

energy savers

Industrial Lighting

INTRODUCTION

Facilities managers today face many challenges as the industrial sector makes the transition to the digital age. Issues of an aging workforce, worker productivity, product quality and technological advancements, such as miniaturization, all affect production facilities.

Improvements in lighting systems are just one aspect of supporting the demands on manufacturing processes. Older lighting systems are not able to provide the quantity or quality of light required for the visual tasks in modern production facilities. At the same time, there is pressure to keep operating expenses in line by managing the energy used by all systems.

LIGHTING ENERGY

Manufacturing facilities are often overlooked as candidates for retrofit or relighting since the amount of energy consumed by lighting systems is low (5% to 10%) due to process heating and cooling and motor (machine drive) loads that consume a much larger percentage than in commercial buildings (Figure 1).

LIGHTING ECONOMICS

The economics of choosing a lighting system include both the initial and operating costs. Initial cost includes the purchase price of the system and the cost of labor to install it. Operating cost usually includes energy, lamp and lamp replacement labor. All three factors must be considered together when performing an economic evaluation of operating cost (Figure 2 on next page).

Purchasing lamps based on cost can increase electricity and labor costs. Purchasing more energy-efficient sources reduces electricity cost, and using longer life lamps reduces maintenance labor cost. Lamp cost may be higher, but this increase is usually offset by the reduction in electricity and/or labor cost to reduce total operating cost.

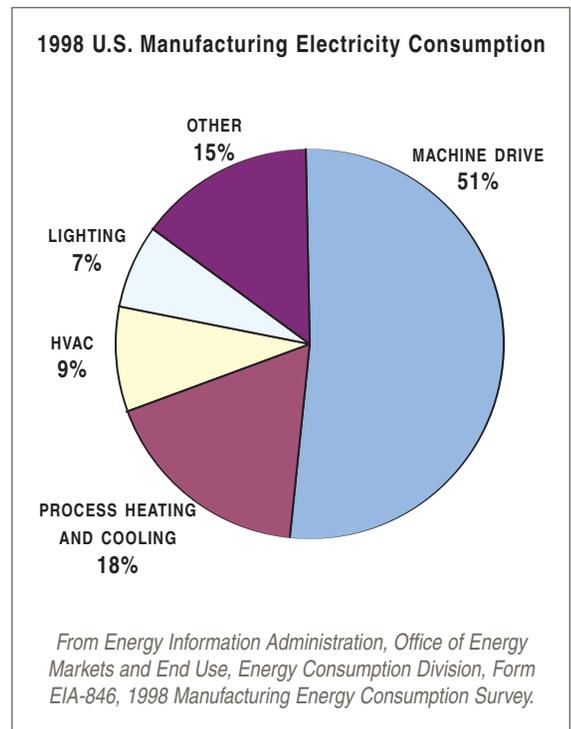


FIGURE 1:
ENERGY CONSUMPTION IN THE MANUFACTURING INDUSTRY



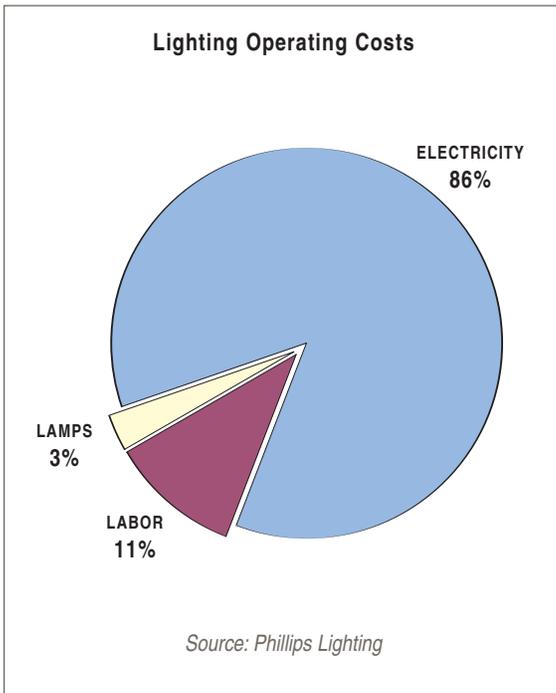


FIGURE 2:
LIGHTING OPERATING COSTS

CRITERIA FOR CHOOSING LIGHTING SYSTEMS FOR INDUSTRIAL FACILITIES

Each facility will have its own lighting specifications — from varied lighting levels to specialized task lighting and from color rendering to cost. Here are some tips and types of lighting to help you select the appropriate lighting for your facility.

Retrofit, relight or upgrade? Retrofitting and its benefits. Retrofit involves the reuse of old fixtures, which usually is not a problem when they are quality fixtures. There is no recycling cost when fixtures are reused. However, retrofitting is usually limited to lamp and ballast improvements because it is difficult to easily improve fixture efficiency.

Upgrading existing fixtures. If the physical condition of existing fixtures is good enough to be considered candidates for retrofitting, there are several ways to improve their efficiency:

- Install new lamps and ballasts
- Clean reflecting surfaces
- Install or replace reflectors
- Replace lenses or diffusers

Relighting and its benefits. Relighting requires more than retrofitting and involves replacing existing lighting systems. Numerous benefits result from a well-designed relighting project, including the opportunity to change the parameters of a lighting system (quantity of fixtures, number of lamps per fixture and the layout for better light distribution). In addition, the Underwriters Laboratories (UL) listing is retained, which can be an issue for some retrofit solutions.

Maintenance economics. Proper maintenance saves money and keeps lighting systems operating effectively. Some industrial facilities have special maintenance challenges due to environmental factors, including dirt, vibration, temperature variations and corrosive environments.

Reducing cost. Electric cost can be reduced by installing more efficient lighting. Of all the ways to save energy in a plant, lighting is the simplest and most risk-free. There are two approaches: retrofitting and relighting. The decision to retrofit existing fixtures or relight with new fixtures involves several considerations. Retrofitting involves putting new hardware in existing fixtures; relighting requires that new fixtures be installed.

Making the investment. There must be convincing reasons to invest in a retrofit or a relighting project, and there should be a payback that pays for the investment. The principal benefits are lower energy cost (due to improved efficiency) and reduced maintenance costs (due to longer life products). These tangible benefits are easily calculated. The intangible benefits of improved lighting quality and their effect on productivity, morale and company image are more difficult to measure. However, many companies are investing in retrofit and relighting projects knowing that they will have better, more productive workplaces.

Designing a lighting system. Many industrial lighting systems are designed to provide just a certain light level on the horizontal work plane. When an ambient system is supplemented with task lighting, this approach works well. However, inadequate lighting often results when only an overhead system is expected to light challenging vertical tasks found in most manufacturing facilities today.

An engineering approach to lighting manufacturing tasks starts with the visual requirements for the tasks and in an ambient system that may use daylight, high-intensity discharge metal halide or high-intensity fluorescent supplemented with task lighting. This approach takes into account the visual needs of the workers performing specific tasks.

A lighting design program that can render light patterns can help model the light on vertical work surfaces. This is a departure from the past method of simply looking up a recommended (horizontal) light level for a certain task in a particular industry. Many visual tasks are similar among industries; the Illuminating Engineering Society of North America (IESNA) Handbook¹ discusses the visual tasks and quality requirements for each. Better industrial lighting should result from this approach.

LIGHTING TYPES

Metal halide technology. Metal halide technology, introduced in 1964 as a replacement for mercury vapor, has several disadvantages — their lumen depreciation curves are too steep, they take too long to start (and restart) and color consistency is not good enough for many white light applications. Today, the disadvantages of standard metal halide lamps have been eliminated with the introduction of high-wattage, pulse-start metal halide systems. New and retrofit metal halide systems today are pulse-start, making standard metal halide systems obsolete.

Pulse-start technology. Pulse-start (PS) technology is not new; the application of this technology to high-wattage metal halide lamps (175 watts and higher) is what is new.

Pulse-start lamps are new formed-body arc tubes that feature uniform geometry, higher fill pressures and smaller pinch seals. This design results in less heat loss and improved temperature control, thus reducing lamp-to-lamp color shift. The low mass arc tubes provide faster starting and restarting and higher lamp efficacy (up to 110 lumens per watt), improved lumen maintenance, longer life (20,000 hours) and consistent lamp-to-lamp color (within 100°K).

Upgrading to pulse-start systems can be done with retrofit kits or by replacing fixtures and results in significant performance improvements. Energy savings is the main advantage of converting to pulse-start. For example, a common retrofit kit is available that uses a 320-watt PS lamp, ballast, socket and starter to replace standard 400-watt components.

Fluorescent solution advantages. Despite advancements in metal halide technology, many industrial applications are now being lighted with alternative fluorescent designs. Fluorescent lamps operated at high frequency on electronic ballasts eliminate flicker, which can be especially important for high light level visual tasks, such as product inspection. This also eliminates inspector complaints of headaches, nausea and eyestrain. Using lamps with high CRI rating (> 80) improves lighting quality.

HID has historically dominated high-ceiling applications, but fluorescent solutions can provide better performance and considerable energy savings (up to 50%). There are compelling reasons for using fluorescent, including higher lumen maintenance, instant-strike (and re-strike) operation, and ease of control by dimming or bank switching.

There are a number of new fluorescent designs intended for high-ceiling applications, known as HIF (high-intensity fluorescent). These use multiple T5HO or high-performance T8 lamps and multi-lamp high light output electronic ballasts.

T5HO linear lamps. T5 lamps measure 5/8" in diameter and millimeter lengths and feature high lumen output. T5HO lamps generate nearly twice the light output (188%) of T8 and T12 systems with the same number of lamps. This means that one-lamp

NOMINAL WATTS	LENGTH MM/(IN)	LAMP CURRENT (MA)	LUMENS (INITIAL)	LUMENS (DESIGN)
24	549/(21.6")	300	2,000	1,900
39	849/(33.4")	340	3,500	3,325
54	1,149/(45.2")	460	5,000	4,750
80	1,449/(57.0")	552	7,500	7,125

FIGURE 3:
T5HO LAMP RATINGS

T5HO fixtures can now take the place of two-lamp T8 fixtures. However, at 83 to 94 lumens per watt, they are up to 8% less efficient than T8 systems. Also, each lamp wattage requires a unique ballast.

T5HO lamps are designed to peak in their lumen rating at 95°F (vs. 77°F for T12 and T8 lamps). This characteristic provides higher light output in confined applications. Another operating characteristic that is different from T8 and T12 lamps is a warm up delay of up to four minutes that can limit occupancy switching applications for warehouse aisle lighting, for example. Additionally, the high-bulb wall brightness can limit direct applications in low ceiling height conditions because of glare discomfort.

Electronic Ballasts for T5HO lamps. Some manufacturers provide program-start ballasts for T5HO lamps. Program-start ballasts start the lamp(s) by precisely applying high-cathode heat prior to lamp ignition, and then removing it once the lamp has ignited. This design maintains energy efficiency while providing optimum starting conditions to obtain up to 100,000 starts. When T5HO lamps are used in HIF, they should be rated for the high temperatures that are encountered in high-bay applications.

High-performance (“super”) T8 systems. This new generation of T8 lamps has higher lumen output (3,000), higher CRI rating (85) and a longer life rating (24,000 hours). In addition, lumen maintenance is rated at 0.94, and it levels off after that. Standard 3,000 K, 3,500 K and 4,100 K colors are provided. These lamps are sometimes designated high-performance or extended performance. By combining a high-lumen, extended life lamp with a low ballast factor electronic ballast, these systems are 15-20% more efficient than standard T8 systems and can provide savings up to 40% when replacing reduced-wattage 34-watt T12 systems. These “barrier-coat” lamps have an initial lumen rating starting at 3,100 lumens and a high-lumen maintenance rating over 90%.

SUMMARY

While good lighting is expensive, poor lighting is even more expensive for manufacturing facilities when considering the quality of light issues that impact production. A high-quality industrial lighting system increases productivity and saves money.

REFERENCES AND NOTES

¹IESNA Lighting Handbook, 9th edition 2000, Illuminating Engineering Society of North America, New York, NY.

²For more information on payback analysis, including examples and technical lighting bulletins, contact your Progress Energy account manager.

SUPPLEMENTARY RESOURCES

Cooper Lighting — <http://www.cooperlighting.com>

GE Lighting — <http://www.gelighting.com>

Lighting Application Bulletin — Industrial Lighting, General Electric Company, Cleveland, OH. Publication 204-71516.

Lighting Resource Center — <http://www.lrc.rpi.edu>

Philips Lighting — <http://www.lighting.philips.com>

Waste Reduction Partners — <http://www.landofsky.org/wrp>

FOR ADDITIONAL INFORMATION ABOUT *Industrial Lighting*, contact your Progress Energy representative.