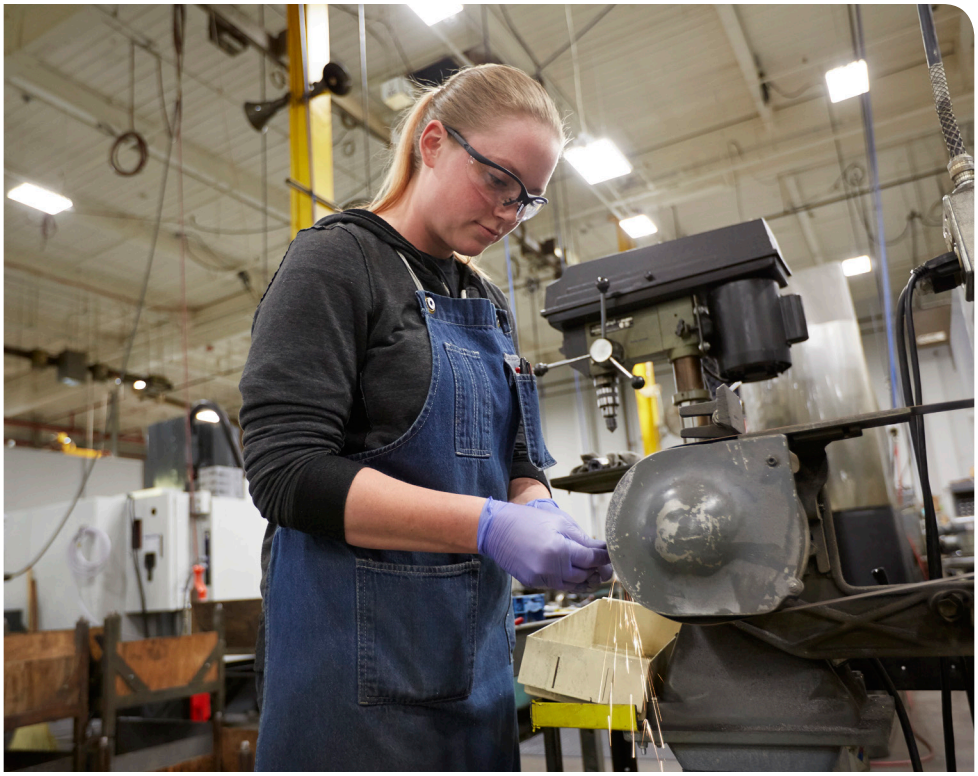
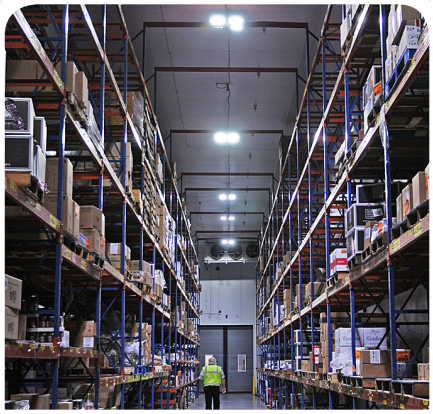


Guide to new, energy-efficient lighting technologies for industry

Industrial lighting systems are changing rapidly, ushering in a new era of high-quality energy-efficient technologies. Upgrading to today's improved industrial light sources, fixtures and controls could significantly reduce your facility's lighting energy costs, with some improvements paying for themselves in just a few years. New lighting technologies and controls are also extremely long lasting, decreasing maintenance costs and disruption from lamp replacement. Improved lighting can also increase production, improve safety and security, lighten the load on your electrical system and boost employee productivity.

EnergyTrust of Oregon

This efficient LED surface mount luminaire helps illuminate the main business entrance



LED high-bay lighting provides even illumination throughout the warehouse and controls turn the lights off when the space is not in use

Energy-efficient LED exterior lighting provides high quality light and safety for employees

Brighten your business and bottom line

This guide introduces you to lighting systems and control options that work well in a range of industrial settings—from manufacturing plants to refrigerated warehouses to cleanrooms. It will help you work more effectively with your lighting professional and understand what lighting solutions deliver the highest value for your facility.

To gain the best results from your investment in a lighting project talk with your lighting professional to share your goals.

- Do you need specialty luminaires?
- Does your facility have specific lighting needs?
- Where can you utilize controls?
- Who needs to be involved with project design and purchasing?
- What is the budget?
- What are the maintenance issues?
- Other considerations?

KNOW YOUR TERMS

The lighting industry uses the term ***lamp*** when referring to the light source (what you may think of as a bulb) and uses the word ***luminaire*** when referring to the light fixture. This guide uses the terms ***lamp*** and ***luminaire***.

PHOTOS: LED high-bay fixtures

Getting started

PLAN AHEAD FOR A SUCCESSFUL PROJECT

Before considering lighting improvements, review your goals and how you'd like to improve your existing lighting system. Do you want to reduce energy costs? Is lighting maintenance problematic? Are high ceilings or dirty fixtures swallowing all of the light? Have machines moved or tasks changed since you installed your existing lighting? Do shadows or glare impact production? Answering these and other questions will help ensure an upgrade that works for your facility.

THINK LONG TERM–BEYOND FIRST COST

The decisions you make today will affect energy and maintenance costs for years. The quality of your lighting also has a direct influence on production output, production quality, health, safety and profit.

GET EXPERTISE FROM ENERGY TRUST LIGHTING PROFESSIONALS

Energy Trust's team of experienced lighting consultants, trade allies and contractors can help bring your project to fruition. We understand that industrial lighting decisions must factor in production requirements, equipment, ceiling height and other conditions. Our lighting contractors may be able to construct mock-ups and test options before you make final decisions.

KNOW YOUR TERMS

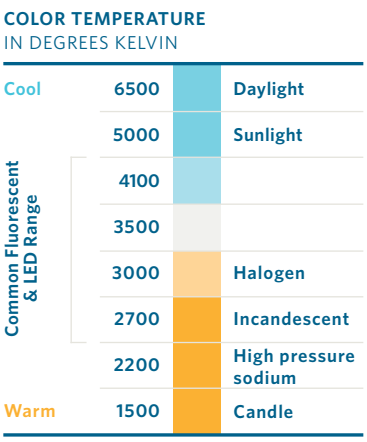
Think lumens not watts. Light output is measured in lumens—the total quantity of light emitted by the luminaire.

Lumens per watt, often referred to as efficacy, measures the amount of light delivered per watt of energy.

Lumen maintenance refers to how a lamp maintains its light output over time, or how much it depreciates in lumen output over time.

A foot candle is the amount of light that actually falls on a given surface and is measured with a light meter.

Lighting must match the production environment



A lighting upgrade begins with assessing the space and how it's used. Your lighting professional will evaluate the quantity and quality of light. Both are essential for visual comfort, accurate performance of tasks, quality control and safety. The assessment and resulting lighting design should take into account:

Lighting quantity, measured in foot candles at the work surface. The Illuminating Engineering Society, IES, recommends foot candle levels for industrial areas based on task, size of objects, level of detail required, object contrast and other factors (see chart on right). New energy-efficient lighting systems deliver more light at less cost, and the careful selection of lamps and luminaires direct light where needed.

Color quality. Lighting sources vary in their ability to render colors accurately. Poor color quality can reduce object contrast, making it difficult to perform some production tasks accurately. Today's LED and linear fluorescent lighting offer excellent color.

Shadows and glare. Both can create unsafe situations and impair productivity. An experienced lighting professional will help ensure your lighting design minimizes both.

Lighting uniformity. Large variations in brightness can contribute to eye fatigue and hazards. Lighting should be reasonably uniform within work areas.

Ceiling height, daylight and environmental conditions. Today's lighting options make it easy to efficiently illuminate high-bay areas. In some situations, a lighting professional may recommend minimizing ambient lighting and maximizing task lighting at the work surface. The lighting design must account for environmental conditions: Dusty environments need easy-to-clean fixtures and luminaires that stand up to particulates. Refrigerated areas benefit from LEDs, which produce less heat. Your lighting professional should also take steps to maximize available daylight.

Building area/task recommended foot candles, FC*	Averaged maintained FC (horizontal)	Averaged maintained FC (vertical)
Simple assembly/large items	30	30
Difficult assembly/fine objects	100	100
Large component manufacturing	30	30
Medium component manufacturing	50	50
Warehouse/small labels	30	15
Warehouse/large labels	10	5

Light level recommendations vary depending on task. Consult with your lighting professional for specific foot candle targets.

**IES, The Lighting Handbook, 10th edition*

KNOW YOUR TERMS

Kelvin temperature, or degrees Kelvin, °K, is the lighting industry's standard for measuring the color appearance of light. The higher the color temperature, the cooler or bluer the light.

Energy-efficient light sources

TECHNOLOGY	RATED LIFE (HOURS)	FEATURES	APPLICATIONS
LED	25,000 to 100,000+	• Can be either highly directional or omni-directional • Excellent lumen maintenance and color quality over time • Suitable in tight spaces with insufficient space for linear fluorescent lighting • High durability, shock resistant, don't "break" like bulbs • Extremely long life, substantial maintenance savings • Achieve full brightness instantly • Produce less ultraviolet light and heat • Most fixtures are highly controllable • Increased savings from controls due to "instant on"	• High-bay lighting • Warehouses • Cold storage, refrigerated areas • Hazardous, dusty, dirty locations • Interior office spaces • Task lighting • Exterior poles and wall packs • Frequently switched applications
T8 high-performance linear fluorescent with electronic ballast	42,000 to 80,000+	• Wide distribution of light • Low first cost • Excellent lumen maintenance • Wide range of wattage options and color temperatures • Low overall operating cost • Good replacement for HID; faster startup, better color, less glare • Variety of control options, including instant on/off with occupancy sensors • Consistent lamp type throughout the facility • Requires hazardous disposal	• Low-bay lighting • Interior office spaces • Hallways, conference rooms, restrooms
T5 high-output (HO) linear fluorescent with electronic ballasts	30,000 to 46,000+	• Wide distribution of bright light • Small lamp size offers excellent optical control • Good replacement for HID; faster startup, better color, less glare • Excellent lumen maintenance • Lighting uniformity • Variety of available control options • Requires hazardous disposal	• Ceilings heights above 20 feet, including high-bay lighting • Good replacement for HID • Warehouses
Induction	100,000	• Wide distribution of light • Instant start • Requires hazardous disposal	• Excellent for difficult-to-access areas, such as above equipment

Lighting controls deliver savings, safety and security

The latest generation of lighting controls can adjust light levels based on time of day, occupancy or a combination of the two—and they can be fine tuned to ensure employees always have sufficient light for safety, security and egress. Many come pre-installed in new fixtures and retrofit kits.

Occupancy sensors are effective for areas where full light levels are not always needed. Occupancy sensors can be mounted on ceilings, walls or luminaires.

Vacancy sensors are like occupancy sensors except they require pressing a manual button to turn on, preventing false-on events and saving more energy. Most occupancy sensors can be programmed to be vacancy sensors.

Lighting control panels turn lights on and off at prearranged times and are useful where occupancy follows a well-defined pattern. Control panel equipment can be mechanical or electronic, and can include the use of an energy management system.

Daylight controls, photocells or photo sensors adjust light output by dimming or turning off lights, based on changes in light levels.

Full-range dimming systems make it possible to control a portion of lumen output of a luminaire in a specific area. This protects employees who may be working under equipment or engaged in an activity that requires minimal motion.

Wireless controls are now available for difficult-to-reach areas, such as above equipment, high ceilings and inaccessible hard-ceiling surfaces.

Astronomical time clocks adjust outdoor lights according to time of day. They're often used in conjunction with photo sensors. A common scenario is to set the photo sensor to turn on all lights at sunset and the time clock to dim lights to security levels after the last shift, or share lighting loads throughout the night.

PHOTOS TOP TO BOTTOM: Linear fluorescent high-bays with luminaire-mounted occupancy sensor, touch panel control equipment, efficient LED surface-mount luminaire

PHOTOS: LED high-bay lighting provides excellent illumination; LED exterior lighting

Remember these guidelines for a successful project

Here are some guidelines to discuss with your lighting contractor:

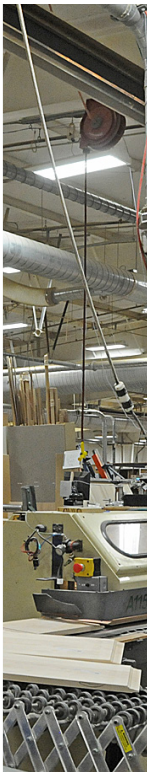
- Match light levels and luminaire types to the space and task.
- Use the most energy-efficient light source appropriate for the application.
- Take advantage of daylight.
- Factor in the cost of maintenance.
- Use automatic controls to turn off or dim lights as appropriate.

LOW COST / NO COST OPTIONS

- Turn off the lights (also reduces cooling loads).
- Use lower-wattage replacement lamps, HID and linear fluorescent.
- Disconnect luminaires that are no longer needed.
- Lower luminaires to increase light levels.
- Reposition luminaires to areas that need more light.
- Use energy-efficient task lights.
- Clean luminaires to increase light levels.
- Clean the walls and ceiling.
- Paint the walls and ceilings lighter colors.

DON'T OVERLOOK OUTDOOR LIGHTING

An experienced lighting contractor will help you select lamps and luminaires that direct light where it is needed, distribute it evenly, avoid glare and reduce light trespass. LED technology has become the preferred option for outdoor lighting, offering good color quality, better control options and additional security benefits.



BACK COVER PHOTO:
High-performance linear fluorescents with electronic ballasts provide energy-efficient lighting at this loading dock

FRONT COVER PHOTOS:
LEDs provide high-color rendering, proper light levels and quality lighting in facilities and at the task plane

Energy Trust can help illuminate your world

Energy Trust of Oregon offers cash incentives on the installation of qualified energy-efficient lighting equipment that can help you lower energy use and reduce operating costs. We also offer technical assistance and can connect you with a lighting professional to meet your goals.

Get more from your energy.
Visit **www.energytrust.org** or call **1.800.326.2917**.

Energy Trust of Oregon 421 SW Oak St., Suite 300, Portland, OR 97204 1.800.326.2917 **energytrust.org**