

LIGHTING UPGRADES WITH LED BULBS

WHY UPGRADE TO LED

Light emitting diode (LED) technology has evolved to the most efficient light source and costs can be competitive with incandescent, halogen and CFL bulbs. Upgrading from incandescent or halogen can:

- Produce energy savings up to of 75%.
- Have simple payback in 1 to 3 years for many applications.
- Reduce frequency of bulb burnout by a factor of 10 for incandescent and halogen bulbs.

The range of efficiency of CFLs and LED overlap and a detailed comparison is needed to identify the preferred type.

This fact sheet covers LED bulbs available in Standard "A", flood, spot, globe, and candelabra configurations. (Linear lamps are covered in a separate fact sheet.)

How much light is enough?

Illuminating Engineering Society of North America sets officially recognized standards measured in foot candles (or lux).

Illumination Level for Space /	Foot candles, fc
Corridors, Stairs	5 min.
Parking Garage	10
Lobbies , Reception, Hospitality Guest Rooms	10 to 30
Offices , Meeting Rooms, Kitchen, Industrial	30 to 50
Retail, Inspection, Detail Work	50 to 100

EIGHT STEPS TO EVALUATE LED BULB OPPORTUNITIES

1. Get the right quantity of light. The goal is to provide sufficient illumination for people to do their activities comfortably and in a pleasing environment (see sidebar). Use a light meter or get a lighting survey to determine if any areas are over or under lit. Determine the lumen output of the current lighting and proportionally adjust the target lumen level of the new bulbs to bring the illumination in line with standards.

Uniformity of illumination is as important as amount of light. The darkest areas should have at least 1/3 the illumination as brightest.

2. Get the right quantity of light. Determine the color temperature and Color Rendering Index (CRI). Color temperature is typically specified as 3000 K or less for hospitality, 3000 to 4000 K for indoor and 4000 K or more for outdoor.

We have grown accustomed to incandescent lighting which has been defined as a color rendering index of 100. Other light sources differ in their distribution of light through the spectrum and this affects the perceived color of objects. Specify a CRI of at least 80. This information is available on most LED packaging.



Evaluate color temperature and CRI of sample bulbs before committing to a large scale replacement.

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3. Use Energy Star or Design Lights Consortium Qualified Bulbs. Both these rating systems establish minimums for a wide range of performance parameters simplifying procurement specifications.

ENERGY STAR[®] Certified Light bulbs – Product finder http://www.energystar.gov/productfinder/product/

DesignLights Consortium http://www.designlights.org/

4. Rank efficiency in lumens per watt. For incandescent bulbs with equal wattage, the light output in lumens was virtually to same. For LED and CFL products with similar light output, the wattage varies significantly. Therefore it is important to compare products on their efficiency measured in lumens per watt. Bulbs should be readily available with efficiency better than Energy Star minimums as illustrated in the accompanying table.

Recommended Efficiency to Specify

	Energy St Min	Specify Efficiency	
Bulb Type	Current Lumens/W	Proposed Lumens/W	Lumens/W
General Purpose	50 to 55	65	> 75
Candelabra > 7 W < 7 W	40	65 55	> 65 > 60
Flood & Spot	40	65	> 65
MR16	40 to 45	65	> 60

To maximize the benefits of an upgrade, it is imperative to obtain the highest lumens per Watt in relation to cost. Suggestions for specifying the efficiency are listed in the table. Seek guidance from your lighting supplier. 5. Special Requirements Checklist

Check bulb compatibility with existing fixture.

LED bulbs typically have a larger base than the corresponding incandescent or may have a different height. Track lighting in particular should be checked to physical interference.

Check angular distribution of light. LED bulbs are good for directional uses such as flood and spot bulbs. For standard, globe and candelabra bulb replacements, test the LED bulb in the fixture.

Check compatibility with existing dimmers and transformers. Existing dimmers were designed for the high wattage of incandescent bulbs and may not be able to dim LED bulbs over the full range. LED compatible dimmers are now readily available. For low voltage lighting such as MR16 bulbs, there is a potential incompatibility of the external transformer circuit and the internal electronics of the LED bulb.

Check for adequate cooling. Heat buildup shortens LED life, so make sure that the cooling fins on the bulb have access to free air flow.

Light output of the downlight is what counts. Downlights that use white or reflective surfaces to direct the light need a replacement bulb that radiates from the same location in the fixture and with the same spatial distribution. An Integrated LED/luminaire (or modification kit) is likely to perform better than bulb replacement. For downlights it is important to evaluate all the options.

6. Determine annual energy costs. Start with an estimate of the hours a bulb is operated per year and the electric rate.

[Annual operating cost] = [Wattage] x [Hours per year] x [Cost per kWh] x [.001 kW per Watt]

Application		Output, Lumens per Watt		Best Increase Over Avg.		
LED Type	Lumen Range	Average	Best			
General Purpose	700 to 1600	69	94	36%		
Directional	600 to 1300	57	89	56%		
MR16	400 to 600	55	77	40%		
Decorative	400-700	58	77	33%		

Light Output Efficiency Varies Significantly

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As an example, consider a retail site open 12 hours per day and paying \$0.116 per kWh on Duke Energy Small General Service Schedule. The annual electric costs per bulb are listed below.

Incandescent		Energy Star Average		
Tungsten	Halogen	CFL	LED	
75 W	53 W	17.3 W	15.7 W	
\$38.20	\$26.99	\$8.79	\$7.99	

Example of Operating Cost for 12 Hours per Day

7. Determine payback. For bulbs operating more than 40 hours per week, the annual energy cost saving may be sufficient to justify upgrading tungsten or halogen bulbs to LED. In other situations, the higher cost of LED bulbs may appear to be a barrier to an upgrade. For these cases, a more detailed cost analysis is required and should include initial cost and rebates, labor, and replacement cost and labor.

The worksheet below allows the current bulb to be compared to upgrade by prorating the cost of operation on an annual basis. This method allows a direct comparison of a low-cost/short-life bulb with a highercost/long-life bulb.

Basic information about the before and after cases is entered in the white cells. The values for the gray cells can then be calculated with the formulas in the column on the left. The costs per fixture are easily scaled by the number of fixtures to the estimated project costs.

Excel version available at Waste Reduction Partners: wastereductionpartners.org. Enter values in white cells Calculate values in gray cells using formulas on left COMPARISON EXAMPLE Before After Saving Before After Saving Project Parameters Halogen LED vpe Watts per fixture 57 Operating hours per year 3000 3000 Incremental usage rate per kWh, Note 1 \$0.116 \$0.116 Demand rate per kW, Note 1 Annual Energy Cost per Fixture Kilowatt hours per year, kWh 171 216 45 [Watts] x [Operating hours] x [.001 kW/W] Electric usage cost per year \$25.06 \$5.22 \$19.84 [kWh per year] x [Incremental usage rate] = Electric demand cost per year \$0.00 \$0.00 \$0.00 [Watts] x [.001 kW/W] x [demand rate] x [12 months] Annual Maintenance Cost per Fixture Life, hours 1,000 25,000 Replacements per year 3.00 0.12 [Life] / [Hours on per year] = Material cost per replacement, Note 2 \$1.49 \$18.4 Material cost per year \$4.47 \$2.22 [Material cost] x [Replacements per year] = \$2.00 Labor cost per replacement, Note 3 \$2.00 abor cost per year \$6.00 \$0.24 [Labor cost] x [Replacements per year] = Maintenance cost per year \$10.47 \$2.4 \$8.01 [Material cost per year] + [Labor cost per year] Annual Saving per Fixture Annual Savings [Usage savings] + [Demand savings] + [Maintenance \$27.85 Savings] = Investment Cost per Fixture Material cost of lamp(s), kit or fixture \$18.47 \$10.00 Rebate Labor cost for installation \$2.00 nvestment cost per fixture \$ 10.47 [Cost] - [Rebate] + [Labor] = Payback Period 0.4

WORKSHEET FOR COST COMPARISON AND PAYBACK OF LED LIGHTING UPGRADES

Download this worksheet here: http:// www.wastereductionpartners.org/ phocadownload/Energy/ led_worksheet_pro.xlsx

Simple Payback, years

[Investment cost] / [Annual saving] =

Note 1. Refer to an electric bill or utility web site for rate schedules. The incremental usage rate is the rate that would be applied to the last kWh consumed. For meters on a Time of Use rate,

estimate the fraction of on peak and off peak for the lighting involved. Then combine the on peak and off peak rates weighted by these fractions.

The demand rate would apply only if the lighting was turned on during the short period when peak demand occurs. Use zero

if lighting upgrade will not change demand charge EXAMPLE. Duke Energy Small General Service rate for first 3000 kWh per month is \$0.116238 per kWh (decreases to

\$0.071353 for higher usage) and no demand charge for less then 30 kW per month

Note 2 Replacement costs may not be well known, EXAMPLE assumes new

8. Financing Options

DSIRE is a comprehensive database of information on federal, state, local, and utility incentives and policies that support renewable energy and energy efficiency. <u>http://www.dsireusa.org/</u>

Duke Energy SmartSaver[®] Prescriptive incentives include \$10 per Energy Star LED and larger rebates for LED fixtures. <u>http://www.duke-energy.com/pdfs/SS-Comprehensive-Prescriptive-NC.pdf</u>

Duke Energy Progress Incentive Program <u>https://www.progress-energy.com/assets/www/docs/business/</u> Progress Lighting Application 123113-FINAL.pdf

Lime Energy is Duke Energy's authorized contractor for the Small Business Energy Saver Program. Duke Energy will pay up to 80 percent of select energy-efficiency improvements. The program pays the rebate upfront, so reducing investment cost without waiting for a rebate. The upgrade is completed by a local contractor who takes care of all necessary material and labor. https://www.progress-energy.com/carolinas/business/save-energy-money/sbes/index.page?

Additional Resources.

More detailed information about specific types of bulbs can be found in the following:

LED General Service Lamps http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/led_general-service-lamps.pdf

LED Directional Lamps http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/led_directional_lamps.pdf

LED MR16 Lamps

http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/led mr16-lamps.pdf

Recessed LED Downlights http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/recessed_downlight.pdf

DOE Adoption of Light-Emitting Diodes in Common Lighting Applications <u>http://apps1.eere.energy.gov/buildings/</u> publications/pdfs/ssl/led-adoption-report 2013.pdf

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