



# Guide to new, energy-efficient lighting applications for your business and properties

**Commercial lighting systems have advanced at a rapid pace, with LEDs now taking center stage.** LEDs offer excellent lighting quality, durability, long life, simple controls, energy efficiency and low cost. They are a cost effective and viable technology for almost all applications—from manufacturing sites, to office buildings to multifamily living.

Whether you're constructing a new building or upgrading your existing location, this guide highlights how you can use LEDs to take lighting to the next level. The information will prepare you to work effectively with contractors, lighting vendors, designers and other professionals. You'll learn what works best in different applications, and how factors such as color quality put your business in the best light.

## BENEFITS OF LEDS

- ▶ Reduce lighting energy by 50 percent or more
- ▶ Excellent light quality and color
- ▶ Long life: Up to 100,000 hours
- ▶ Maintenance savings
- ▶ Highly controllable
- ▶ Instant-on
- ▶ Produce minimal heat



## DAYLIGHTING

*Well-designed lighting systems, including daylighting with advanced controls, save energy. They also can enhance visual comfort, reduce eye fatigue and improve performance—leading to higher productivity and sales.*

*PHOTO: Light shelves direct daylight deeper into a space.*



## AESTHETICS

*Quality lighting makes a space pleasant for residents, customers and employees, opening the door to more business and lower absenteeism. Coupled with energy savings, these benefits can make lighting a profitable investment.*

*PHOTO: LED track lighting.*



## SAFETY/SECURITY

*LED technology works well for garage and exterior lighting and offers the advantage of being instant-on.*

*PHOTO: LED security lighting.*



**LEDS LAST  
3 TO 4 TIMES  
LONGER  
THAN T8  
FLUORESCENT  
LAMPS**



# Brighten your bottom line

Lighting in commercial buildings accounts for more than 15 percent of electric use, which can have a big effect on your bottomline. But you can save 50 percent or more on lighting energy with today's LEDs, fixtures and controls. With good design, the savings from energy-efficient lighting typically pays for the upgrade in a few years.

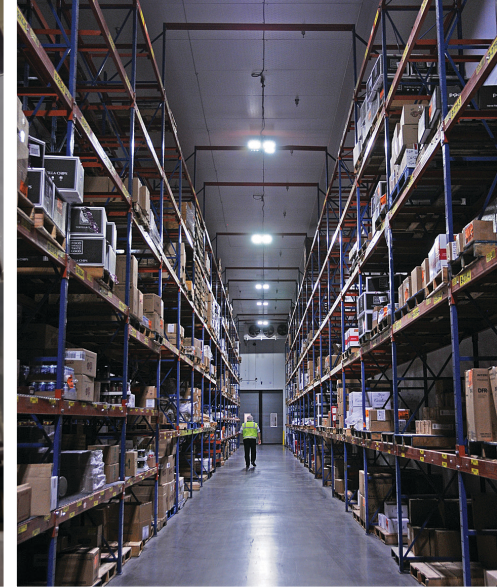
An energy-efficient LED lighting system offers additional benefits, including:

- Giving your building a modern, attractive look
- Providing higher quality light
- Reducing the load lighting puts on air conditioning, ventilation, refrigeration and electrical systems

LEDs come in a variety of styles, offering flexibility for your design and business. Explore this guide to see what new lighting can do for your business.

## KNOW YOUR TERMS

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



PHOTOS: LED high-bay fixtures.

# Getting started

## PLAN AHEAD FOR SUCCESS

Understand your goals: Do you want lower operating costs? Are you trying to keep maintenance to a minimum? Do you have safety concerns? Are you unhappy with your current lighting? Have you seen lighting in other businesses that you do or don't like?

## A COMPREHENSIVE LIGHTING DESIGN CAN MAXIMIZE VALUE

Comprehensive lighting design is critical in new buildings and major renovations. It is increasingly used during retrofits because many businesses recognize it makes more sense to redesign lighting holistically rather than simply replace lamps or fixtures. Comprehensive lighting design can also maximize energy savings and provide better comfort, health and productivity for occupants.

During a comprehensive lighting design, a professional prepares a layout and recommends a product and controls approach that factors in:

- Aesthetics
- How lighting integrates with other building systems like heating and cooling
- Light levels suitable to each application and location
- Uniformity of light
- Available daylight
- Integration of lighting controls
- Glare and shadows
- Safety
- Total operating cost of the lighting systems

## THINK LONG TERM—BEYOND FIRST COST

With rising energy costs, the decisions you make today will affect your operating costs for years. Because LEDs are so long lasting, they can lower maintenance costs by drastically reducing the need to replace lamps.



## LIGHTING PROFESSIONALS

Energy Trust's experienced lighting professionals can help ensure a successful project and save you time and money.



# Balancing lighting quantity, quality & color

## KNOW YOUR TERMS

### **Think lumens not watts.**

The total quantity of light produced by a lamp is measured in lumens.

**Lumens per watt**, also called lumen efficacy, measures light delivered per watt. LEDs deliver more lumens per watt than older lamps and fixtures.

**A foot candle** is the amount of light that falls on a surface and is equal to one lumen per square foot as measured by a light meter.

**Lumen maintenance** is the standard lighting term for the percent of initial lumens a light source maintains over time.

**Lighting power density** is calculated as watts per square foot and varies by occupancy and how a space is used, as specified by energy codes.

**Fixture efficiency** accounts for how much of a lamp's light gets out of the fixture. Dedicated LED luminaires are tested as a complete fixture, rather than as a lamp, delivering 100 percent of the stated lumens.

Successful lighting design begins with assessing how occupants use a space and their resulting lighting needs. Your lighting professional will evaluate the quantity and quality of light according to those needs, taking these factors into account.

## LIGHTING QUANTITY

The quantity of light needed, measured in foot candles, varies by task. Lighting professionals recommend an office lobby have 10 foot candles, a classroom 40, a retail space 50, and manufacturing anywhere from 30 to 100. New LED lighting systems deliver more light at less cost, and the careful selection of lamps and luminaires, directs light where needed.

## LIGHTING QUANTITY IN THE PRODUCTION ENVIRONMENT

Proper lighting levels are critical for maintaining a safe workplace in manufacturing. The Illuminating Engineering Society (IES) recommends foot candle levels for industrial areas based on task, size of objects, level of detail, object contrast and other factors. Here are examples:

Building area/task	Averaged maintained FC*	
	Horizontal	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 by task. Consult with your lighting professional for specific foot candle targets.

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



PHOTOS LEFT TO RIGHT: LED downlights and LED accent lights; LED downlights and LED track lights; LED high bay fixtures.

### 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 contrast can contribute to eye fatigue and hazards. Lighting should be reasonably uniform within the same work area.

### COLOR QUALITY

Color quality is critical for aesthetics and for properly performing tasks in the business and production environments. Lighting experts use two metrics to evaluate color.

**Color Rendering Index (CRI)** is a scale that measures the ability of a light source to show the true color of objects realistically. CRI is expressed on a scale of 0-100, where 100 is the best in producing vibrant color in objects. A CRI of 80 or more is considered excellent for most interior applications.

**Correlated Color Temperature (CCT)** accounts for the color appearance of LEDs and is measured in degrees Kelvin. Even two lamps of the same source, both incandescent bulbs or both LEDs, can produce light with a slightly different color. The higher the color temperature, the cooler or “bluer” the light. The “right” color temperature is a preference and varies by application. As seen in the graph to the right, LEDs span the full spectrum.

### 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 also must account for environmental conditions. Dusty environments need easy-to-clean fixtures and luminaires. Refrigerated areas benefit from lighting that doesn’t produce heat. Your lighting professional can also take steps to maximize available daylight.

#### COLOR TEMPERATURE IN DEGREES KELVIN

LED Range	Cool	5000	Sunlight
		4000	Industrial
		3500	Office lighting*
		3000	Restaurant
	Warm	2700	Incandescent

\*Most common



#### TIP FOR ENSURING GOOD COLOR QUALITY

Ask your lighting professional or supplier to bring a sample of the fixture and lamp to your business to see how the lighting looks in your space.



PHOTOS LEFT TO RIGHT: LED high-bay fixtures; LED pendant lights.

## Go for the layered look

Layers of interior lighting can work together to illuminate an area according to function and style.

- **Ambient** (*top*) – Provides overall illumination to the space.
- **Task** (*middle*) – Provides auxiliary illumination, when needed, for specific tasks. Task lighting should be free of glare and shadows but bright enough to avoid eye strain.
- **Accent** (*bottom*) – Provides a focal point of illumination that highlights products or features or adds drama to a space.
- **Vertical** – Can help balance light, aid tasks, or provide accent lighting in some applications.



The type of lamp, fixture and amount of light can vary significantly depending on whether it is supplying ambient, task, accent or vertical lighting.

### FACTOR IN FIXTURES

Light fixtures can deliver their light downward (called direct lighting), upward (indirect), or a combination (direct/indirect).

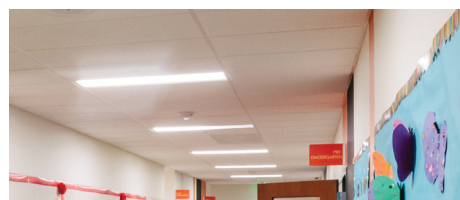
**Direct lighting** typically uses reflectors to help direct light out of the fixture. A diffuser, lens or louver covers the face of the fixture to help guide the light and conceal the lamp from view. Today's designs for lenses and louvers are more efficient than old-technology diffusers, which caused significant light loss.

**Indirect lighting** can make a space feel brighter with less light because it illuminates the ceiling and tops of walls. When these surfaces are light-colored, minimal light is lost resulting in even illumination. Indirect lighting works well with a task-ambient lighting scheme. Indirect lighting or a direct/indirect combination also offers excellent glare control and visual comfort.

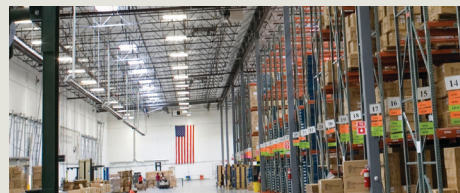
**Direct/indirect lighting** combines both approaches. Fixtures can be specified to provide a blend of direct and indirect lighting.

# Examples of LED fixture applications

**Lay-in fixtures** are an excellent source of ambient light. They are easy to connect to controls. They can be direct, indirect, or a combination.



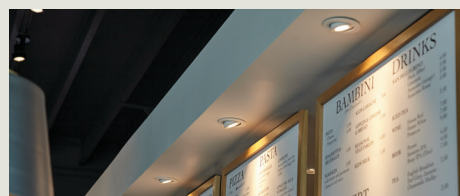
**High-bay fixtures** can be mounted at 15 feet or higher.



**Pendant-hung fixtures** are another ambient lighting strategy that can be direct, indirect or both.



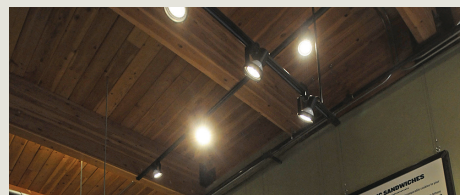
**Recessed downlights** are a real workhorse in commercial buildings and multifamily properties, providing ambient or accent lighting. LEDs outperform other options in these applications for energy efficiency, maintenance, durability and heat output.



**Wall sconces** provide accent lighting in select areas such as hallways. Many wall sconces accept LED replacement lamps, other applications benefit from new fixtures.



**Track lighting** is used primarily for accent products or features.



**Exterior wall-mount fixtures** provide ambient light for walkways and safety on a building's exterior and offer several control options.



**Outdoor lighting** offers safety and security, but should also reduce light trespass (putting light where it's unnecessary or unwanted). LEDs, when combined with controls, can reduce light levels when minimal security lighting is needed and instantly switch to 100 percent when motion is sensed.





## Pay attention to 24/7 areas and outdoor lighting

Lighting upgrades are particularly cost effective in areas with lights that are on 24/7. Examples include parking garages, stairwells, exit signs and multifamily common areas such as lobbies and hallways. The switch to LEDs in these spaces delivers an excellent return on investment—often paying for itself in energy savings in less than two years. LEDs greatly reduce maintenance costs because they don't need to be replaced for years. They also improve aesthetics, safety and security. Most LED fixtures provide security light when an area is unoccupied, and ramp up to full brightness when occupancy is detected.

Outdoor lighting also requires attention to design. Proper lighting is critical for safety and security and contributes to the overall appearance of your building. An experienced lighting contractor can help you select lamps and fixtures that direct light where it is needed, distribute it evenly, avoid glare and reduce light trespass. LEDs are ideal for exterior lighting applications because you easily can direct light where you need it most. They offer instant to full brightness even in cold temperatures, a long service life and flexible control options.

### WE'RE HERE TO HELP

Energy Trust trade allies are located statewide and can help you figure out the best plan and product(s) for an upgrade to LEDs. They are experienced in installing LEDs for businesses throughout Oregon.





*PHOTOS LEFT TO RIGHT: LED exterior parking lot lights; LED security lighting; LED high bay fixtures*

## LED light sources

Fixtures	Lumens per watt	Rated life (hours)	Features
Lamp-only replacement (driver in lamp)	50 to 100+	25,000 to 50,000+	<ul style="list-style-type: none"> <li>• Can be highly directional or omni-directional</li> <li>• Durable, shock and vibration resistant, won't "break" like bulbs</li> <li>• Emit minimal heat</li> <li>• Instant on, achieve full brightness instantly</li> <li>• Won't emit heat or ultraviolet light</li> </ul>
New fixtures or kit (driver in fixture)	60 to 100+	50,000 to 100,000+	
"A" lamp	50 to 100+	25,000 to 50,000+	

### KNOW YOUR PRODUCT

Not all LEDs are equal in quality and durability. Talk with Energy Trust or your trade ally about lamp life, light quality and other factors to make sure the products you purchase will stand up to the demands of your environment



## Lighting controls deliver savings, safety and security

Lighting controls can adjust light levels based on time of day, occupancy or a combination of the two. They can be fine-tuned to ensure occupants always have sufficient light for safety and security. Many come pre-installed in new fixtures and retrofit kits.

**Occupancy sensors**, which sense motion, are effective for areas where full light levels are not always needed. Occupancy sensors can be mounted on ceilings, walls or embedded in luminaires.

**Vacancy sensors** are like occupancy sensors except they require pressing a manual button to turn on. This prevents false-on events and saves 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 integrate with 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 lumen output of a luminaire in a specific area. These systems can maximize use of daylight or, in production environments, help protect employees working under equipment or engaged in a minimal motion activity.

**Wireless controls** are available for difficult-to-reach areas, such as above equipment, high ceilings and inaccessible hard-ceiling surfaces. They can save on wiring costs.

**Networked lighting controls (NLCs)** integrate lighting and building controls for one room, a whole building or even multiple campuses. Some of these systems are able to learn building use trends and optimize comfort and energy savings by automatically adjusting lighting and other systems as patterns change over time. They often can provide control right down to an individual's workspace. Some NLCs can also provide complete facility energy use information as well as remote operation and control capabilities. NLCs can be incorporated into a retrofit or specified during the planning stages of a new building. Luminaire level lighting controls, a form of NLCs, are available as wireless systems, offering out-of-the-box integrated sensor installation advantages.



**PHOTOS TOP TO BOTTOM: LED high-bays with luminaire-mounted occupancy sensor; touch panel control equipment; daylighting with LED pendant fixtures and track lighting.**



*PHOTOS LEFT TO RIGHT: LED security lights at a community college; LED pendant fixtures in a historical building.*

## We make it simple

**1**

### FIND A TRADE ALLY CONTRACTOR

Check our list of licensed and insured trade ally contractors to find one near you, or use your own.

**2**

### GET PRE-APPROVAL AND ENROLL YOUR PROJECT

Energy Trust pre-qualifies all lighting upgrades. A qualified trade ally contractor can help you.

**3**

### PURCHASE AND INSTALL EQUIPMENT

Start saving energy and enjoying better lighting.

**4**

### SUBMIT YOUR PROJECT DOCUMENTATION

A trade ally contractor can help.

**5**

### GET YOUR INCENTIVE

Keep on saving through reduced energy costs.

**BACK COVER PHOTO: LEDs provide high-color rendering, proper light levels and quality lighting in facilities and at the task plane.**

**FRONT COVER PHOTOS LEFT TO RIGHT: LED pendant lighting makes this space pleasant and inviting for residents; high powered LED recessed downlights and cove lighting with daylight controls contribute to a bright and airy environment.**



# We're here to help

Energy Trust of Oregon offers cash incentives on the installation of qualified LED lighting equipment and lighting controls 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.



Visit [www.energytrust.org](http://www.energytrust.org) or call **1.800.326.2917**.