The Skinny on LEDs

With initial cost for bulbs coming down, there just aren't any good reasons left for not making the switch to LEDs

By Doug Walter

The promise of LEDs is that if you change your light bulbs today when your child is, say, starting kindergarten, they won't need to be changed again until he or she is a couple years out of grad school.

Commercial success stories abound, but what's the payback for the average homeowner? How can you justify paying three or four times the cost of a "normal" light bulb for this newfangled, strange-looking LED bulb, which you know little about? Many consumers can't see beyond the low initial cost of incandescents, ignoring the energy payback and replacement cost savings inherent in LEDs. It's time to change that thinking.

When I started doing the math for light bulb operating and replacement costs, the results floored me. I thought payback may occur in three or four years, but if you're replacing incandescent or halogen bulbs, in most cases you can recover your increased investment *within the very first year* (see "What's the Payback?" on page 48). After that, there are at least a dozen additional years of pure savings. Bernie Madoff couldn't have gotten away with promising anywhere near that return on investment.

Are incandescents bad? No, they're not bad, they're *horrible!* Why would you cling to a lighting technology that delivers just 10 percent of the energy used as light and converts the rest to heat? An incandescent bulb is really just a very expensive and inefficient space heater. We cling to them because they're what we know. But it's time that we learn some new "tricks."

What about fluorescents? Flourescent bulbs arrived on the scene commercially in the 1940s and took off in the 1950s, especially in offices, schools, and institutions, mostly because they were three to four times as efficient as incandescents. Eventually, they worked their way into homes. The sole light source in the kitchen of our New Jersey home in the 1950s was an unshielded circline fluorescent. (Maybe that's why I'm so obsessed with good lighting today.)

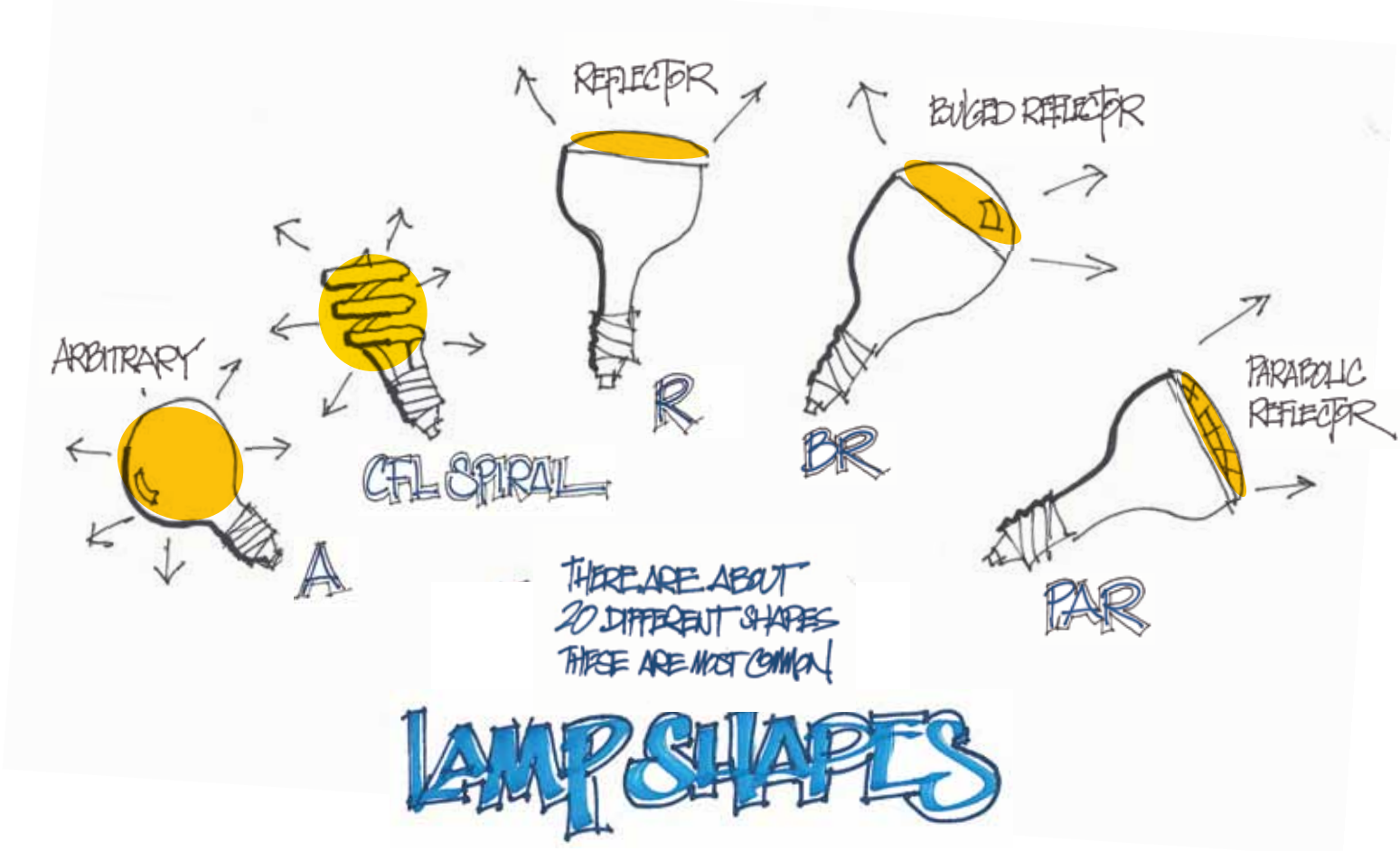
Personally, I think fluorescents of all types, including CFLs, will be gone within five years because LEDs outperform them in so many ways. For starters, fluorescents take time to reach operating temperature and full output. Plus, cold weather and frequent switching reduce lamp life, and it's difficult to find dimmable models. Fluorescents also contain a little bit of mercury, a known toxin, which means that a broken bulb poses a health threat, and even an intact bulb is a disposal problem. There are also lingering concerns about slow flickering from old or malfunctioning fluorescents triggering epilepsy.

Did I mention poor light quality? I've used fluorescent recessed fixtures (R lamps—basically a CFL inside a reflector) on only one kitchen project, but I wasn't happy with the light quality and went back to halogen. I still use fluorescent tube fixtures in garages, basements, laundry rooms, and closets, but I suspect that within a year there will be several good LED equivalents available (Costco already has one). All that has prevented the substitution so far has been the price difference.

Cost & Risk of Relamping

One aspect in the LED debate that has so far received little attention is the safety of the light source itself. Skin starts to burn at about 140°F, but standard incandescents can easily reach 200°F. CFLs are a bit better, reaching about 160°F, but an MR16 halogen accent light, used widely in decorative pendants and lamps, burns at a scorching 400°F. LEDs, by comparison, run at a relatively cool 120°F. If I had toddlers or a live-in senior parent, I wouldn't hesitate to choose safer LED bulbs on this basis alone.

Hard-to-reach fixture hazards. Another often-overlooked but very real safety issue is the difficulty in replacing some light bulbs. This point



was driven home to me when I had to accompany my mother-in-law to the emergency room to get a gash on her leg stitched up after she slipped off the chair she was standing on while trying to replace a burned-out bulb.

Hard-to-reach fixtures aren't just a problem for seniors. Many newer homes have grand entrances with 18-foot-high ceilings or vaulted staircases or family rooms. In many cases, some genius decided to light those spaces with recessed cans. When it comes time to relamp them, you have two choices: hire an electrician with a really tall ladder or scissor lift, or invest in a wobbly aluminum extension pole with an attachment on the end that you will use to try to grab the burned out lamp without breaking it off in the socket. (If you fail at this arcade-like game, you will need to hire an electrician with a really tall ladder. ...)

I talked with Sean Howell, owner of Advantage Electric, in Denver, who has seen plenty of smashed lamps and trims knocked loose by homeowners with poles. He has stepladders up to 24 feet tall, but to safely erect them, it takes three men, so a service call like this would run about $300. For more extensive relamping, Howell brings out his own scaffolding, but he says homeowners should "plan on a $700 or $800 bill for that." Hmm. You could buy *a lot* of LEDs for that kind of money!

Howell also told me that he offers an LED alternative. "But on the service side, there's not much buy-in," he adds. "[Homeowners] will wait until the last one burns out to call me. I find that people who are building new are more open to the LED conversation."

There are literally dozens of bulb shapes; these are just the most common ones we deal with. Although you can buy recessed cans that are optimized for A lamps, the light still blasts out in every direction instead of mostly down, which is where you need it. The solution: "reflector" lamps, which decrease in beam width from BR to R to PAR to better direct the light. Only a PAR bulb will avoid glare in a recessed fixture, which is why you should avoid recessed cans for ambient lighting. This is also the advantage of a dedicated LED fixture or screw-in retrofit LED kit: The homeowner can't mess it up by replacing a carefully chosen but burned out PAR lamp with a spiral CFL that has none of the characteristics you planned.

Type & Color Temperature Matter

My guinea pig for this article was a colleague, intern architect Don Gibson, who happened to mention to me that his kitchen lights were burning out too frequently. And so, on a recent lunch hour, off we went to the lighting aisle at The Home Depot to learn about new lamp technologies.

The vast array of offerings is a bit overwhelming, so I suggested that we start by finding the bulbs that he currently uses. He picked up a Philips halogen BR 30, which uses 65 watts to put out 620 lumens; it has a 2,700K color temperature, a lamp life of 2.3 years, and a price

BULB TYPE	LED	CFL	HALOGEN	INCANDESCENT
	PAR 30	PAR3 0	PAR 30L	BR 30
COST (EACH)	$15.97	$7.66	$9.47	$3.99
LUMENS	750	630	620	950
LAMP LIFE (YEARS)	13.7	5.5	2.4	1.4
WATTS	10.5	15	50	65
ANNUAL USE (HOURS) *	1,825	1,825	1,825	1,825
ANNUAL KWH USED	19.2	27.4	91.3	118.6
COST/KWH *	$0.115	$0.115	$0.115	$0.115
ANNUAL ENERGY COST	$2.20	$3.15	$10.49	$13.64
13-YEAR COST OF BULBS	$15.97	$22.98	$47.35	$39.90
13-YEAR OPERATING COST	$28.65	$40.93	$136.42	$177.34
13-YEAR TOTAL COST	$44.62	$63.91	$183.77	$217.24

* GOVERNMENT-MANDATED "LIGHTING FACTS" ON LED PACKAGING ESTIMATES 3 HOURS OF USE PER DAY AND 11 CENTS PER KWH

WHAT'S THE PAYBACK?

The table at left compares initial cost and operating expense for a single LED PAR 30 bulb with the equivalent CFL, halogen, and incandescent bulbs. Given that many of the numbers used here are more conservative than those in the government-mandated "Lighting Facts" table found on lamp packaging, this table represents a "worst case" scenario.

For example, bulb life for LEDs is typically based on 3 hours of use daily; I believe that 5 hours is a more realistic number. The cost of electricity also varies widely geographically. I've used current cost in Denver, where I live, but the national average is about 12 cents per kWh. Idaho is lowest at 8 cents; Hawaii, highest at 33 cents,

of $3.99 each. The LED version was a Philips BR 30 65-watt equivalent, using 9.5 watts to produce 730 lumens; the price was $16.97.

But a BR 30 has an extremely wide spread of about 75 degrees (see "Lamp Shapes," on page 47), so it has much more potential for glare and doesn't deliver enough foot-candles (fc) to the countertop (20 fc, more or less, in an 8-foot ceiling). As an alternative, I suggested the Philips PAR 30 LED, which has a tighter beam spread (about 30 degrees) and delivers about 39 fc to the counter. This lamp uses 10.5 watts and puts out 750 lumens, with a 3,000K color temperature and a lamp life of 22.8 years. The price (gulp!): $22.97 apiece.

The next morning, Don reported that he very much liked the neutral whiteness of the LED, but that his wife preferred the warmth of the old halogens. So after living with the 3,000K LED over the weekend, he headed back to the store on Monday to swap it for a 2,700K version. He borrowed my light meter and reported that the LED delivered 37 foot-candles to the work surface—coincidentally, that's about 37 percent more than the 27 fc delivered by the BR 30 that he had previously been using.

Name brands vs. off brands. A recent report I saw from a British trade publication talked about a shipment of LEDs that was seized by customs. Three-quarters of the bulbs tested were found to be unsafe or noncompliant with European energy regulations. The takeaway here: Stick with brands you know. These manufacturers have reputations to uphold and will be around to honor their warranties. Also, name brands use "binning," a process that groups like-color outputs together. It adds cost, but it creates more consistent color lamp to lamp.

The truth about dimming. I'm a huge fan of dimmers, whatever the light source. I think it is far better to "over-light" a space and provide dimming than it is to under-light a space. In my last kitchen remodel, we had five circuits of lighting, and the only ones that we typically ran full-strength were the decorative pendants and undercabinet fluorescents. Everything else usually ran at about half-strength.

If LEDs have a downside, dimming is it. John Quade, senior lighting consultant with MH Lighting, in Denver, says, "If you thought dimming fluorescents was complicated, try dimming LEDs." According to Quade, phase-cut dimming works well with resistive loads such as incandescent or halogen, but not necessarily as well with electronic loads like CFLs or LEDs. Consequently, sophisticated LED dimmers often cost more than standard dimmers, even though they are the same size. (They also run cooler because they handle far less load.)

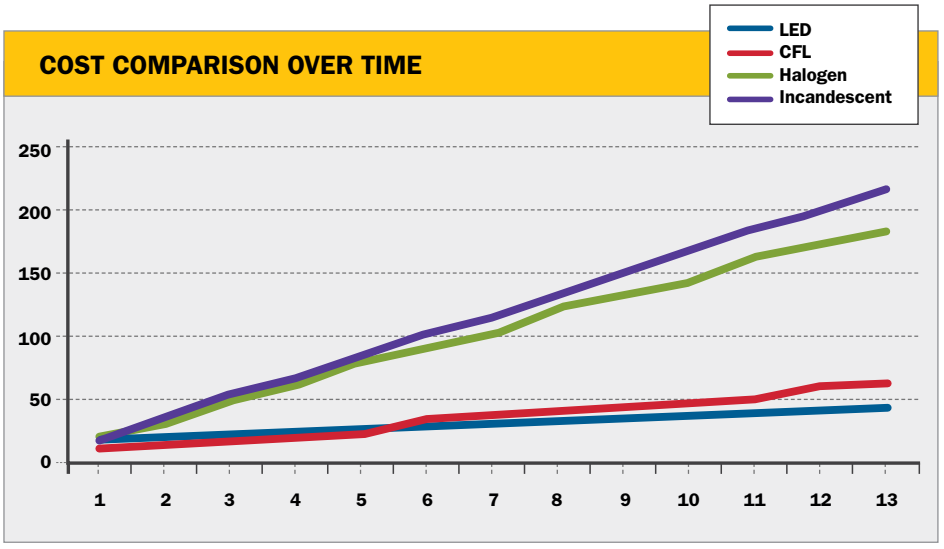
In addition, not all dimmers designed for LEDs will work with all types of LED lamps. The problem seems to be confined to dedicated LED fixtures.

Advantage Electric's Sean Howell has seen plenty of problems with dimmer compatibility, but says, "Fortunately, most LED replacement lamps you buy are very compatible with incandescent dimmers." But, he adds, it's important to make sure that the lamp says it is "dimmable" and to what extent. Most LEDs dim nicely down to 10 percent but may not go to zero, like an incandescent bulb can.

with many states, such as New York, at around 18 cents. Obviously, the higher the rate per kWh, the quicker the payoff for LEDs.

Keep in mind that the costs shown here apply to just one bulb of each type. But the average new home or whole-house remodel uses nearly 100 surface or recessed fixtures. When I do that math, the savings over halogen or incandescent bulbs is about $16,000 over the 15,000-hour (13.7-year) estimated life of the LED. The savings over CFLs—which are second only to LEDs in efficiency and bulb life—is about $4,000.

But remember, that the 15,000-hour LED bulb life estimate is itself conservative. In a fixture specifically designed for LEDs, bulbs can last two or three times longer (40,000 to 50,000 hours).



The table (opposite) compares initial expense and annual operating cost for one bulb of each type. The graph above compares total cost over the 13-year estimated life of an LED bulb. Costs include 1 LED and initial and replacement costs for 3 CFLs, 5 halogens, and 10 incandescents.

The Hybrid Solution

For several years now, remodelers have been specifying standard incandescent recessed cans but equipping them with screw-in LED lamps. And until recently, that's exactly what I have been doing.

But there are two problems with that approach. First, it shortens the life of the lamp. LEDs already last a long time—about 15,000 hours (13 years at 3 hours per day). However, lighting manufacturers have told me that this estimated lifespan is deliberately conservative because they don't know the heat-dissipation characteristics of the fixture it will be used in. So if you were to specify a dedicated LED fixture, which has the lamp built in, the rated hours jump to 40,000 (about 36 years) or more. That's because the entire fixture has been engineered to optimize lamp life and performance.

The second problem is that when it comes time to relamp a standard recessed fixture, the homeowner might not know or be able to find the correct replacement. If your carefully chosen LED spotlight gets replaced with an A lamp or a CFL, it undermines the photometrics intended in the original design.

A better solution: plug-in modules. To accommodate the millions of recessed cans currently in use, manufacturers have developed LED modules that screw into a standard Edison base. I saw four brands at The Home Depot, with prices between $17 and $29.

For example, a Halo retrofit baffle with a built-in LED fits 5- or 6-inch recessed cans. It installs easily and converts the can to an airtight, IC- and shower-rated unit. As a bonus, it's rated for 50,000 hours—triple the rating of screw-in LED replacement lamps. The HALO retrofit baffle is available with LED lamps in 2,700K, 3,000K, 3,500K, and 4,000K color temperatures, and a CRI (Color Rendering Index) rating of either 80 or 90, depending on which model you choose.

Stop Making Excuses

Good lighting is subjective; what works for me may not work for you (or your spouse). If you haven't had real-world experience with LEDs, I recommend that you first experiment, the way Don did.

Pick up three or four LED bulbs that you think may work. Where you shop matters. The big-box stores have a broad selection, and a lighting showroom will have live dedicated LED fixtures on display. Choose several color temperatures between 2,700K and 3,500K.

Back home, try for a side-by-side trial by replacing your kitchen incandescents with the LEDs (save the packaging because some of them are going back). You can even use a free light-meter app on your smartphone to compare light levels. Live with the new lamps for a weekend, keep your favorite, return the others, and buy more of the winner. If the bulbs perform as advertised, you won't have to buy lamps again for at least 13 years. But save the receipt; every now and then an LED experiences early failure. **PR**

Doug Walter is senior architect at Godden/Sudik Architects, in Centennial, Colo. An active member of the NAHB, AIA, NKBA, and the Illuminating Engineering Society, Doug has specialized in residential remodeling since 1979. He currently manages from 15 to 20 clients at any one time, all of whom need major upgrades to their lighting.