

TOOLBASE™ TECHSPECS

Energy-Efficient Lighting

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TECH @ A GLANCE

BENEFITS (+)/DRAWBACKS (-)

- + **ENERGY EFFICIENCY:** Compared to conventional incandescent lighting, energy-efficient lighting creates an equivalent level of light with less energy use. Also, energy efficient lights give off less thermal energy than incandescent lighting, thereby reducing cooling loads.
- + **AFFORDABILITY:** CFL lamps costs less, when factoring upfront and operating cost, over the lifetime of the lamps.
- + **CONVENIENCE:** Lamp life is much longer for CFLs and LEDs than incandescent lamps.
- + **AESTHETICS:** When designed appropriately, energy-efficient lighting can add to the aesthetics of a home.
- + **PERFORMANCE:** LED light is very directional, so it makes excellent task lighting.
- **SAFETY:** CFLs contain a small amount of mercury and, although they can be legally disposed of in regular trash collection (in most locations), should be disposed of at a recycling facility which can recover the element.
- **INSTALLATION:** Energy-efficient lighting strategies can require more upfront design work. Dedicated fluorescent fixtures do not have universal fittings for lamp bases and, therefore, it can be relatively difficult to find replacement bulbs. However, a new base (GU24) provides a universal fitting for any wattage fluorescent lamp.
- **AESTHETICS:** CFL packaging does not always report light quality indicators (i.e., color temperature and color rendering index). Some CFLs produce undesirable cool (bluish) light.
- **CONVENIENCE:** For dimming, special dimmable CFLs are needed and the technology is still emerging. Also, CFLs take time to reach full illumination.

- **PERFORMANCE:** The light from LED lamps is very directional and, therefore, not always appropriate for ambient lighting. However, new LED downlights use reflectors to distribute the light and provide more multidirectional lighting.

MAKING THE SWITCH

Knowledge of available products and specifications for replacement bulbs is all that is required to make the switch. It may be useful to consult a lighting designer, especially when first switching to energy-efficient lighting packages.

INITIAL COST

Fluorescent lamps that can be retrofitted into conventional light fixtures cost between \$5 and \$17 per lamp, depending on type, wattage, and features. Dedicated CFLs, which can fit only into fixtures dedicated for fluorescent use, cost less than screw-base CFLs.

Dedicated CFL fixtures tend to cost more than conventional light fixtures, but as the variety of available fixtures expands, prices are coming down. Although the variety of light fixtures makes it difficult to make a direct fixture price comparison, one major manufacturer's pendant lamp cost \$51 in the incandescent version and \$79 in the dedicated CFL version (about 55% more for the CFL). Designing a dedicated fluorescent lighting system can save money over time because replacement bulbs cost less than screw-base CFL replacements. Architectural features can be used to create lighting with standard straight tube fluorescent lights (e.g., cove or indirect lighting) to save hardware costs, but this technique may increase construction (carpentry, drywall) costs.

LED downlights for ambient lighting cost about \$120 for a 6-inch fixture. Fixtures can be

expected to last for a decade or two. However, when replacement is necessary, there are no replacement bulbs and the entire fixture must be replaced.

OPERATIONAL COST

The energy cost for operating CFL and LED lamps is about one-third to one-fourth the energy cost of incandescent lamps, and incandescent bulbs must be replaced about 10 to 50 times more frequently. For a typical 20 watt CFL operating 2 hours per day at an electric rate of \$0.10 per kWh, annual utility cost would be \$1.46. The same 75 watt incandescent would cost \$5.48 to run under the same conditions, resulting in an energy cost savings of \$4.02 per year. With the CFL expected to last approximately 10 years and an incandescent life of approximately one year, 5-year operating cost is about \$15 for the CFL and \$31 for the incandescent lamp.

CODE ACCEPTANCE

There are no specific code issues with using energy-efficient lighting instead of standard lighting.

RESULTS FROM THE FIELD

Field studies show that there can be significant reductions in energy used for lighting by switching to energy-efficient fixtures and bulbs. Increased initial expenditures can be recouped in a few years. However, it is important to pick the proper lighting type for the intended use, such as the different needs for hallway and bathroom lighting.

WARRANTY

Standard CFL warranties vary from 1 to 3 years, while typical LED fixture warranties last 3 years.

THE BASICS

Lighting technology has advanced tremendously over the last decade, and numerous options are available for providing aesthetically-pleasing ambient light at a fraction of the energy usage of traditional incandescent lamps. Two types of lamps provide energy-efficient residential lighting—LED and fluorescent lamps.

Compact fluorescent lamps (CFLs) are well suited for ambient lighting. CFLs are categorized by their type of base—screw-type, pin-type, and the new GU24 twist and lock sockets. Screw-type lamps fit into standard fixtures, while pin-type and GU24 bases must be matched to dedicated fluorescent fixtures. The variety of dedicated fluorescent fixtures is rapidly increasing, due in part to programs such as ENERGY STAR (www.energystar.gov) and fixture design competitions such as Lighting for Tomorrow (www.lightingfortomorrow.com).

Many CFLs provide light quality similar to the quality of incandescent light. For lights that mimic the warm light of incandescent lamps, look for color rendering index (CRI) over 80 and a color temperature of about 2700 or 2800 K.

Due to the small amount of mercury in CFLs, the EPA recommends that bulbs which have reached the end of their useful life, or which have broken, should be disposed of at a local recycling facility. The EPA is working to expand recycling options for fluorescent lamps. It should be noted, however, that the amount of power plant mercury emissions avoided by the bulb's efficiency eclipse the small amount of mercury contained in a CFL.

Ubiquitous in consumer electronics indicator lights, light-emitting diodes, or LEDs, especially white LEDs, are gaining a foothold in other applications, including residential lighting. Currently, LED lamps are best suited for directional light applications, such as under-cabinet lighting, task lighting, landscape lighting, and stairway illumination. LED lamps last on the order of 50,000 hours and rarely fail (they slowly lose their luminescence over time rather than simply “burn out”); fluorescent lamps last about 10,000 hours and incandescent lamps about 1,000 hours. LED bulb costs are still fairly high compared to other lighting options, which may limit use in residential applications, however technology and manufacturing practices are improving, so prices should come down, and more models with multi-dimensional applications should be available in the near future.

Lighting controls—such as occupancy sensors and dimming switches—can further reduce energy needs associated with lighting. ENERGY STAR labeling is currently available for energy-efficient light fixtures and CFLs and is under development for LED lamps. National standards for LED lamps are also under development.

DOLLARS AND SENSE

If 10, 60-watt incandescent lamps, which last 750 hours and cost \$0.75 each, are replaced with 10, 15-watt fluorescent lamps which last 10,000 hours and cost \$7.50 each, the upfront investment cost would be recouped in one year. The estimated 5-year operational cost of the incandescent lamps would be \$513, while the 5-year cost of the fluorescent lamps would be \$185.

TECH CHECK

Below is a checklist of steps to follow in order to implement this technology in each of your projects.

- Learn about color temperature and color rendering.
- Learn what to look for to buy CFLs that will mimic natural lighting.
- When retrofitting existing light fixtures, carefully select the right CFL size, shape, and wattage that will work in the light fixture—many options are available but getting the right lamp requires some effort.
- There is no need to do anything differently with respect to wiring.
- You may need to work with a knowledgeable lighting designer.
- Using architectural features to hide tube lights is a technique that can enhance the overall beauty of the home and the appearance of the lighting, but may increase carpentry and drywall cost.

MAKING THE SWITCH

What is required to transition from your current building practices to using this technology?

There is a growing array of dedicated fluorescent fixtures that can provide many options to suit almost any homeowner's budget and taste. When designing a home to use dedicated fluorescent lamps, the assistance of a lighting designer maybe useful. The lighting designer can help with selection of fixtures, and ideas for using conventional tube fluorescent lamps along with architectural features to produce aesthetically pleasing lighting.

A few LED fixtures for ambient lighting are emerging in the marketplace. There are also several LED task lighting products, such as under-cabinet lighting, that are suitable for residential task lighting.

No changes in technology or construction techniques are needed to switch to screw-base CFLs. However, slightly more effort will be required to determine the size, wattage, and type of CFL needed for the application. When making the switch to energy-efficient lighting, it is important to understand where each type of fixture makes the most sense, and what options are available.

FOOD FOR THOUGHT

This section provides some things to think about before switching to this building technology – make sure it's the right choice for you.

- Technology is rapidly advancing. Check with manufacturers or lighting suppliers for the latest information.
- Efficient lighting packages are more expensive upfront, yet offer tremendous life cycle cost savings.
- Efficient lighting packages will save energy and money in any climate and type of home. Dedicated fixtures are best for new construction, while screw-base CFLs and LEDs can be retrofitted very easily into existing homes.
- Consider working with a lighting designer to get the best effect from an efficient lighting system.
- Use the ENERGY STAR website to help find the best-suited fixtures and lamps for the application.

RESULTS FROM THE FIELD

This technology has been used by other builders in real-world building situations – learn from their experiences.

**Grand Forks, ND, Selkirk Twin Homes
(2004 PATH Field Evaluation)**

- Increase lighting from 10% to 85% fluorescent
- Incremental installed cost \$200
- Annual savings \$31
- Simple payback 6.5 yrs

**Henderson, NV, Asdal Builders
(2002 PATH Field Evaluation)**

- LED directional light fixture was installed in an entryway
- Lighting was very directional and did not provide adequate illumination for the entryway in the existing fixture (550 lumens versus 860 lumens with incandescent)
- Homeowners did not like the limited amount of light in the entry and planned to replace the LED bulb after the study

**Tucson, AZ, John Wesley Miller Companies
(2004 PATH Field Evaluation)**

- Dedicated fluorescent fixtures throughout Zero Energy Home
- Reduced predicted lighting load from 1,873 kWh/year to 779 kWh/year; actual use 20% lower than predicted
- Cost of recessed can fixtures were prohibitively expensive—almost 10 times the cost of incandescent can lights
- Technology improvements are still needed to provide dimming capability, reduce start time delay, and improve color rendering
- Fluorescent fixtures were not immediately available which caused a small construction delay



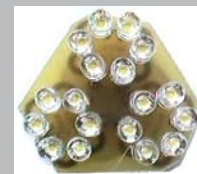
CFLs in interior lighting scheme, Sustainable Development Inc., 2008 EVHA Silver Winner



*CFL in exterior light fixture
Yavapai College, Residential
Building Technology Program,
2007 EVHA Gold Winner*



*Evolution Bulb
www.aerolights.com*



White LED lighting



Screw-base CFL from IBASCO



*LED
<http://www.ccrane.com/lights/led-light-bulbs/index.aspx>*

DEFINITIONS

Ballast

An electrical device for starting and regulating fluorescent and discharge lamps.

Compact fluorescent lamp (CFL)

A lamp which produces light by fluorescence and is used in place of an incandescent lamp. CFLs with a screw base can be fitted into a conventional lamp socket, while dedicated CFLs must be fitted into a fixture containing a matching ballast.

Lamp—(also called a bulb)

An artificial light source which produces visible light.

Light emitting diode (LED)

Semiconductor devices which produce light when electrons pass from one side of the junction to the other.

Light Fixture

The combination of housing and electronics which holds a lamp to create light and decoration.

RESOURCES

General information about energy-efficient lighting and its installation in homes:

ToolBase Services

Information on this building technology and many others brought to you by PATH and the building scientists at the NAHB Research Center.

www.toolbase.org

ENERGY STAR Program

www.energystar.gov

Program materials include:

- ENERGY STAR Advanced Lighting Package (ALP):
www.energystar.gov/index.cfm?c=fixtures_alp_consumers
- Light Fixtures:
www.energystar.gov/index.cfm?c=fixtures_pr_light_fixtures
- Compact Fluorescent Light Bulbs:
www.energystar.gov/index.cfm?c=cfls_pr_cfls
- Information about mercury in CFLs and their disposal:
www.energystar.gov/ia/partners/promotions/change_light/downloads/Fact_Sheet_Mercury.pdf

Energy-Efficient Lighting Information from EarthEasy

www.eartheasy.com/live_energyeff_lighting.htm

Efficient Lighting Strategies (US DOE Fact Sheet)

www.nrel.gov/docs/fy03osti/26467.pdf

Lighting for Tomorrow Competition

www.lightingfortomorrow.com



The Partnership for Advancing Technology in Housing (PATH) is dedicated to accelerating the development and use of technologies that radically improve the quality, durability, energy efficiency, and affordability of America's housing. Managed by HUD, the PATH partnership includes the homebuilding, manufacturing, insurance and financial industries, and Federal agencies concerned with housing.

PATH addresses barriers to innovation, provides information on advanced building technologies, and advances housing technology research; making affordable, quality American homes a reality.

For more information on the PATH program, visit www.pathnet.org.

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