

## LED Lighting: Is It Time to Change From Fluorescent and Incandescent Lighting?

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Year after year articles and speeches foretell that THIS is the year LED lighting will take off and massive replacement of lamps, tubes and bulbs will begin in earnest. Can one blame a business owner for being skeptical of such claims? After all, the basic questions still loom:

- ◆ Do LED replacements light the area as well as fluorescent or incandescent lighting?
  - Is there enough light?
  - Does it “look” as good?
- ◆ Do LED replacements save money? If so, how soon?
- ◆ Will changing to LED lighting help or harm the environment?

This paper addresses the Functional, Financial and Environmental issues from a business owner’s point of view. It is not intended to be a detailed, comprehensive analysis of all the factors, but rather a common sense look at the practical considerations around LEDs and workplace lighting, as of March, 2010.

### Functional Considerations

How the issue of whether LED lights do an adequate or better job of lighting an area is viewed depends a lot on the basic philosophy of what matters most -- 1. How does it look? 2. How does it measure up? Sure, both factors are important, but because the source of LED light is significantly different and the characteristics and attributes are different from technologies that have been the norm for over 50 years, the way everyone evaluates “what is right for their work space” has a lot to do with whether they are primarily a qualitative or quantitative thinker, or both.

### How Does It Look?

If a person is in this camp, what is important to them is whether or not their workplace environment is diminished in any way with LED versus Fluorescent lights.



Typical Incandescent Spectrum

Typical Fluorescent Spectrum

Typical LED Spectrum

People are used to fluorescent lighting, maybe too used to it. There is a tendency to overlook the flaws, because of familiarity and a resignation to the inherent lack of features. For instance, fluorescent light has a spectrum with gaps, particularly in the blue area. Earlier versions of LED lighting were sometimes reported to seem bluish or not as bright, but some of that perception could have been due more to a fluorescent deficiency than to an LED excess. Better LED chip technology and lamp design have improved the spectrum display, such that now LED lighting seems fuller and richer than fluorescent lighting to most people.

Fluorescent lights cannot be dimmed or the method is so expensive it is rarely done. Out of necessity, the option is forgotten. Wouldn't it be nice to be able to change the intensity of light in a workspace, to be able to personalize a desk area and not make every office feel like a factory floor or grocery store?

There is a fundamental difference in the way LEDs project light – it is directional. This is different from the 360° emitted light of a tube or bulb; however, in the workplace much of that light is wasted unless there is a reflector in the fixture. As LED lighting becomes more common, fixtures are being designed specifically to take advantage of the characteristics of LEDs, instead of LEDs having to adapt to inefficient fluorescent and incandescent fixtures. Outdoor lighting regulations in some areas of the country now require limiting “Light Pollution” so that wildlife and neighborhood standards are safeguarded. The directional nature of LEDs make them ideal for these applications.

Finally, as LED lighting ages, it gradually loses intensity; however the consistency of light distribution (across the length of a tube, for instance) is maintained. Fluorescent manufacturers conveniently forget to mention that aging tubes flicker, darken at the ends, and abruptly fail totally, without warning. It is not so easy to ignore the visual and audible weaknesses when you are sitting for hours under a humming, pulsating light. The Canadian Centre for Occupational Health and Safety points out that “flicker is usually a potential problem only with lighting that requires the use of ballasts, like fluorescent lights.” Some studies have shown that the combination of flicker and over-illumination yield a particularly high incidence of fatigue in workers subjected to this condition.

#### How Does It Measure Up?

If a person is in this camp, the subject gets more complicated. New technologies with different characteristics by necessity require that different measurement techniques be developed. It occurred with the introduction of fluorescent and high intensity discharge (HID) lighting and now it is happening with LEDs.

Observe the instance of how color standards have changed. The development of the correlated color temperature rating (CCT) grew out of the attempt to understand and define color difference and create a uniform description in response to the introduction of the visibly different light from fluorescent lamps; different, that is, from incandescent. As noted before, fluorescent sources are made up of spikes of color bands and do not have complete spectral distributions, so (CRI) color rendering index was devised. And now, the National Institute of Standards and Technology (NIST) has developed an updated protocol CQS, or color quality scale to help redefine color accuracy. This takes into account the fuller spectrum of LED lighting.

Are LED lights as bright as other lighting sources? All lighting products show specifications for their output, measured in lumens. The simple answer is to find a lamp that has a rating that meets or exceeds your requirement; however, the measurement of lumens at the task level, which includes the effects of both the source lamp and the efficiency of the fixture is what really matters, not just the amount of light leaving the lamp. In short, of course LED lighting can be as bright as fluorescent or incandescent, if the selection of the lamp and fixture is correct.

### Financial Considerations

Interestingly, LEDs have an indefinite lifetime of light output, in theory, when operating at a low temperature and with proper current regulation. They are solid state devices with no filaments, no gas to fail, and for practical purposes they have no “failure” mode in the conventional sense. As a result, the standards applied to older lighting sources are ineffective with a device that can last thousands of hours and whose technology changes rapidly. Unlike computer technology where operating system changes can make software obsolete, waiting for generational changes in LED technology is a fool’s errand, because savings lost during the wait will never be recouped.

Actual ratings for LED products are based on 30% to 50% reduction in lumens, rather than a complete loss of function. Recognizing the fact that LED lights can last in excess of 50,000 hours, or 5.7 years when operating 24/7, further research is needed to determine true measurement standards. It may be some years before the industry can truly define and understand the life of LED products. In the meantime, the published service life of LED products is based on theoretic data regarding the life of the LED and signal conditioning components, but the data can tell us something conclusively: LED lighting technology lasts longer than its fluorescent and incandescent counterparts.

For the quantitative consumer, “lasts longer,” as in fifty times longer than incandescent lamps and 5 times longer than the typical comparable fluorescent tube, translates to savings. There are fewer replacement lamps to purchase, fewer replacement ballasts to purchase, lower replacement installation labor costs, and no disposal bookkeeping and handling costs for the toxic fluorescent lights being replaced.

The next most significant cost savings can be found in reducing energy consumption. LED lights require a fraction of the energy to operate compared to fluorescent tubes. The cost savings associated with that kind of energy differential is obvious. To put this savings into perspective, LED lights can function at 80% efficiency, which means 80% of the electrical energy is converted to light energy with the remaining 20% lost as heat energy. Compare that with fluorescent lights which operate at about 35% efficiency and incandescent bulbs at 10% efficiency. This means 65% and 90% of the electrical energy is lost as heat. Consider that equation when figuring out how much is being spent to actually light a room, versus the cost being spent on wasted heat. The wasted heat from fluorescent tubes also raises air conditioning costs everywhere in warmer months and year-round in Southern states.

A savings aspect which has been virtually ignored until recently, mostly because fluorescent lighting is not suited to take advantage of the feature, is controlled lighting. A study by the Lighting Research Center at Rensselaer Polytechnic Institute found that “50% of the subjects could not detect illuminance reductions less than 15% for the paper task and reductions of 20% for the computer task, regardless of the original illuminance.” Simple applications include adding occupancy sensors and light level sensors to either dim or turn off LED lighting. More comprehensive approaches take advantage of building automation systems, often already in place for controlling heating, ventilation, air conditioning and/or security equipment. The least amount paid for energy is when the lights are not even on!

Federal, state and municipal governments are offering tax savings for commercial and industrial companies implementing “green” technology for cost savings and outright reductions

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in consumption. In addition, utility companies offer rebates and rate savings, depending on the type of retrofit. Many of these incentives are linked to the amount of energy savings, so the more a project is able to reduce consumption, the greater the offset is. Utilities are also offering incentives to firms who participate in SmartGrid programs where during peak usage periods, the utility and company agree to shed non-vital loads for short periods – another place where controlled lighting can help. By paying firms to participate, utilities do not have to add power manufacturing capacity and build larger transmission and distribution facilities as quickly. All these incentives can result in major savings for a company in both the long and short-term.

### Environmental Considerations

When people hear about greenhouse gas emissions, or polluting emissions, they inevitably think about automobiles as the prime contributor. In truth, buildings are the largest contributor to greenhouse gas emissions. According to a recent study by the Pew Center for Global Climate Change, a staggering 40% of greenhouse gas emissions can be blamed on actual buildings (Brown M., et al., “Solutions to a Climate-Friendly Built Environment,” June 2005). Energy efficiency is the key to reducing the harmful environmental impact caused by running and maintaining buildings.

One very simple way to reduce energy consumption is by replacing current lighting with LED technology. The Department of Energy predicts that the conversion to solid state lighting (LEDs) has the potential to reduce energy use by 1/3 by 2030. LED lighting requires less energy to function compared to fluorescent alternatives. That’s the equivalent of saving the output of 40 large (1,000-megawatt) power plants, the greenhouse gas emissions of 47 million cars and \$30 billion.

Another important environmental consideration is the toxic chemical makeup of fluorescent lighting. Fluorescent and compact fluorescent lights contain argon and mercury. The mercury contained in one standard fluorescent lamp will contaminate 6000 gallons of water beyond safe drinking levels. Imagine how many fluorescent bulbs are improperly disposed of every day in the United States alone. According to the Environmental Protection Agency (EPA), approximately 800 million fluorescent lamps are disposed of every year. When the bulbs break, mercury can contaminate the environment, including soils, water, people and animals. Mercury is a potent neurotoxin that can severely harm the human nervous system through ingestion, inhalation or skin absorption. Simply touching a broken fluorescent bulb could lead to serious health problems. Clearly, disposing of fluorescent bulbs is of great importance, but the “how-to” can be staggering. The EPA offers a detailed, 11-step procedure that must be followed if a fluorescent bulb breaks: Air out the room for a quarter of an hour. Wear gloves. Double-bag the refuse. Use duct tape to lift the residue from a carpet. Don’t use a vacuum cleaner, as that will only spread the problem. The next time the area is vacuumed, immediately dispose of the vacuum bag.

Some states have even taken steps to ban the improper disposal of fluorescent bulbs. California is one of only seven states — Minnesota, Ohio, Illinois, Indiana, Michigan and Wisconsin are the others — that ban disposing of fluorescent bulbs as general waste. That means it is actually illegal in these states to simply throw away fluorescent tubes.

When fluorescent bulbs are recycled, a special hazardous waste company generally carries

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out the process of collecting the unbroken bulbs, crushing them and capturing both the remaining mercury gas and the spent mercury solids. These companies then ship the mercury-bearing waste, using an EPA-permitted hazardous waste transporter, to an EPA-approved hazardous waste treatment, storage and disposal facility. But most compact fluorescent lights simply end up in landfill and are not recycled at all, because most consumers simply throw them in the trash rather than recycling them. LED lights on the other hand do not contain toxic material and can last for years beyond the normal fluorescent, meaning less waste, and more importantly NO poisonous repercussions.

Incandescent lights are being banned throughout the world. Brazil and Venezuela started to phase them out in 2005, and other nations are planning scheduled phase-outs: Australia, Ireland and Switzerland, in 2009; Argentina, Italy, Russia and the United Kingdom by 2011; Canada in 2012; the European Union by September 2009; and the U.S. between 2012 and 2014. How long will it take for fluorescent lights to fall under such a ban, particularly toxic compact fluorescent lights?

Clearly LED lights have a significantly reduced impact on the environment from a disposal, lifetime and toxicity perspective, but how else can they be environmentally beneficial? As mentioned previously LED lights require far less energy to function than almost all other forms of lighting. This results in a much cooler operating temperature. In the summer months especially, this means a much heavier burden on air conditioning systems which themselves can produce unwanted chemicals and pollutants. LED lights do not over-burden these systems with unnecessary heat. This means the workplace will be more comfortable for employees, and a company will be spending less money to make that possible.

What does it all mean?

The facts are simple; LED lights take a fraction of the energy to run and last up to five times as long as their counterparts, pose little to no threat to the environment and can ultimately improve the look and feel of a workplace. The cost of replacing current lighting with LED lighting is insignificant when compared to the long-term cost of continuing to run an unsafe product that is destroying the environment, while also chipping away at a company's bottom line.