

GPG-026 | APRIL 2016

LED DOWNLIGHT LAMPS FOR CFL FIXTURES



LED Downlight Lamps Save Energy, Match Pre-Existing CFLs for Light Level and Quality

According to a 2013 U.S. Department of Energy (DOE) survey, the General Services Administration (GSA) has approximately 95,000 compact fluorescent (CFL) downlights in its commercial building portfolio.¹ CFL downlights provide illumination in hallways, lobbies, and other common areas, and are often used as accent lights. Compared with light emitting diode (LED) lamps of similar form factor, however, they are relatively short-lived and therefore require frequent replacement. They also consume considerable amounts of energy. For these and other reasons, replacing CFLs with LED lamps represents a significant cost- and energy-savings opportunity. LED downlight lamps last four to six times as long as CFLs and consume roughly half as much electricity. There are many options for retrofitting pin-based CFLs, and in 2014, GSA's GPG program worked with researchers from the Pacific Northwest National Laboratory (PNNL) to evaluate the simplest of them—a replacement lamp that uses the same four-pin socket and electronic ballast as an incumbent CFL. In addition to cost- and energy-savings, researchers measured light levels, distribution, uniformity, and occupant acceptance of the new technology at three test-bed locations. They found that light levels from the new LED lamps met or exceeded preexisting light levels and that occupants were generally satisfied with the quality of illumination. At the national average energy cost of \$0.11/kWh, payback was under three years.

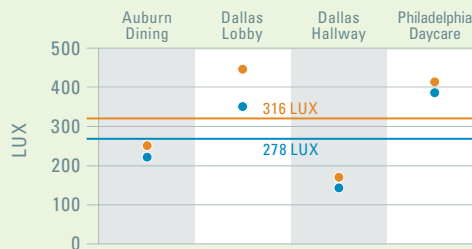
INTRODUCTION

Photometric Performance

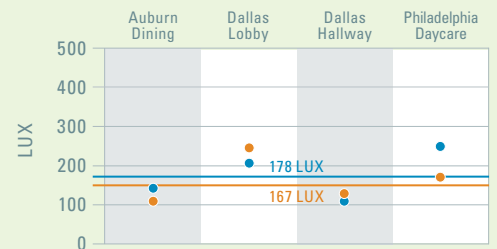


To compare the new LED lamp with the incumbent CFL, horizontal and vertical light levels were measured. A difference of less than 100 Lux is typically not noticeable by the human eye.

Average Horizontal Light Levels Work Surface or Floor



Average Vertical Light Levels Wall



Key: • CFL — CFL AVERAGE ACROSS TEST BEDS • LED — LED AVERAGE ACROSS TEST BEDS

“The LED downlights were easy to install and occupants noticed little difference between the old CFL light and the new LED light.”

— Frank Campagna
Energy Project Manager
GSA Greater Southwest Region
U.S. General Services Administration

TECHNOLOGY SPECIFICATIONS

LED Downlight Lamps

- CFL Base – 4-pin (2-pin available)
- Powered By – electronic ballast (magnetic available)
- Mounting – horizontal and vertical
- Efficacy – 70 lumens per watt
- Light Output – minimum 450 lumens
- CRI – 80+
- CCT – 3000K, 3500K, 4000K
- Lifetime – minimum 36,000 hours L70
- Warranty – minimum 5 years

What Is This Technology?

ONE-TO-ONE LAMP REPLACEMENT POWERED BY EXISTING CFL BALLASTS

The LED downlight technology assessed in this evaluation is a one-to-one lamp replacement that the manufacturer characterizes as “plug-and-play.” It fits standard G24q-series 26W, 32W and 42W CFL four-pin sockets, installs within the luminaire either vertically or horizontally, and is powered by the existing fixture’s electronic ballast. Unlike CFLs, which are inherently omnidirectional, LED downlights direct most of their light toward living and work surfaces. This both reduces the need for the CFL luminaire’s secondary optics, which serve to redirect fluorescent light that is not focused downward, and increases the LED lamp’s overall efficiency. The technology assessed during this evaluation was not capable of dimming but a new lamp from the same manufacturer is, if the legacy ballast supports this feature (some do, though many do not).

What We Did

ASSESSED DIFFERENT LIGHTING CONFIGURATIONS AT THREE GSA SITES

In 2014, GSA replaced pin-based CFL downlights with LED lamps in three federal buildings: GSA’s regional headquarters in Auburn, Washington; the Cabell Federal Building in Dallas, Texas; and the Veterans Administration Center in Philadelphia, Pennsylvania. The test-bed locations offered different lighting configurations, from 6-inch aperture, vertically oriented, 1-lamp, pin-based CFLs, arranged 6-feet-by-6-feet on-center, to 8-inch aperture, horizontally oriented, 1- or 2-lamp, pin-based CFLs, spaced 4-feet-by-4-feet on-center. To assess the new lamp’s performance, PNNL researchers conducted interviews and surveyed occupants and facility managers, in addition to measuring LED light levels and comparing them with measurements taken previously of the incumbent technology. They also gauged energy savings and cost-effectiveness.

FINDINGS



ENERGY SAVINGS BETWEEN 40% AND 50% When installed in a 26W CFL downlight fixture, the LED technology saved 50%, or 60 kWh per year. At the national average of \$0.11/kWh, the LED lamp saved \$6.37 in energy costs per year over a typical compact fluorescent lamp.



LAMP ORIENTATION AND FIXTURE APERTURE AFFECT LIGHT DISTRIBUTION Because LEDs deliver more lumens per watt, replacement LED light levels were generally higher than those of the existing CFLs. Also, the assessment revealed that LED light distribution was not as uniform as that of CFLs. The greatest differences in distribution between CFL and LED downlights were found in fixtures with horizontal lamps and large apertures, though the differences were often too small to be detected by the human eye. In fixtures with vertical lamps and small apertures, differences in light distribution were negligible.



COST-EFFECTIVE AT ALL ENERGY RATES Assuming the average utility rate of \$0.11/kWh, and a material cost of \$22 per unit[§], simple payback was 2.9 years. Assuming that installation costs are the same for a CFL ballast replacement, an LED retrofit kit, and a new LED fixture, replacement lamps are still more cost-effective than a retrofit or new fixture, even when the ballast must be replaced.



OCCUPANTS GENERALLY SATISFIED Occupants noticed little difference between light from the existing CFLs and that from the replacement LEDs. In general, they were satisfied with both technologies.



REDUCED MAINTENANCE AND MORE ENVIRONMENTALLY FRIENDLY In addition to requiring about a fifth of the maintenance CFLs require, LEDs do not contain mercury and therefore avoid disposal issues associated with the fluorescent lamp.



REPLACE CFLS WITH LEDs Replace all CFL downlights with LEDs. If your CFL ballasts are relatively new, and controls are not desired, cost and ease-of-use recommend the one-to-one lamp replacement assessed here. If your legacy ballasts are at or near the end of their useful lives, consider a retrofit, which supplies its own LED driver, or a completely new fixture, which may have the added advantage of compatibility with current advanced lighting controls (ALC). In any case, sample a small number of lights where they will be installed, assessing such things as fit, light levels, color, and glare.

LED Replacement Options for CFL Downlights

Consider compatibility and controls when selecting an LED replacement

	REPLACE WITH LED LAMP IF :	INSTALL LED RETROFIT KIT IF :	INSTALL NEW LED FIXTURE IF :
COMPATIBILITY	CFL ballast is verified to work with LED replacement lamp (per manufacturer or by testing).	Lamp is incompatible with CFL ballast (consult manufacturer specifications).	New construction or renovation.
CONTROLS	No controls are necessary.	Dimming is desired and CFL ballast does not support it.	Integrated advanced lighting controls are desired (tuning, occupancy sensing, daylighting).
	PAYBACK—2.9 years* Cost \$39 (Material \$22 [§] , Install \$17) With ballast replacement \$94 (\$38 + \$56) Payback 7.1 years	PAYBACK—10.4 years* Cost \$137 (Material \$81, Install \$56)	PAYBACK—12.4 years* Cost \$165 (Material \$109, Install \$56)

*Assumes maintenance savings included; midrange material cost; derived labor estimates; national avg. energy rate \$0.11; 4000-hr/yr operation

[§]April 2016 — updated material cost of \$15, provided by the vendor, reduces payback to 2.4 years

CONCLUSIONS

These Findings are based on the report, “LED Downlight Lamps for CFL Fixtures,” which is available from the GPG program website, www.gsa.gov/gpg

For more information, contact GSA’s GPG program gpg@gsa.gov



Footnotes

¹DOE FEMP, “Interior Commercial Lighting Market Characterization for the Federal Sector,” September 2013.

Technology for test-bed measurement and verification provided by Lunera.

What We Concluded

A ONE-TO-ONE LED LAMP REPLACEMENT IS AN EXCELLENT OPTION IN MOST CASES

Replacing CFL downlights with LED lamps of similar form, fit, and function results in significant energy- and cost-savings. Assessing this technology in test-beds in Washington, Texas, and Pennsylvania, researchers found that LED downlights consumed as little as half the electricity CFLs did and were cost-effective across a wide range of energy rates, from \$0.06/kWh to \$0.24/kWh. They also found that, by and large, occupants were pleased with the new light, even when compared with fluorescent light they had previously found satisfactory. There are, however, circumstances in which a simple one-to-one lamp replacement is either impossible or not the best option, and a retrofit kit or new downlight assembly is warranted. See the table on page three for direction.

ISSUES TO CONSIDER WHEN REPLACING CFL DOWNLIGHTS

- **Lamp Use** If the space in question uses its recessed downlighting infrequently or might be remodeled in the near future, a long-lived lamp might not be practical or cost-effective.
- **Light Output** Because LEDs are directional in nature, the LED replacement lamp typically only needs 70% of the CFL total lamp lumens to match light levels on surfaces below.
- **Color Temperature** LED products are available in the same general color temperatures as CFL and incandescent directional lamps. They range from warm white (2700K) to cool white (5000K). If the existing color temperature is appropriate, choose the same color LED lamp. Occupant spaces are commonly lighted with warmer color temperatures (3000K to 4100K) because of the truer treatment of skin tones.
- **Installation Compatibility** If replacement lamps operate on existing CFL ballasts, verify that the new LEDs will function on *all* ballast types within the project area. If existing ballast types are unknown, or it is impractical to verify their compatibility with an LED replacement product, consider using an LED kit replacement or new downlight fixture that includes a dedicated LED driver. Also, if a replacement kit is a good option, make sure that the kit under consideration fits properly within the existing downlight housing. Confirm this with the manufacturer and also with a trial installation. If a kit sits too low in the recessed fixture, glare might be an issue.

Reference to any specific commercial product, process or service does not constitute or imply its endorsement, recommendation or favoring by the United States Government or any agency thereof.