WHY LED STREET LIGHT TECHNOLOGY

LED Lamp (Light-Emitting-Diode)

A light-emitting-diode is a semiconductor diode that emits light when an electric current is applied in the forward direction of the device. The effect is a form of electroluminescence where incoherent and narrow-spectrum light is emitted from the p-n junction in a solid state material. The light characteristics of an LED are a focused narrow band of light. Until recently diffusing the light beam into a large area has been a problem. With current technological advancements the light stream can be focused to any size area in any pattern desired. The extreme low energy consumption is the wonder of the LED. A 100 lumen incandescent lamp will burn 100 Watts per hour, while a 100 lumen LED will burn 17 watts per hour. The 100 Lumen induction lamps will burn 23 watts per hour, making the induction the only real competition for LEDs. The battle boils down to light focus (light pollution) and environmental hazards. The LED can be focused, the induction lamps cannot, and the induction lamps have mercury, ***the LEDs have nothing harmful to the environment***, easing disposal and cutting maintenance costs, yet again.

The Advantages of LED Lamps:

☐ Long life span 100,000+ Watt hours;

☐ Very high energy conversion efficiency of between 80 and 100 Lumens/watt;

☐ Minimal lumen depreciation (decline light output with age) compared to other lamp types as filament evaporation and depletion is absent;

☐ “Instant-on” and hot re-strike, unlike Sodium vapors and Metal Halides;

☐ Ability to focus exact luminous area;

☐ Focus area and color design help eliminate light pollution;

☐ CRI (Color Rendering Index) of 80-90;

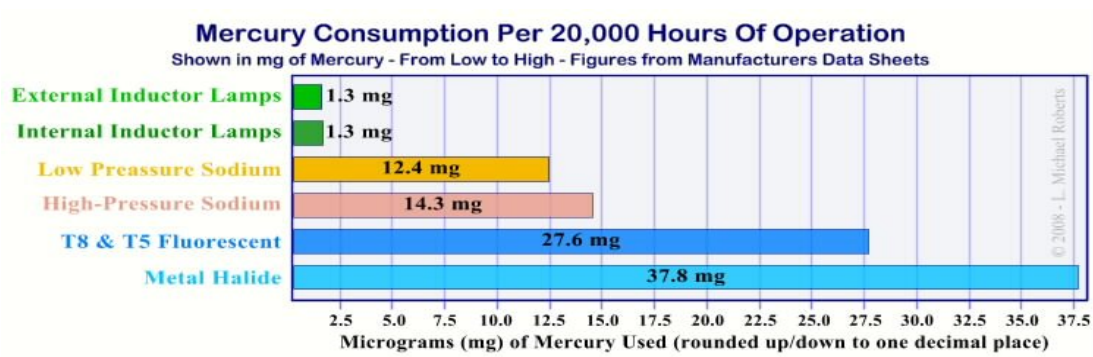
☐ CCT (Correlated Color Temperature) available from 2000K to 10,000K;

☐ No toxic materials used in manufacturing;

☐ Solid State construction, no moving parts, very rugged;

☐ Environmentally friendly, uses less energy (76% less than current lamps);

☐ Environmentally friendly, can be disposed of in landfills.



LED HAS NO MERCURY CONSUMPTION

The Disadvantages of LED Lamps:

☐ Increased upfront cost (more expensive than Sodium Vapor or Metal Halide).

Other Lamp Types:

There are many other types of lamps ranging from xenon arc lamps used in movie projectors, to metal halide, mercury vapor and sodium types, to fluorescent types, to light emitting diodes [LEDs].

Fluorescent Lamps:

A fluorescent lamp is a type of gas discharge tube where an electrical current excites mercury vapor in an inert gas producing UV light, typically at the 253.7 nm and 185 nm wavelengths. The UV light is up-converted, by a coating of phosphors on the inside of the glass tube, into visible light. At each end of the typical fluorescent lamp, there are small tungsten filaments which are usually coated with a blend of metallic salts such as barium, strontium and calcium oxides. The filaments are provided to bring the electric current into the lamp, and the metallic salts are designed to promote the emission of electrons, in order to stimulate the mercury ions, which are released by the liquid mercury in the tube.

Fluorescent lamps are a negative resistance device [as more current flows, the resistance decreases allowing even more current to flow] so the lamps require a ballast to control the current to the lamp. The most common and simple type of ballast is a magnetic or “core and coil” ballast. This is a form of current limiting transformer which provides the lamp with the correct current needed for operation. These ballasts are cheap but inefficient as they emit heat [wasted energy] - typically between 12% and 15% of the energy consumed by the lamp is wasted in the ballast. Newer types of fluorescent lamps use high frequency electronic ballasts. While these are more costly to manufacture, they are much more energy efficient typically only wasting between 5% and 8% of the energy consumed by the lamp. The choice of phosphor, or combination of phosphors, used in the coating on the inside of the tube influences the perceived color of the light emitted. Certain phosphors emit red, green or blue light when excited by the UV light inside the tube. By combining various phosphors, manufacturers can offer “warm white”, “cool white” and “daylight” types of lamps (where these designations refer to the approximate color temperature of the lamp) by mixing and matching the phosphors used in the lamp coating.

Electrode-less Lamps:

Almost all of the light sources currently in use have one thing in common, metal electrodes sealed into the walls of the bulb to bring the electrical current inside the lamp chamber/envelope. The main failure mechanisms in these typical lamps with electrodes [other than breakage is:

☐ Failure of the filament due to depletion of the filament material over time as atoms are stripped off by the electrical current;

☐ Vibration which breaks the filament, especially when it is hot;

☐ Failure of the seal integrity of the lamp; typically caused by thermal stresses in the area where the electrodes go through the glass walls. The failure of the seal can either be sudden and complete, or a “slow leak” over time allowing the entry of atmospheric gasses which contaminate the interior.

Solutions:

The most reasonable method to reduce cost, energy consumption and impact on the environment is one of two solutions:

1. LED light replacement, or
2. Induction light replacement

Magnetic Induction Lamps:

Magnetic induction lamps are basically florescent lamps with electromagnets wrapped around a part of the tube. High frequency energy, from the electronic ballast, is sent through wires, which are wrapped in a coil around the ferrite inductor, creating a powerful magnet. The induction coil produces a very strong magnetic field which travels through the glass and excites the mercury atoms. The mercury atoms emit UV light and, just as in a florescent tube, the UV light is up-converted to visible light by the phosphorus coating on the inside of the tube.

The Advantages of Induction Lamps:

☐ Long life span due to lack of electrodes – between 65,000 and 100,000 Watt hours depending on the lamp;

☐ Very high energy conversion efficiency of between 62 and 87 Lumens/watt;

☐ High power factor due to low loss in high frequency electronic ballast which are 98% efficient;

☐ Minimal lumen depreciation (decline light output with age) compared to other lamp types as filament evaporation and depletion is absent;

☐ "Instant-on" and hot re-strike, unlike Sodium vapors and Metal Halides;

☐ Environmentally kind using less energy (50% less than current lamps), and the mercury can be recycled at the end of its life.

The Disadvantages of Induction Lamps:

☐ Requires a retro fit in current lamp housing;

☐ Are harmful to the environment and listed as personal hazard by OSHA due to the mercury content (protocols are established by OSHA in the event of a bulb breakage);

☐ Must be disposed of properly, strong concerns abound if the lamp is disposed of in a landfill;

☐ Special disposal is more costly and will be passed on to the consumer;

☐ Induction and CFLs emit microwaves that might be harmful to humans and animals;

☐ Electromagnetic fields are also strong due to the magnetic induction (for both external and internal induction);

☐ Increased upfront cost (more expensive than Sodium Vapor or Metal Halide);

☐ Inability to focus the light flow adds to light pollution.

Environmental Facts Relating to Mercury and Light Bulb Recycling

- *Each year, an estimated 600 million fluorescent lamps are disposed of in U.S. landfills amounting to 30,000 pounds of mercury waste.*
- *In 1992, mercury-containing lamps were added to the United States' Environmental Protection Agency's (EPA) list of hazardous substances. (The EPA's regulatory threshold of 2 mg./litre is usually exceeded by mercury-containing lamps).*
- *The Mercury from one fluorescent bulb can pollute 6,000 gallons of water beyond safe levels for drinking.*

"Mercury Study Report to Congress" - US Environmental Protection Agency (EPA); December 1997

Comparison of Co2 Emissions

CO2 EMISSIONS BY LIGHT SOURCE

Energy Waste & Carbon Dioxide Emissions

Energy waste results from light pollution. Typically, 30 to 50% of the light we produce is never used, shining sideways or upwards instead. Misdirected light, using too much light, and leaving the lights on all night when nobody is around, are all wastes of energy.

Quality lighting can reduce electricity consumption and thereby reduce carbon dioxide emissions. In Alberta, most electricity is produced by at coal and gas fired generators. Each kilowatt-hour (one kilowatt-hour = one 100 W bulb left on for 10 hours) of electricity generated this way results in the emission of one kilogram of CO2 into our atmosphere. The use of energy efficient light sources should be encouraged. In the table below, the lights all produce about the same amount of light (lumens) but consume energy at different rates (watts):

Type of Bulb	Watts per 1000 lumens	Comments	Kg of Co2 Emission per KwH
Incandescent (ordinary bulbs)	60 watts	Least efficient	**60**
Mercury vapour	24 watts		**24**
Metal halide	17 watts		**17**
High pressure sodium	12 watts	Typical street light bulb	**12**
Low pressure sodium	8 watts	Efficient	**8**
LED Lighting	4 watts	Most Efficient	**2**

Here's how to tell the difference between different outdoor lighting sources:

Incandescent: this common indoor light is very inefficient and has a relatively short life-span. Essentially, these lights are heat sources that also happen to emit some light. Much of the energy emitted is in the infrared. These lamps are okay if used in low wattage applications (e.g., Christmas lights) but are a poor choice for outdoor lighting.

Quartz: these are arc or filament lamps (like incandescent) and also produce glare. They are inefficient and have a short service life. These lamps are often used as spotlights or floodlights.

Mercury Vapour: this glary arc source that was the dominant source of outdoor lighting, especially street lighting, for many years. Much of the output was in the blue and violet ultraviolet (UV) portion of the spectrum, parts of the spectrum that the eye either does not see (UV) or does not focus well at night. The lamps' output fades with time and the lamps were typically housed in poorly shielded fixtures. It is usually cost effective to replace them with more efficient sources.

Metal Halide: these lamps are another common white light source. They are more efficient than mercury and being of more recent design, are usually housed in better fixtures that control light output distribution. If not well shielded, this arc source is glary. Look for them in parking lots and car dealerships where colour rendition is important.

High Pressure Sodium (HPS): these pinkish or amber coloured lamps are more energy efficient than any of the above sources. They are an arc source and can cause glare. Colour rendition is somewhat impaired because much of the emitted light is in the yellow through red part of the spectrum. Many communities, including The City of Calgary, have replaced mer-cury street lighting with HPS lighting. Unfortunately, usually only the lamps are replaced with HPS (at the same wattage) but not the old light fixtures (lots of light trespass, glare, and sky glow remains). Fitted into new, full cutoff light fixtures, these make good streetlights without the problems of light trespass, glare and sky glow.

Low Pressure Sodium (LPS): LPS lamps look yellow like the amber light in signal lights. LPS is a tube source, like fluorescent lamps, and are not glary under most conditions. Proper shielding can reduce glare further. Additionally, LPS lamps are so energy effi-cient (the most efficient avail-able) that a 55 watt LPS lamp has about the same output as a 100W HPS lamp or a 175W mercury lamp and three times the output of a 150W incan-descent lamp. This efficiency is due to all emitted light being in the visible spectrum, specifically the two sodium emission lines in the yellow-orange part of the spectrum and because the eye at night sees yellowish light most efficiently. Colour rendition by LPS is very poor, however.

In Alberta, a single 100-watt incandescent porch light left on all night shines 1/2 of its light into space and causes 390 kg of carbon-dioxide pollution each year. That's enough to fill 44,340 twenty cm (8") party balloons! From one light bulb!

Calgary will save over $2 million per year and reduce carbon-dioxide emissions by 18,000 tonnes per year after it converts to full cut-off streetlights and by using only as much light as necessary.

Approximately 25% of the electricity generated in the United States is used for lighting. In Canada, a similar percentage of electricity is also anticipated to be used for lighting. If energy efficient lighting were used just where economically sound, the electricity required for lighting would be reduced by 50%, with a national electricity demand reduction of 10%. Corporations will profit by lowering their electric bills, and reducing air pollution caused by electricity generation.

Comparison of Lumen Maintenance Curves for Various Commercial Light Types