

# Linear LED Buyer's Guide

Find the right LED solutions  
for your business



Together, Building  
a Better California



## What's inside

### Who should read this

Business owners, facility managers, building operators and lighting contractors

### About linear LEDs

Advantages, what to watch out for and how to work with a contractor

### Replacement options

Linear LED replacement lamps, retrofit kits and dedicated luminaires

### Factors to consider when upgrading

Key system factors, different lighting components and lighting system types

### PG&E offers

Financing, incentives and rebate programs

### Resources



# Introduction

## Out with the old In with the new linear LEDs

**Fluorescent lighting has been a “go-to” technology in commercial and industrial facilities for years because it provides quality light output, durability and good energy efficiency.**

However, linear light-emitting diode (LED) technology—like LED technology in general—is getting more attention now because it has the potential to offer even greater energy efficiency and improved light quality with a longer lifespan and better control. Modern linear LED lighting solutions are available for places where fluorescent lights now prevail, including office spaces, classrooms, health care facilities, retail space and more.

Our goal at Pacific Gas and Electric Company (PG&E) is to help everyone become more knowledgeable about these options so that we can work together to safely maximize the cost and energy efficiency of any lighting upgrade project—from business owners to facility managers to licensed lighting contractors.

This guide highlights the main advantages of linear LEDs over fluorescent lighting, outlines the main types of linear LED retrofit products and offers guidance on which key variables and factors to consider when deciding on an LED upgrade for a fluorescent system. Lastly, we include information on financing, incentives and rebates that are available from PG&E to help defer upgrade costs and increase the pace of return on investment (ROI).

## Who should read this:

Business Owners,  
Facility Managers, Building Operators,  
Lighting Contractors

# Why linear LEDs

## Advantages of linear LEDs

**Linear LEDs, like all LEDs, use semiconductors to convert electricity into light, making them far more akin to computer chips than light bulbs. Because of this, LEDs offer many more technological advantages over conventional fluorescent lights.**

- **LEDs are directional light sources**, reducing the need for reflectors and diffusers that can trap light within the fixture and decrease the efficiency.
- **LEDs convert energy to light more efficiently** than other sources, and when combined with improvements in fixture design, can lead to improved fixture efficiency as well.
- Quality LED products have the potential to **last two to three times longer** than traditional fluorescent lamps.
- **LEDs turn on at full brightness almost instantly** with no strike delay, even when cold, making LEDs a smart choice inside cold locations, such as walk-in refrigerators, cold storage facilities and outdoor areas like parking lots.
- **LEDs are resistant to breakage and heavy vibrations** because they do not have filaments or glass bulbs.
- Quality LEDs **can last longer** when properly matched to their application, resulting in lower maintenance costs.
- LEDs offer a potentially **reduced environmental footprint** because they are mercury-free and the lighting industry has reduced other environmental toxins.
- LEDs' compact form and low profile allows for **more flexibility in luminaire design**.
- **Quality LEDs can be dimmed**, although care must be taken to ensure compatibility between the different hardware devices (e.g., the driver and dimmer). Adding lighting controls can eliminate overlighting and greatly enhance savings.





## Not all LEDs are created equal

**Linear LED lighting can deliver outstanding energy efficiency. However, LED lamps and fixtures are not all the same when it comes to performance.**

To get the energy efficiency and performance you expect, PG&E recommends that you consult our qualified products list found at [pge.com/led](http://pge.com/led). All the products on this list are ENERGY STAR®-qualified, DesignLights Consortium (DLC)-approved or utility-approved. The list is updated on a daily basis to reflect a real-time view of LED products qualifying for possible PG&E energy-efficiency incentives or rebates. You can also find this list by going directly to [pge.com/ledqpl](http://pge.com/ledqpl).



## Work with a lighting contractor

**Experienced, certified lighting contractors can help a business not only to cut down on current utility costs but also to save revenue dollars to maximize its success and longevity.**

Contractors who are part of PG&E's Trade Professional Alliance (TPA) can help businesses work through the lighting options available to them for installation, repair, upgrades and retrofit. They have industry and product knowledge, troubleshooting experience and an understanding of the financing, rebate and incentive options for small- and medium-sized businesses throughout Northern and Central California.

As a result, these contractors can help a business manage all aspects of its lighting needs. To find a participating Trade Professional Alliance contractor for your next project, go to [pge.com/tradeprofessional](http://pge.com/tradeprofessional).

## Safety Certifications

Several Laboratories (Underwriters Laboratories, Intertek, Canadian Standards Association) perform numerous tests for linear LEDs and apply a variety of marks on these products to show the level of examination a product has undergone and what standards it has met. It is important to understand the different safety markings because some products claim to meet UL, ETL or CSA standards, but do not. To learn more, go to [ul.com/labels](http://ul.com/labels), [csagroup.org](http://csagroup.org) or [intertek.com](http://intertek.com).



## Product lifetime: What it is, and why it is important

A long lifespan is a critical factor when calculating the cost-effectiveness of LED replacement lamps. Current prices for linear LED replacement lamps vary considerably, from \$10 to over \$40 per lamp, while fluorescent tubes cost \$2 to \$10 per lamp. To offset their higher initial cost, LED replacement lamps must last longer than their fluorescent counterparts and be more energy efficient.

Traditional lamps are typically measured in hours to lamp failure, but because LEDs last longer than traditional light sources and depreciate more slowly, an LED's useful life is measured in the number of hours the product can maintain at least 70 percent of its initial lumen output. This is known as "L70."

To learn more, visit [energy.gov/eere/ssl/led-basics](http://energy.gov/eere/ssl/led-basics).

## Who should read this:

Business Owners,  
Facility Managers, Building Operators,  
Lighting Contractors

# Linear LED replacement options

## Linear LED replacement lamps

Today's quality linear LED replacement lamps are easy to install and fit most existing fluorescent lamp sockets/fixtures right out of the box, making them the ideal upgrade solution where energy savings and easy installation are key considerations.

### ADVANTAGES:

- Enjoy possible energy savings (T8 LED lamps are nearly 10 percent more efficient, on average, than typical fluorescent T8 lamps.)
- May benefit from maintenance savings due to longer lifespan
- Simple "plug and play" replacements (no rewiring required)
- May be more cost-effective than other LED retrofit options, if the linear LED replacement lamps are compatible with the existing fluorescent ballasts

### THINGS TO CONSIDER:

- Manufacturer data sheets may be vague, so make sure your vendor confirms the compatibility of the existing T8 fluorescent ballast and the new linear LED T8 replacement lamp.
- Verify wattage savings by asking how the LED replacement lamp being considered will operate with the existing ballast.
- Some lamps only will work on instant start electronic T8 ballasts, while others will be more universal.
- System life will be dependent on the remaining life of the existing T8 electronic ballasts.
- Not all linear LED T8 replacement lamps are compatible with emergency battery backup systems.
- As a directional light source, LED replacement lamps with diffused lenses and wider aperture openings will typically be more acceptable.
- Products should be safety certified (UL, ETL or CSA listed) and included on PG&E's LED qualified products list found at [pge.com/led](http://pge.com/led).

**NOTE:** PG&E does not recommend the use of T8 LED replacement lamps on T12 ballasts.

## Linear LED retrofit kits

Linear LED retrofit kits are designed to replace existing fluorescent lamps and require some form of rewiring (such as replacing the ballasts). Each kit typically comes prepackaged with all the required components to complete the retrofit, making installation easier. Kits come in two forms: either as an LED retrofit kit, such as light bar and lamp-style replacement, or as an LED troffer retrofit kit with new doorframe and lens assemblies.

### ADVANTAGES:

- Linear retrofit kits incorporate many features for mounting and quick-connect technologies. These kits come in a variety of configurations (two-, four- and six-foot lengths, light bar, lamp style, etc.), making them a versatile upgrade option.
- Realize more energy savings, as dedicated systems do not suffer energy losses from operating with existing fluorescent ballasts.
- Enjoy longer life expectancy because most retrofit kit systems are designed to dissipate heat through existing fixtures, increasing system life.
- Get “out-of-the-box” dimming and control capabilities because new systems are available with integrated controls.
- May be easier and less expensive than a complete LED luminaire (or light fixture) replacement because kits require less labor, and using existing fixtures reduces disposal and recycling fees.
- Provides a great option for ceilings with asbestos or insulation directly above the luminaire.
- Offers a repeatable, efficient retrofit solution for the majority of fluorescent troffers in today’s building stock.

### THINGS TO CONSIDER:

- For optimal visual comfort and efficiency, each LED troffer retrofit kit should include a new doorframe and lens assembly. Troffer retrofit kits reuse the original housing of the existing troffer and install quickly with no disruption to ceiling tiles or removal of existing fixtures.
- Look for LED retrofit kits that are continuously dimmable down to 10 percent.
- Verify light distribution, light output and the quality of light before purchasing in volume.
- Look for higher-efficacy products (100 lumens per watt and higher).
- Products should be safety certified (UL, ETL or CSA listed) and included on PG&E’s LED qualified products list found at [pge.com/led](http://pge.com/led).
- Kits should only be installed by qualified electricians.



## Dedicated LED luminaires (troffers)

Dedicated LED luminaires can often easily replace existing linear fluorescent luminaires. While typically higher in cost (because it is a complete light fixture), this option often provides all the benefits of linear LED technology in a well-designed package that allows for a simple redesign or a reduction in the fixture layout.

### ADVANTAGES:

- Enjoy energy savings (LED troffers are, on average, 44 percent more efficient than typical fluorescent troffers.<sup>1</sup>).
- Realize greater maintenance savings, as a quality-designed LED luminaire is specifically built to maximize the life of the LED and its components.
- Improve lighting quality with modern optics and appearance.
- Fine-tune lumen output to reduce waste with integrated controls.
- Benefit from LED advantages going forward, since luminaires are designed specifically for LEDs.

### THINGS TO CONSIDER:

- Think about relocating fixtures where most needed.
- Look for higher-efficacy products (100 lumens per watt and higher).
- While new dedicated LED luminaires may be the most expensive option in the short term, the long life cycle and light-quality benefits often outweigh the higher initial costs.
- Products should be safety certified (UL, ETL or CSA listed) and included on PG&E's LED qualified products list found at [pge.com/led](http://pge.com/led).
- Dedicated luminaires should only be installed by qualified electricians.

## Troffers: How to make the switch

Troffers are rectangular light fixtures that typically fit into modular dropped ceiling grids and are the most common fluorescent fixture in use today. However, the fact that LEDs only emit directional light, while troffer fixtures are designed to take full advantage of a fluorescent tube's omnidirectional 360 degrees light, has slowed down retrofitting troffers with LEDs until now.

Thanks to ongoing LED advancements, there are many products on the market today that deliver LED energy efficiency and lifespan with the high-quality lighting and aesthetic appeal troffers provide. Choose from LED troffer retrofit kits (with new doorframes and lens assemblies) that work with existing troffers to complete LED luminaires designed to specifically replace fluorescent troffers. Many manufacturers offer both retrofit kits and new fixtures so that your upgrade project will provide the same appearance throughout the facility.

<sup>1</sup> CALiPER Exploratory Study: Recessed Troffer Lighting, Prepared for the U.S. Department of Energy by the Pacific Northwest National Laboratory, PNNL-22348, 2013.



**Who should read this:**  
 Business Owners,  
 Facility Managers, Building Operators,  
 Lighting Contractors

# Factors to consider when upgrading to linear LEDs

Selecting the best linear LED retrofit option depends on a number of factors, including the type of fluorescent lighting system to be upgraded, its current condition, the desired light level and the initial and ongoing economic goals for the upgrade.

## Overall lighting system factors

SYSTEM FACTORS TO CONSIDER	DESCRIPTION	Linear LED Replacement Lamps	Linear LED Retrofit Kits	Dedicated LED Luminaires (Troffers)
Ballast Compatibility	Magnetic T12	NOT RECOMMENDED	CONSIDER OTHER OPTIONS	SUGGESTED SOLUTION
	Works with emergency battery backup	CONSIDER OTHER OPTIONS	SUGGESTED SOLUTION	SUGGESTED SOLUTION
Current Light Levels	Should not be reduced	NOT RECOMMENDED	CONSIDER OTHER OPTIONS	SUGGESTED SOLUTION
	Reductions of 10% or more are OK	SUGGESTED SOLUTION	SUGGESTED SOLUTION	SUGGESTED SOLUTION
Dimming Required	No dimming required	CONSIDER OTHER OPTIONS	SUGGESTED SOLUTION	SUGGESTED SOLUTION
	Dimming required	NOT RECOMMENDED	CONSIDER OTHER OPTIONS	SUGGESTED SOLUTION

**KEY:**  
 NOT RECOMMENDED  
 CONSIDER OTHER OPTIONS  
 SUGGESTED SOLUTION

Chart Source: U.S. Department of Energy

## Other system considerations

**Design aesthetics:** Before moving forward with any lighting upgrade, retrofit or replacement, consider how the design will affect the way customers view and interact with the business. For highly customer-oriented businesses, like restaurants and retail stores, finding ways to complement the advantages of a lighting project with aesthetics is particularly important.

**Employee and customer comfort:** Light quality is one of the most important influences on workplace performance and business success. It is vital to understand how the LED upgrade option could potentially affect staff and customers alike. Because bare LED sources produce intense, bright light that can lead to discomfort, it is a good idea to consider well-diffused LEDs in spaces that will be occupied on a regular basis.

**Compliance with state and federal energy reduction requirements:** As of July 1, 2014, more lighting retrofit projects are considered alterations that must comply with California’s Building Energy Efficiency Standards (Title 24). For more information on which sections of Title 24 energy code are triggered based on the scope of your lighting project, go to [energycodeace.com](http://energycodeace.com) and select “Trigger Sheets” under the “Resource Ace” tab.

## Existing lighting system conditions

In addition to overall system factors, the existing conditions of the current lighting system can affect which LED upgrade option may be most suitable. It is essential to factor in the current condition of different lighting system components like the ballast, sockets, fixture surface and lens louver (cover).

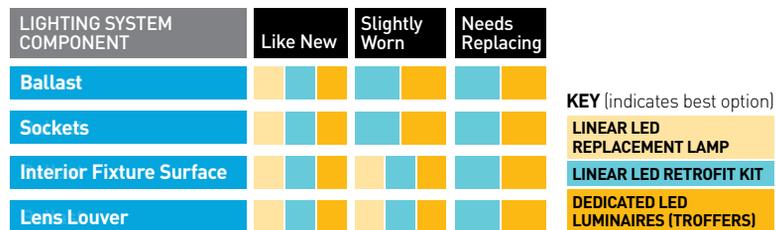


Chart Source: U.S. Department of Energy

For more information, visit [energy.gov/eere/ssl/led-linear-lamps-and-troffer-lighting](https://energy.gov/eere/ssl/led-linear-lamps-and-troffer-lighting).

## Other considerations

**Thermal management:** The ability of a linear LED replacement lamp to manage heat affects its performance, longevity and safety. To select suitable linear LED replacement lamps for existing troffers, thermal performance should be analyzed in the specific troffer being considered for retrofit, with careful attention paid to how the lamp is built to manage heat.

## Factors to consider when upgrading to linear LEDs



Linear LED Replacement Lamps



Linear Lamp-Style Retrofit Kit



Fixture Retrofit Kits



Troffer Style Retrofit Kit with New High-Performance Lens



New Luminaires



## Try them before you buy them

Because there are so many variables in choosing a linear LED solution, the U.S. Department of Energy recommends viewing mockups in place before ordering a large quantity of lamps or fixtures to ensure they are right for your business. To do so, secure enough samples of the candidate linear LED lamp, kit or new luminaire for an experienced lighting contractor or facility electrician to retrofit at least two fixtures in the facility. Evaluate these mockups for appearance and visual comfort, as well as the time required per fixture to modify and install it, before finalizing any order. If possible, also check energy use and verify potential savings.

# Factors to consider when upgrading to linear LEDs

## Types of lighting systems

SYSTEM TYPE	DESCRIPTION	Linear LED Replacement Lamps	Linear Lamp-Style Retrofit Kits	Fixture Retrofit Kits	Troffer Style Retrofit Kit with New High-Performance Lens	New Luminaires
Linear Fixtures	Strip					
	Industrial with Reflector					
	Cove					
	Linear High-Bay					
Ceiling or Wall-Mount Wrap Lens	Corridor					
	Wide Body					
Indirect/Direct	Wall Mount or Pendant Indirect					
	Wall Mount or Pendant Indirect/Direct					
Troffer	Flat Prismatic Lens					
	Indirect/Direct Basket					
	Parabolic Louvers					
	High-Performance Troffer					

### KEY:

N/A
NOT RECOMMENDED
CONSIDER OTHER OPTIONS
SUGGESTED SOLUTION

## Other considerations

**Match Linear LED to application:** To get the most out of any linear LED upgrade, it is also critical to make sure the option (be it replacement lamps, retrofit kits or dedicated luminaires) can meet the needs of the fluorescent lighting application it is replacing. These needs include light delivery, light distribution and color quality. In general, the attributes of LED technology make the following typically good applications:

- Directional applications where the source efficacy and optical efficacy benefits are useful, such as downlights, troffers, exterior flood lights and street lights
- Applications where energy and maintenance costs are high
- Applications that benefit from “white light” and improved uniformity such as warehouse, street and area lights
- Applications with environmental constraints such as mercury restrictions or green building requirements
- Applications that involve cold temperatures such as cold storage facilities and outdoor locations like parking lots and gas stations
- Applications that benefit from instant-on capabilities such as lights that are activated by occupancy sensors or high-security situations

## Who should read this:

Business Owners,  
Facility Managers, Building Operators

# Financing, incentives and rebate programs from PG&E

When it comes to making energy-efficient upgrades for commercial buildings, the amount of time it takes for a business to see its return on investment is usually one of the first considerations. Between the financing options available for installation, the rebates that businesses get for switching to energy-efficient products and monthly utility bill savings, the pace of return on investment (ROI) for a business can be much quicker.

## Zero-interest financing for business customers

**PG&E offers zero percent loans through its On-Bill Financing program. Business customers may qualify for loans between \$5,000 and \$100,000 per premises, with loan periods of up to 60 months.\***

Financing is available to fund many energy-efficient technology upgrades, including LED lighting, refrigeration, HVAC, food service and LED streetlight projects.

To be eligible, customers must have a PG&E business account that has been continuously active for the past 24 months and has been in good standing for the past 12 months. For details, go to [pge.com/obf](https://pge.com/obf).

## PG&E incentives and rebates

**PG&E offers both incentives and rebates for retrofitting and installing new energy equipment.**

Incentives are for preapproved projects. Incentive amounts are calculated by the amount of energy the project saves. Rebates are payments received for installing qualifying energy-efficient products. For more information, visit [pge.com/businessrebates](https://pge.com/businessrebates).



# Financing, incentives and rebate programs from PG&E

## Private financing

Governments and utility companies are not the only entities that are making energy-efficient products more affordable. Private banks are becoming more open to financing energy-efficiency projects.

Your contractor may have suggestions about which banks to pursue.

## Business Energy Checkup

PG&E's Business Energy Checkup is the ultimate online self-assessment tool. It provides highly customized recommendations that can lower your operating costs.

To learn more, visit [pge.com/businessenergycheckup](http://pge.com/businessenergycheckup).

## Use your contractor's insider knowledge

The best way to take full advantage of all the available financing, rebate and incentive programs is to work with certified lighting contractors. Their experience and knowledge will help ensure that any repairs, upgrades, retrofits or replacements are performed properly and that the costs for those projects are kept as affordable as possible with the help of financing and rebates.





## Next Steps

**If you are a contractor, distributor, installer or engineer** and want to receive special training and tools to help you stay up to date on the latest energy-efficiency news and trends—including linear LEDs—join PG&E's Trade Professional Alliance. To learn more, visit [pge.com/tradepro](http://pge.com/tradepro) or call the Business Customer Service Center at 1-800-468-4743.

**If you are a business owner or facility manager** who is ready to get started on upgrading your fluorescent lighting system with linear LEDs and needs to find a local certified contractor, go to [pge.com/tradeprodirectory](http://pge.com/tradeprodirectory).

**If you are a business owner or facility manager** who would like to take a more personal approach to finding a contractor for a potential linear LED project, call the Business Customer Service Center at 1-800-468-4743.

# Additional Resources

## FACT SHEETS:

Energy Efficiency of LEDs, U.S. Department of Energy  
[energy.gov/eere/ssl/technology-fact-sheets](https://energy.gov/eere/ssl/technology-fact-sheets)

LED Retrofit Options for Linear Fluorescent Luminaires, California Lighting Technology Center, University of California, Davis  
[cltc.ucdavis.edu](https://cltc.ucdavis.edu)

Upgrading Troffer Luminaires to LED, U.S. Department of Energy  
[energy.gov/eere/ssl/technology-fact-sheets](https://energy.gov/eere/ssl/technology-fact-sheets)

## WEBSITES:

Pacific Gas and Electric Company, LED Lighting  
[pge.com/led](https://pge.com/led)

U.S. Department of Energy, Building Technologies Office  
[energy.gov/eere/buildings/building-technologies-office](https://energy.gov/eere/buildings/building-technologies-office)

California Lighting Technology Center  
[cltc.ucdavis.edu](https://cltc.ucdavis.edu)

## Acknowledgements:

- U.S. Department of Energy
- California Lighting Technology Center
- Tubular LED Guide created by SMUD (Sacramento Municipal Utility District)



# Did you know?

**Every dollar invested in energy efficiency brings back \$2 in benefits.**

**This may include savings on utility bills and reduced long-term environmental impact.**

Source: California Public Utilities Commission

## Common Lighting Terms

**Color Rendering Index (CRI)** is the current industry standard for measuring how accurately a light source renders the colors of objects it illuminates. The maximum CRI value is 100. A higher CRI means better color rendering or less color shift. CRIs from 75 to 100 are considered excellent, while 65 to 75 are good. The range of 55 to 65 is fair and 0 to 55 is poor. Under higher CRI sources, surface colors appear brighter, improving the aesthetics of the space.

**Correlated Color Temperature (CCT)** indicates the warmth or coolness of light emitted from a particular source. Light sources with a low CCT (2,700–3,000 kelvin) emit light with a warmer appearance. Those with a higher CCT (4,000–6,500 kelvin) emit light with a cooler color appearance.

**Efficacy** indicates how much light is produced by a lamp or lighting system per unit of electrical power it consumes, measured in lumens per watt (lm/W).

**Luminaire** is the lighting industry's term for what is commonly referred to as a "light fixture." It is also the term used in California's Building Energy Efficiency Standards (Title 24, Part 6). A luminaire consists of the housing, power supply (ballast or driver), "lamp" or light source (linear fluorescent tube or LED array, etc.) and optical components, such as reflectors and lenses.

Source: California Lighting Technology Center

"PG&E" refers to Pacific Gas and Electric Company, a subsidiary of PG&E Corporation. ©2017 Pacific Gas and Electric Company. All rights reserved. These offerings are funded by California utility customers and administered by PG&E under the auspices of the California Public Utilities Commission. PG&E prints its materials with soy-based inks ♻️ on recycled paper. ♻️  
January 2017 CSB-0117-7377

