packaging materials, and transport.
- **Networkable & monitorable** LED lights have the ability to be monitored on a regular basis, ensuring that failures are predicted and responded to quickly. In addition, networked lights are provide an avenue for incorporating sensors that can further reduce energy consumption and improve asset utilization.
- **Less heat** Heat produced by lighting contributes 42% of the entire cooling load in the United States. The energy efficiency noted above reduces the amount of heat put out by LED lighting, which translates into less energy usage for air conditioning for homes, offices, enterprises, and all indoor light usage.

PRODUCTIVITY BENEFITS

Lighting affects all of us both indoors and outdoors. In the office environment, the quality of office lighting affects not only the productivity of employees, but also their emotional and psychological wellbeing. Employees who work with bad lighting (incorrect lighting levels, wrong color temperatures) not only make more errors, but bad lighting can harm sight as well as reduce morale.

In the 2012 study [Effects of Four Workplace Lighting Technologies on Perception, Cognition and Affective State](#), the authors compared fluorescent lighting with three different LED lighting values. Key findings include...

- LED supports positive mood, extended wakefulness, and speeded performance
- 8.3% improvement in visual and cognitive tasks
- Faster reaction times
- Reduced fatigue
- Increased vigor / activity
- Lower rates of depression

Education, retail, hospitality, and healthcare will be the first adopters of features such as white-tuning due to productivity benefits, revenue savings, and interest in providing healthier environments. The bottom line is that studies for years have shown that good office lighting makes a difference.¹

In summary, MI&S believes the combination of energy efficiency, longer lifespan, reduced maintenance costs, and increased productivity makes LED technology a solid investment that is not just revenue-neutral, but also provides the ability to save significant cost over the lifespan of the lighting systems.

UNLOCKING THE VALUE IN LIGHTING

To achieve real value from both current and future lighting solutions, it is necessary to add the appropriate control features to LED lighting systems. MI&S recommends that vendors consider the following characteristics:

1. **Internet Protocol (IP)-Based Control** MI&S believes IP connectivity is crucial to the broad-based acceptance of connected lighting installations, whether they be parking lots, tunnel lighting, or standard building installations. There are two key reasons for the shift to make every endpoint in the lighting system accessible. First, developing useful, smart systems requires data. “Big Data” comprise all the small dynamic data provided by each lighting fixture. Second, lighting must be both integrated with other similar control systems, such as building automation (BA) systems, and accessible anywhere in the world. Using an IP-based foundation provides the ability to run multiple legacy protocols (LonWorks, BACnet, DALI) while migrating to new assets such as LED lighting: the “new” interoperating and integrating with the “old”. IP is, and will be, the connectivity technology that stitches together localized data for analysis, either locally or in cloud-based systems in the future.
2. **Adherence to Open Standards** MI&S is a firm believer that for future installations to be successful, they must use open standards. By implementing systems that are both **open** and **standard**, implementations can mix and match “best of breed” technologies from a variety of suppliers, whether for end devices, fixtures, drivers, sensors, or light sources. Adherence to open standards also allows control systems to be endpoint agnostic, so customers have greater choice in the types of lighting fixtures, light engines, and sensors they deploy.

¹ For example, a lighting upgrade at a Reno postal facility saved \$50K/year in energy, but the productivity gain was estimated at \$500K <http://www.andrewjensen.net/how-office-lighting-affects-productivity/>

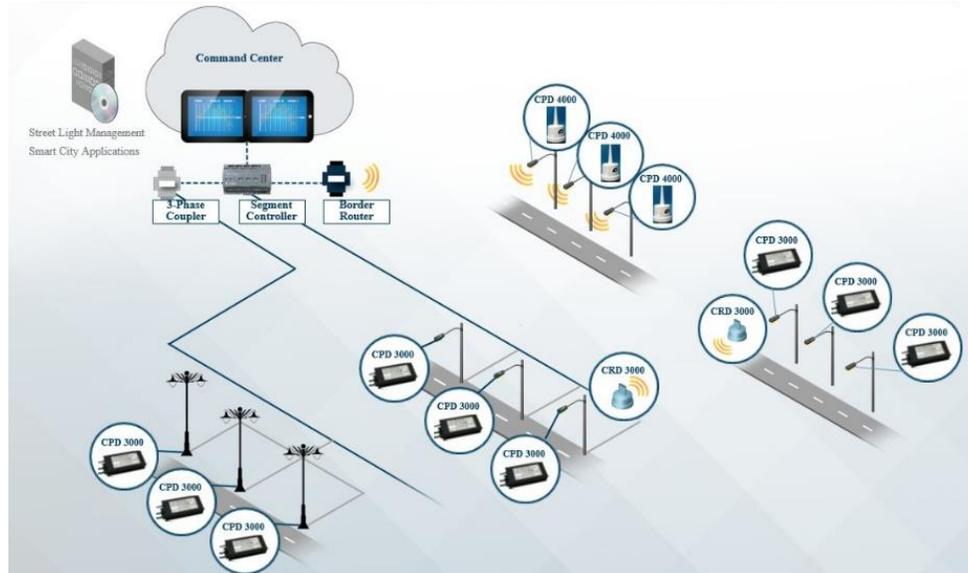
3. **Both Wired & Wireless Capabilities** Wi-Fi, Bluetooth, Zigbee, RF, and power-line communication protocols are, and will be, the prevalent communications technologies in enterprise and home infrastructures. While wireless technologies are far more prevalent than wired in the United States, there are some situations (certain industrial environments, concrete parking structures, tunnels) where wireless communications do not function. For that reason, it is important to have a control solution that supports both wired **and** wireless options.
4. **Adaptive & Predictive Controls & Software** The real benefit from intelligent lighting installations is derived from the use of adaptive software and controls. Using LED lighting saves energy, reduces maintenance costs, and increases productivity and safety. Combine these benefits with adaptive controls, and you can now realize a system that **optimizes** energy consumption, **further** reduces maintenance costs, and provides a platform for integration of additional devices, sensors, and software applications. This enables truly smart features such as...
 - a. Constant output lighting, which compensates for the reduction in output over time due to luminaire degradation
 - b. Virtual power output that allows the use of any wattage lamp in a fixture
 - c. Fixed-time dimming and an astronomical clock that compensates for seasons
 - d. Dynamic and motion sensor lighting that follows movement and lights only sections of roads or hallways that are being used
 - e. Programmability to optimize for multiple goals, including energy savings, revenue enhancement, safety improvements, or enhanced health
 - f. Support for applications ranging from lighting-related like white-tuning (which has been shown to affect human moods and behavior and which promises to improve customer satisfaction as well as promote greater learning or health) to asset management

ECHELON SMART LIGHTING SOLUTIONS

MI&S believes smart lighting is an application that is viable **today** and that can provide real benefits to cities as well as to residential and commercial consumers.

Echelon can provide outdoor lighting solutions that MI&S believes are implementable, cost-effective, and able to provide real features and benefits to users. Under the Lumewave by Echelon brand, the company offers a range of products that include outdoor RF (wireless), PowerLine (wired), and hybrid (RF + PowerLine) solutions.

FIGURE 2: ECHELON HYBRID RF / PL SYSTEM OVERVIEW



Echelon’s current Lumewave by Echelon solutions have the following characteristics:

- It is a **fully integrated** system. The Lumewave system is an integrated platform of hardware and software: everything needed to implement a solution.
- The system provides **energy savings** through the incorporation of state-of-the-art sensors and the use of adaptive lighting as well as **operational savings** through more efficient maintenance. In addition, the system is set up to provide process improvements through usage and failure analysis.
- Echelon uses trusted and mature industry **standards**.
- Echelon focuses on end-to-end **security** using standard protocols such as NSA Suite B algorithms for public and private key cryptography.
- Echelon provides **worldwide voltage compatibility** to meet the different standards used across the globe.

Echelon already has completed deployment of a number of large-scale lighting solutions, including two key installations: a retrofit project at the University of California at Davis and a networked adaptive lighting solution at Vaca Valley Hospital.

The retrofit project at the UC Davis campus addressed more than 3,000 outdoor fixtures including post top, wall packs, roadway, and area fixtures. The solution succeeded in reducing outdoor lighting energy use 86% on average, surpassing the 60% goal set by the campus. It also now provides extensive maintenance savings based on longer-lived

lights and energy monitoring services that allow for proper lighting based on occupancy. The true savings can be easily seen in Table 2.

TABLE 2: LED SAVINGS

	STREET & AREA LUMEC ROADSTAR 59% Occupancy			WALL PACKS DAY-BRITE WTM 20% Occupancy			POST-TOP FIXTURES LUMEC ECOSWAP WITH COLLAR 40% Occupancy			TOTAL SYSTEM SAVINGS FOR ALL FIXTURES
	BEFORE	AFTER	SAVINGS	BEFORE	AFTER	SAVINGS	BEFORE	AFTER	SAVINGS	
Energy Savings			73%			89%			87%	86%
Annual Energy Consumption (kWh)	1,111	300	811	828	87	741	861	111	750	1,231,758
Annual Energy Cost	\$83	\$23	\$60	\$62	\$7	\$55	\$65	\$8	\$57	\$91,277
Annual Maintenance Cost	\$19	\$0	\$19	\$17	\$0	\$17	\$27	\$0	\$27	\$29,632
15-Year Energy Cost	\$1245	\$345	\$900	\$930	\$105	\$825	\$975	\$120	\$855	\$1,369,155
15-Year Maintenance Cost	\$285	\$0	\$285	\$255	\$0	\$255	\$405	\$0	\$405	\$444,480
Total 15-Year (Lifetime) Cost for All Fixtures	\$2,060,910	\$464,715	\$1,596,195	\$119,685	\$10,605	\$109,080	\$118,680	\$10,320	\$108,360	\$1,813,635

Values listed are per-fixture quantities unless otherwise noted and reflect average performance. All post-retrofit solutions include photocells, motion sensors and network system controls. Savings are based on data reported through the Lumewave network lighting control system.

The second project, Vaca Valley Hospital exterior lighting, initially consisted of 40 induction luminaires, 13 high-pressure sodium (HPS) luminaires, and 7 metal halide luminaires, all operating at full lighting power throughout the night. The new installation consisting of a total of 57 luminaires was installed with dimmable LED technology and motion sensors. The integrated software system provides lighting schedules and the ability to adjust and monitor the system on a continuous basis. The retrofit reduced the site’s exterior lighting energy use by 66.4%, dramatically reduced lighting maintenance needs, and received positive reviews from 88% of end users surveyed for feedback.

These two installations and the features and functions of Echelon’s complete package of products leads MI&S to believe that as the market matures, Echelon will be a key driver of Industrial IoT lighting solutions.

CALL TO ACTION

Lighting is a critical factor in our home and work life, affecting everything from safety to productivity. Current incandescent and fluorescent fixtures are outdated and have real bottom-line budgetary and productivity costs. LED solutions are available today to enterprises, governments, universities, and other large lighting installations, and MI&S recommends they move to these solutions as rapidly as possible.

MI&S recommends organizations with large lighting installations audit their current lighting solutions for costs and energy consumption to determine when and how to move to LED solutions. MI&S highly recommends all new installations include intelligent connected LED solutions from the beginning.

MI&S recommends investigating Echelon solutions for new connected LED lighting installations. Compatible with systems worldwide, Echelon solutions provide the key features and functions needed to bring outdated systems up to current and likely future standards. As long as Echelon continues to provide innovative adaptive lighting features, compatibility with both existing and future standards, and strong overall security, customers will gain real benefits today...and the ability to efficiently scale for tomorrow.

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