

# When considering an LED retrofit or incentive policy, do your research

Evaluation of 250 LED bulbs and fixtures from 23 leading vendors indicates that LEDs offer compelling payback periods when compared to conventional incandescent and halogen lighting solutions. However, as **DAVID RAEZER** and **ROMAHLO WILSON** describe, LEDs are not yet competitive as replacements for compact fluorescent, metal halide, and linear fluorescent lights.

While LEDs can save substantial energy and maintenance costs over the course of their lifetime, the investment case associated with their adoption is often difficult to discern among the maze of general lighting reports, marketing materials, and strong competition from conventional lighting solutions. The information and independence that municipalities, institutions, and real estate stakeholders need is often so illusive that a large municipality asked Cleantech Approach (CTA) to determine the scenarios—spanning a range of vendors, products, applications, and end-markets—under which it made financial sense to move ahead with LED implementation.

As lighting accounts for approximately 16% of the municipality’s energy consumption, it is a central part of its energy efficiency and sustainability efforts. This information was critical as the municipality considered retrofitting their own facilities and sizable infrastructure, as well as creating effective legislation and financial incentives for property owners and citizens to retrofit their own properties.

## Benchmarking

Effectively charged with determining where

LED payback period by end-market, application, and conventional benchmark

	Incandescent	Halogen	CFL	LF	MH
RESIDENTIAL: LOW INTENSITY DIRECTIONAL LIGHTING (WARM WHITE, UNDER 500 LUMENS)	2.0	107	5.3	–	–
RESIDENTIAL: HIGH INTENSITY DIRECTIONAL LIGHTING (WARM WHITE, OVER 500 LUMENS)	2.9	2.7	12.9	–	8.1
RESIDENTIAL: OMNIDIRECTIONAL LIGHTING (WARM WHITE)	1.7	–	6.2	–	–
COMMERCIAL OFFICE: LOW INTENSITY DIRECTIONAL LIGHTING (COOL WHITE, UNDER 500 LUMENS)	1.8	1.7	4.5	–	–
COMMERCIAL OFFICE: HIGH INTENSITY DIRECTIONAL LIGHTING (COOL WHITE, OVER 500 LUMENS)	3.3	3.4	12.5	8.1	7.8
COMMERCIAL OFFICE: OMNIDIRECTIONAL LIGHTING (COOL WHITE)	1.8	–	5.9	21.5	–
RETAIL: LOW INTENSITY DIRECTIONAL LIGHTING (UNDER 500 LUMENS)	2.3	2.2	5.0	–	–
RETAIL: HIGH INTENSITY DIRECTIONAL LIGHTING (OVER 500 LUMENS)	3.4	3.5	6.9	–	7.8

Applications where average SSL payback periods are quick and extremely attractive are highlighted in green, modestly attractive in yellow, and least attractive in red.

LEDs offer the most compelling return on investment (ROI), we benchmarked them against the most prevalent conventional lighting solutions (incandescent, halogen, CFL, linear fluorescent, and metal halide) across three end-markets (residential, commercial office, and retail).

Given the specificity of products, CTA further subdivided each end-market by application: directional, low-intensity (under 500

lumens, the equivalent of a 50W incandescent); directional, high-intensity (over 500 lumens); and omnidirectional.

With the end-markets and applications established, we used purchase price, performance (total power, light output, and efficacy), and lifetime cost of operation (including electricity, bulb replacement, and maintenance costs) to calculate the payback periods for a representative group of LED products: 250 LED bulbs and fixtures from 23 leading vendors.

Besides the general availability of capital and the relative ROIs of competing ini-

» page 2

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tatives, payback period is often the most critical metric when evaluating upgrades to costlier lighting solutions. To calculate the payback period (in years) for any given LED fixture or replacement bulb, Cleantech Approach determined the time required to recapture the initial price premium (excluding user-specific installation costs) through associated operational cost savings. These operational cost savings included lower electricity costs from higher LED efficacies, as well as the absence of bulb replacement and lower maintenance costs from longer LED lifetimes. It should be noted that CTA's maintenance costs assumed a standard "screw in" replacement. Systems with more time consuming and costlier replacement requirements (e.g., the removal of paneling) would make the payback period even longer.

With this payback-oriented analysis, we isolated the end-markets, applications, and conventional solutions for which LEDs currently offer a compelling ROI, and equally important, where they do not (see table).

### Payback analysis

CTA's detailed report, which can be downloaded at [www.cleantechapproach.com/LEDsMagazine](http://www.cleantechapproach.com/LEDsMagazine), yielded the following four critical conclusions.

#### •Incandescent lighting

Compared with incandescent lighting solutions, LEDs offer a compelling payback period of 1.7 to 3.4 years.

On average, annual electricity costs for incandescent lighting solutions are four to six times greater and their bulb lifetimes are 4% to 5% of their LED counterparts. This yields an overall cost of operation that is 8 to 14 times greater and a payback of the initial LED price premium (7 to 62 times their incandescent counterparts) over 1.7 to 3.4 years. CTA's analysis suggests that paybacks are fastest (1.8 to 2.0 years) for directional, low-intensity applications; attractive (2.9 to 3.4 years) for directional, mid- and high-intensity applications; and surprisingly quick (1.7 to 1.8 years) for omni-directional applications.

#### •Halogen lighting

Compared with halogen lighting solutions, LEDs offer a compelling payback period of 1.7 to 3.5 years.

On average, annual electricity costs for halogen lighting solutions are four times greater and their bulb lifetimes are 4% to 6% of their LED counterparts. This yields an overall cost of operation that is 7 to 15 times greater and a payback of the initial LED price premium (3 to 10 times their halogen counterparts) over 1.7 to 3.5 years. CTA's analysis suggests that paybacks are fastest (1.7 years) for directional,

## The upfront cost of replacing incandescents and halogens can be recouped relatively quickly.

low-intensity applications, and attractive (2.7 to 3.5 years) for directional, mid- and high-intensity applications.

#### •Compact fluorescent lamps

Compared with CFL solutions, LEDs are bordering on competitive payback periods (4.5 to 6.2 years) in directional, low-intensity applications, but are uncompetitive in directional, high-intensity applications.

On average, annual electricity costs for CFL lighting solutions are 1.1 to 1.4 times (10% to 40%) greater and their bulb lifetimes are 11% to 17% of their LED counterparts. This yields an overall cost of operation that is 3 to 7 times greater and a payback of the initial LED price premium (4 to 8 times their CFL counterparts) over 4.5 to 12.9 years. CTA's analysis suggests that paybacks are fastest (4.5 to 5.3 years) for directional, low-intensity applications; uncompetitive (12.9 years in residential and 12.5 years in commercial office) for directional, high-intensity applications; and modestly attractive (5.9 to 6.2 years) for omni-directional applications.

#### •Metal halide or linear fluorescent

Compared with metal halide or linear fluorescent lighting solutions, LEDs offer an uncompetitive payback period of approximately eight years.

On average, annual electricity costs for metal halide and linear fluorescent solutions are roughly equivalent and their bulb lifetimes are 13% to 25% of their LED counterparts. This yields an overall cost of operation that is one to three times greater and a payback of the initial LED price premium over 7.8 to 21.5 years.

### Commentary

Overall, Cleantech Approach's report indicates that large energy savings can be realized by replacing inefficient lighting with more efficient LED solutions. These efforts will concentrate on replacements of standard incandescents and halogens (incandescent technology still represents over 60% of US lamp shipments). Moreover, the

report indicates that the upfront cost premiums of these solutions can be recouped relatively quickly (less than two years) through their associated electricity, replacement, and maintenance cost savings.

Accordingly, depending on the sentiment of their constituencies and the availability of capital, municipalities can make a strong case in favor of hastening the adoption of LED technologies through the creation of "green building" legislation and financial incentives for citizens.

Though the lack of available capital, lower occupancy rates, and the inability to recoup investment costs from tenants has slowed the pace of adoption in the current economy, the rapid pace of LED development will continue to lower costs and payback periods.

For those who are concerned about investing in the technology too early, Cleantech Approach recommends a phased approach of replacing fast-payback bulbs and fixtures to capture upfront cost savings now; other conventional bulbs and fixtures can wait until their associated payback periods fall into a more reasonable range. This approach can be implemented across the board from single residential owners to large commercial and retail facilities.

A complimentary copy of CTA's "Solid State Lighting: Benchmarking Report," containing detailed product analysis by application, is available to *LEDs Magazine* readers and can be downloaded from [www.cleantechapproach.com/LEDsMagazine](http://www.cleantechapproach.com/LEDsMagazine). Cleantech Approach will continue to cover developments in the lighting market through regular updates of its report. 