LEDs for outdoor lighting applications

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INTRODUCTION

Everyone is talking about LEDs for outdoor lighting applications, from architect cabinets to environmental planners. But what are the facts? LEDs bring several advantages to the lighting industry, including high efficiency and durability, and, with superior life over other lamp sources, their required maintenance is greatly reduced. This translates into energy savings, maintenance savings and an overall reduction in cost of ownership over the product's lifetime. Those are the facts. An LED luminaire, if operational eight hours per day, will easily last 18 years without needing to be replaced, will use less electricity, and will require considerably less maintenance work over its lifespan.

The following work provides information to anyone who is interested in LED technology for outdoor lighting purposes. The first section addresses the advantages and disadvantages of LED technology in detail. The second section demonstrates a few examples of how going green helps cities thrive economically as well as environmentally in today's eco-conscious world. The third section showcases a product that uses LED technology that has finally reached its functional maturity and is ready to be implemented in the outdoor lighting field, consuming less energy for the same brightness and contributing to considerable economic savings.

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Part 1.
Advantages and disadvantages of LEDs

1.1 Technical introduction : Physical function

Like a normal diode, the LED consists of a chip of semiconducting material impregnated, or doped, with impurities to create a p-n junction. As in other diodes, current flows easily from the p-side, or anode, to the n-side, or cathode, but not in the reverse direction. Charge-carriers—electrons and holes—flow into the junction from electrodes with different voltages. When an electron meets a hole, it falls into a lower energy level, and releases energy in the form of a photon. The possibilities of LED light cover a wide spectrum, from the infrared LED in your television's remote control to the sterilizing ultraviolet LED light used in the medical field.

1.2 Advantages of using LEDs

> LEDs produce more light per watt than do incandescent bulbs; this is useful in battery powered or energy-saving devices.[1]

> LEDs can emit light of an intended color without the use of color filters that traditional lighting methods require. This is more efficient and can lower initial costs.

> The solid package of the LED can be designed to focus its light. Incandescent and fluorescent sources often require an external reflector to collect light and direct it in a usable manner.

> When used in applications where dimming is required, LEDs do not change their color tint as the current passing through them is lowered, unlike incandescent lamps, which turn yellow.

> LEDs are ideal for use in applications that are subject to frequent on-off cycling, unlike fluorescent lamps that burn out more quickly when cycled frequently, or HID lamps that require a long time before restarting.

> LEDs, being solid state components, are difficult to damage with external shock. Fluorescent and incandescent bulbs are easily broken if subjected to external shock.

> LEDs can have a relatively long useful life. Reports estimates 60,000 hours of useful life, though time to complete failure longer.[2] Fluorescent tubes typically are rated at about 30,000 hours, HID and MH are rated anywhere between 10,000 and 24,000 hours and incandescent light bulbs at 1,000–2,000 hours.

> LEDs mostly fail by dimming over time, rather than the abrupt burn-out of incandescent or HID bulbs.[3] This provides extra safety for any area illuminated by LEDs. Even if the LEDs dim over time, they never fail completely like HID sources before needing to be replaced. LEDs need to be replaced only after they reach 30% lumen depreciation (17-20 years for quality LEDs).

> LEDs light up very quickly. A typical red indicator LED will achieve full brightness in microseconds; Philips Lumileds technical datasheet DS23 for the Luxeon Star states "less than 100ns." LEDs used in communications devices can have even faster response times.

> LEDs can be very small and are easily populated onto printed circuit boards.

> LEDs do not contain mercury, unlike compact fluorescent lamps.

1.3 Disadvantages of using LEDs

> On an initial capital cost basis, LEDs are currently more expensive, measured in price per lumen, than more conventional lighting technologies. The additional expense partially stems from the relatively low lumen output, combined with the cost of the drive circuitry and power supplies needed. However, when considering the total cost of ownership (including energy and maintenance costs), LEDs far surpass other sources. In December 2007, scientists at Glasgow University claimed to have found a way to make Light Emitting Diodes brighter and use less power than energy efficient light bulbs currently on the market by imprinting holes into billions of LEDs in a new and cost effective method using a process known as nanoimprint lithography.[4] Around the same time, in Montreal Canada, Lumec inc. developed an LED light engine that consumes 20% to 30% less energy than HPS (high pressure sodium) and 40% to 50% less than MH (metal halide) while delivering comparable photometric performance, if not better, than HID lights.

> LED performance largely depends on the ambient temperature of the operating environment. Driving the LED hard in high ambient temperatures may result in overheating of the LED package, eventually leading to device failure. Adequate heat-sinking is required to maintain long life. This is especially important when considering automotive, outdoor, medical, and military applications where the device must operate over a large range of temperatures, and is required to have a low failure rate. The most heat resistant LEDs available commercially, such as those used by Lumec inc. In their light engine, the LifeLED™ can function at optimal efficiency from -40°C to +50°C(-40°F to 122°F).

Part 2.
How cities benefit from environmental responsibility

You've heard of green buildings, but green cities? Chicago's Mayor Richard Daley's wants to evolve his hometown into the greenest city in America, according to the NY Times, and his environment commissioner, Sadhu Johnston says it best, "It's not so much about saving the world. It's more about using green technology to save $4 million here, or earn $10 million there, and make the city better by doing that."

The Daley administration has put policy and money where their mouth is:

> planted 500,000 trees;
> putting up the most energy-efficient, ecological municipal buildings in the country;
> provides developers with much faster permits if they construct green buildings;
> promised to obtain 20% of the electricity used by the city from clean and renewable sources;
> established a $600-million-a-year program to repair neighborhoods and city parks
> converted hundreds of abandoned, contaminated properties into desirable locations.

What happened since the green investment? The following results are certainly not to be directly attributed, but they did happen in the same timeframe:

> The city population increased by 112,000 people, including 16,000 downtown;
> Added tens of thousands of downtown jobs while its median income increased 12.6% in the 1990's
> Prompted a high-rise housing boom
> Spurred a $9-billion-a-year visitor and convention industry

Also, a study shows that Millennium Park, Chicago's new 24.5-acre answer to Central Park, was responsible for encouraging at least 25% of the 10,000 units of new housing nearby, and increased hotel, restaurant, shopping and entertainment sales by $190 million a year. Who says green investment doesn't spur green returns?

2.1 Important facts about greening

Greening contributes to rising property values, which in turn contributes to the city's economic growth, according to research provided by The Wharton School's study, Public Investment Strategies: How They Matter for Neighborhoods in Philadelphia.

Property Values Increase by:

> 9% with new tree plantings
> **28**% with improvements to streetscapes
> 30% if they are located adjacent to cleaned and greened lots

Additional studies (conducted by the University of Washington) show that,

> Landscaping adds to the dollar value and sales appeal of commercial real estate and boosts office occupancy rates

USDA researchers in Davis, California found,

> Greening can change people's perceptions of their neighborhoods, reduce violence and crime, and increase neighborhood stability

The addition of environmentally responsible outdoor luminaires to a streetscape or to various neighborhoods and buildings not only has a positive effect on the environment but contributes to a considerable enrichment to the city itself. A street lined with LED luminiares benefits from 30% energy reduction and the property values on that street increase by an estimated 28% which contributes to extra taxes for the city.

Environmentally responsible outdoor luminaires are a visible way for taxpayers to see Mayoral contributions and efforts aligned with the U.S. Mayors environmental protection agreement at a cost that is easily justifiable and accepted by the population. The decision of a city to incorporate LED lighting also creates media visibility which attracts more residents to the city in question and gives the politicians exposure, drawing attention to their home areas and their constituents.

The conclusion speaks for itself… And the planet thanks us in advance.

One of the most common question threads regarding LEDs are their real environmental impact. How much energy can be saved with solid-state lighting? How much will these energy savings reduce CO2 emissions?

Finding the answers to these questions is not easy and the math involved is rather strenuous. So, in order to make it simple, we've done the research and the math for you.

Here are the main points. We'll use statistics from the United States Department of Energy.
A little over one-third of all primary energy is used for generation of electricity, and a little over one-fifth of all electricity is used for lighting. Hence, around one-fifteenth of all energy is used for lighting in the United States alone. Doubling the average luminous efficacy of white lighting through the use of solid-state lighting would potentially:

> Decrease by 50% the global amount of electricity used for lighting.

> Decrease by 10% the total global consumption of electricity (projected to be about 1.8 TW-hr/year, or $120B/year, by the year 2025).

> Free over 250 GW of electric generating capacity for other uses, saving about $100B in construction costs.

> Reduce projected 2025 global carbon emissions by about 300 Mtons/year.

Part 3.
Lumec LifeLED™ light engine

1. The optical system

The optical system's purpose is to throw the light beam to where we want it. The tiny light centre of an LED and the fact that each LED beam can be controlled individually gives us a lot of control in this area. In other words, hardly any light is wasted, so to speak.

2. The light source

The LEDs function as the light source in the LifeLED™ engine, providing a good way to control light thanks to their small arc tube. In order to achieve the highest longevity and efficacy of the LED, the heat at the thermal junction of the LEDs must be stringently managed.

3. The heat sink

The next component in the light engine is the heat sink. It is basically a way to siphon as much heat out of the light engine as possible in order to keep the LED thermal junctions as cool as possible. Since this is basically a large aluminum block with as much surface area as possible, many different designs and shapes can be made to accommodate various Lumec luminaires.

4. The circuit board

The circuit board is the physical connection between the LED's and the power source. Since heat is an issue, lower-end, less expensive circuit boards such as the FR4, which are not heat resistant, are out of the question. In order to get as much as possible out of the LifeLED™, Lumec uses a McPCB board, connecting the LED packages to a dielectric layer with a cooper circuit layer on an aluminum base.

5. The driver

The last element is the driver, which brings power to the LED's. Even this part can contribute to energy savings when compared to magnetic ballasts.

When we properly combine all these elements together, we get the most efficient and flexible system possible: LifeLED™, Lumec's LED light engine.

And, Lumec LifeLED™ is not available for one model of luminaire: Lumec made it possible to LifeLED™ retrofit as many of their models as possible.

Appendices

Lumec LifeLED™ powered luminaires have three main advantages that stand out above all others

A. Energy savings
B. Longevity
C. Photometry

The following appendices will address those three aspects >>

Appendices

A. Energy savings

Scenario 1

Street width = 30’ Spacing = 125’ Setback = 1’ Independent lab IES files Metal halide comparison		LED Light Engine	MH Gardco 3XL	MH SG3
	Classification	Cutoff	Full Cutoff	Full Cutoff
	LLF	0.87	0.72	0.72
	Average (fc)	0.61	0.64	0.6
	Avg/Min	3.05	3.2	N/A
	Lamp Wattage	60	100	100
	Total Wattage	72	120	120

By comparing LifeLED™ to Metal Halide, taking into account all characteristics of light and spacing, the energy savings come out to 40%.

Scenario 2

Street width = 30’ Spacing = 125’ Setback = 1’ Independent lab IES files HPS comparison		LED Light Engine	HPS Gardco 3XL	HPS SG3
	Classification	Cutoff	Full Cutoff	Full Cutoff
	LLF	0.87	0.72	0.72
	Average (fc)	0.73	0.78	0.74
	Avg/Min	3.05	3.2	N/A
	Lamp Wattage	80	100	100
	Total Wattage	96	120	120

When we do the same for High Pressure Sodium we end up with 20% energy savings.

Scenario 3

And in a Study to achieve 1.2fc (boulevard) for a 1000’ street

	Light Engine	Gardco 3XL
Spacing Required	77'	107'
Total Wattage	96	195
Pole Required	13	9
Street Wattage	1248	1755

We still Save 30% of energy!These figures can significantly reduce the power consumption of a city, a park, a street, a neighborhood, an institution, hospital, schools, parking lots etc… The LifeLED™ should be considered for any location where energy is costly, not simply in terms of dollars, but as a price the environment pays for our comfort. The energy savings can rise up to 50% in some cases. Please don’t hesitate to call us for a full photometric analysis of your project.

Appendices

B. Longevity

Longevity of a luminaire is typically measured by how long it can maintain a specified light output before maintenance is required. But that is not the only measure required to calculate the cost of a luminaire throughout its lifespan. To the basic cost of a luminaire, we have to add the cost of maintenance: man hours, cost of gas (and consequently pollution) for maintenance vehicles, employee and department management, bulb replacement, maintenance of fleet, management of personnel, etc...

Research shows that HID bulbs have a life expectancy of between 10,000 and 24,000 hours before needing to be replaced. LifeLED™ light engine lasts an estimated 60 000+ hours before needing to be replaced. 60 000+ hours is 3 to 6 times longer than the lifespan of HID bulbs. This means substantial added savings during the life of the luminaire.

If we consider that a luminaire will be lit for 8 hours per night, a Lumec LifeLED™ powered luminaire will last approximately 18-20 years before needing to have its light source replaced, compared to an HID luminaire which will need to have its optics replaced on average once every 4-7 years. LifeLED™ is also IP66 sealed which means that the optics are protected from environmental wear and tear caused by rain, snow, dust, sand, pollutants and ice. This keeps the optics functioning at optimal levels at all times, in all weather conditions, and again reduces maintenance fees.

Every time the optics need to be replaced in one of the countless luminaires throughout a city, a team of workers and a maintenance vehicle, which consumes large quantities of gasoline and creates pollution, must be deployed to the location. The money saved by doing this once every 20 years VS once every 4-7 years is an added benefit to the ownership of a product with a LifeLED™.

Reduced maintenance costs and a longer life add value to any LED light engine powered luminaire. In most cities the maintenance fleet is utilized to its full capacity. By alleviating the load on the public works department, a city not only saves money on luminaire repairs, part replacement, and general maintenance; the city also saves money on fuel for the fleet (which in turn helps lower green-house gas emissions) and it can reassign the manpower needed for luminaire maintenance to other urgent ventures.

Appendices

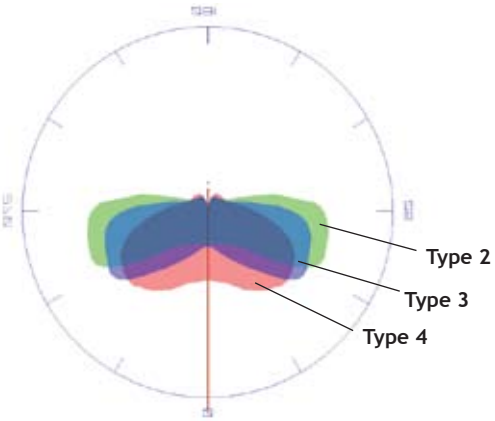
C. Photometry

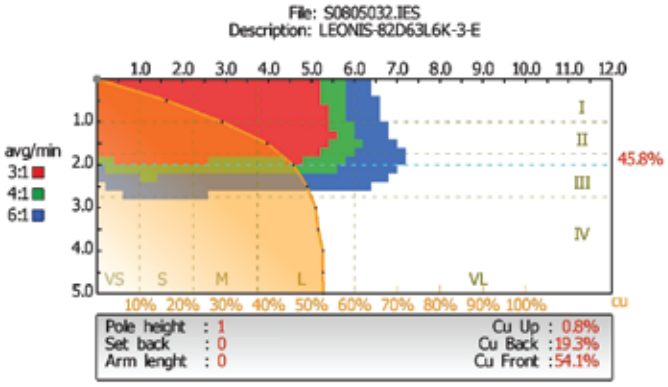
Photometry is the science of measurement of light in terms of its perceived brightness to the human eye. Photometric measurement is based on photodetectors, devices (of several types) that produce an electric signal when exposed to light. Simple applications of this technology include switching luminaires on and off based on ambient light conditions, and light meters, used to measure the total amount of light incident on a point.

Luminaires (known to laypersons simply as light fixtures) are tested using goniophotometers and rotating mirror photometers, which keep the photocell stationary at a sufficient distance that the luminaire can be considered a point source. Rotating mirror photometers use a motorized system of mirrors to reflect light emanating from the luminaire in all directions to the distant photocell; goniophotometers use a rotating 2-axis table to change the orientation of the luminaire with respect to the photocell. In either case, luminous intensity is tabulated from this data and used in lighting design.

Most LED luminaire manufacturers offer LED lighting but with a significant lack of photometric performance.

At this point in time, no other LED luminaire can even begin to be considered in the same photometric category as Leonis by Lumec. The competition simply can't match the patented photometric performance of the LED set in the luminaires by Lumec.





Lumec is on the forefront when it comes to LED photometric performance, design, energy savings and quality of construction. Their dedication to quality is reflected in the incredible performance of their products. And with their comparable dedication to design, Lumec is without doubt the right partner for any of your outdoor lighting projects.

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