Trading Up

A strategic approach that avoids the pitfalls of the CFL launch will be needed if LED replacement lamps are to dislodge incandescents in residential applications

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California will soon embark on a new round of aggressive energy efficiency programs, including rebates and incentives aimed at encouraging the market uptake of new lighting technologies. The new incentive programs will address the deep efficiency goals set through California’s Strategic Energy Plan and the Huffman Bill. Also known as the Lighting Efficiency & Toxics Reduction Act, the Huffman Bill tasks the California Energy Commission with reducing lighting energy consumption in California homes by 50 percent by 2018, considering a 2007 baseline.

LED Edison-base lamps are now seen as the prime candidate for achieving the bulk of this residential goal, but if LEDs are going to achieve long-term market penetration, they must perform as well as their incandescent predecessors—or better—in terms of color quality characteristics, longevity and dimmability. And they absolutely must do better than CFLs have. To truly transform the residential lighting market, we need to evolve a national lamp specification for LEDs, one based on thorough research of consumer preferences and focused more on amenities and less on energy efficiency.

In addition, the industry would be wise to learn the lessons of the CFL launch.

PORTRAIT OF A DOOMED ROLLOUT

When CFLs debuted on the market, energy agencies and efficiency advocates locked onto it as the single best path to residential energy savings, and the CFL became the poster child for the greening of America. It was certainly a great vision, and a good goal, considering that our homes were then almost exclusively illuminated with incandescent lamps—15-lumens-per-watt heaters that haven’t substantially changed since Edison’s era. At 50 lumens per watt, CFLs would, and should, have given us impressive national savings...if only consumers had bought them. But they didn’t. After more than 25 years, the CFL has achieved a national adoption rate of only 10 to 20 percent, despite extensive efforts and a substantial investment of public funds to promote greater adoption. The dollars spent in this country per kilowatt (kW) actually saved with CFLs seem to eclipse any other lighting energy-efficiency program in our history.

The sad reality, however, is that most of this savings has been squandered in a backlash of consumer dissatisfaction stemming from poorly considered performance aspects, such as color and longevity. No well-constructed studies exist to indicate or demonstrate the numbers of sockets that experience a second and possibly third relamping with CFL, the real indicator of market transformation, demonstrating positive consumer experience and justifying further public investment.

In the rush to get CFLs into American homes, energy agencies, environmental groups and their advisors focused heavily on cost as a barrier to widespread market penetration. They rolled out aggressive programs to distribute low-cost CFLs. This, in turn, drove the industry to focus on lowering product costs, often compromising longevity and color quality in the process. High color rendering and enhanced phosphors for color brilliance are expensive, and they reduce efficacy, which, unfortunately, wasn’t subject to compromise. A 40-lumens-per-watt CFL lamp with great color could ultimately have been better than a 50-lumen-per-watt CFL lamp—if the difference had made them popular with consumers.
When CFLs failed to deliver the life, color, quality, and amenity that American consumers have come to expect, many buyers became wary. This is a very important issue that must be addressed in developing and marketing LEDs if we are to avoid making the same mistakes made with CFLs. Recent attempts to educate the consumer on what’s inside the package don’t really change the fact that the product may or may not have the color and quality performance attributes that consumers want. Our current standards and specs have been based on establishing minimum performance criteria, and in the absence of strict enforcement, have resulted in a plethora of poor products. We must make sure we do not repeat the same mistake.

ON THE RIGHT PATH

In May the California Public Utilities Commission issued a decision requiring the California Energy Commission to create a quality-based specification for all future rebate incentive programs directed at Edison-base retrofits. This sets a significant precedent by linking efficiency programs with product quality standards and recognizing lighting quality as a prerequisite for real market transformation.

In support of this directive addressing quality standards, the California Energy Commission and state utilities are supporting a research effort aimed at better understanding consumer preferences related to color, longevity and dimming in residential settings. The California Lighting Technology Center (CLTC) has begun work with its industry and utility partners to establish the initial framework, protocols and structure for these consumer-based research studies.

CLTC has also partnered with the Collaborative Labeling and Appliance Standards Program (CLASP), an international nonprofit, to test LED replacement lamps for quality characteristics that influence consumer satisfaction. The project is aimed at helping the California Energy Commission develop a voluntary, quality-based performance specification for these lighting characteristics, including color appearance, light uniformity and dimmability. In addition to generating the broad data set needed to guide future standards and rebate programs, CLTC will also develop a test methodology for measuring the performance of LED replacement lamps.

These are important first steps, but an enhanced specification alone will not be as effective as a comprehensive strategy, including a national lamp specification based on solid research.

NEXT STEPS

We need to better understand consumer needs and preferences for lighting. First we must establish well-thought-out protocols and studies that reveal needs and prefer-
ences, addressing broad issues of color spectra, intensity and light distribution. This will mean engaging institutions and organizations conducting relevant research in human factors science. Additionally, subtle issues associated with shape, packaging and distribution need to be better understood in terms of what people want in their homes, and not just what they will tolerate. Clearly, circadian rhythms for better health and well-being. This may be the true value that will move consumers toward LEDs, assuming LED light sources also do well in color rendering and longevity. Parents, for instance, might be willing to pay more for lighting technologies that not only allow them to enjoy the visual aspects of their homes, but also help their children sleep better during the night and study more effectively during the day. The same is already true for air filters, water filters, ergonomic bedding and other amenities that offer improved comfort, health benefits and peace of mind.

Based on research of consumer preferences, and, ideally, our biological needs as they relate to lighting, we can develop clear, unambiguous lamp specifications that address the following core issues:

1. **Color brilliance.** This is essentially how all colors are rendered, not just discrete samples. Both CRI and CQS are based on a limited number of color samples. We should focus more on proposed color rendering metrics that use extensive color sampling across the complete color gamut to ensure effective characterization for color rendering performance. We need the same or better performance than incandescent technologies; almost the same, with wide variations across brands, isn’t good enough.

2. **Light color appearance.** The color of the light itself is very important in residen-

tial applications. Consumers ask themselves: How does my skin look under this light? How about the art on the living room wall, or the food on the dining room table? Again, color appearance can also have a significant impact on circadian function and human health—yet another reason to set standards for this aspect of lamp performance.

3. **Light color uniformity.** Light needs to appear consistent from the same lamps in a space, especially when used in groups, as with downlights, sconces and table lamps. The human eye is very good at discriminating small light color variations between lamps. This may be tolerable in lighting garages, but certainly not when lighting dining and living rooms. The specification should include consideration of perceptible variations in color appearance between samples of the same LED lamp types.

4. **Dimmability.** People like to dim lamps and, based on their experiences with incandescent lamps, they expect smooth dimming without flicker or drop in blue content. Dimming also is a very promising way to save energy. Dimming is common in most new homes, and it’s a typical upgrade in renovations. Consumers have had bad experiences with CFL dimming, and we must ensure we do it right with LEDs.

5. **Longevity.** This is perhaps the most important underlying issue in why America has become disillusioned with CFLs. We have catch-up work to do here as we have created enormous suspicion within the consumer marketplace by promoting long life then falling short. Complicated testing and labeling pro-

We have created enormous suspicion within the consumer marketplace by promoting long life then falling short. Complicated testing and labeling programs won’t easily overcome a marketplace flooded with short-life products.
grams won’t easily overcome a marketplace flooded with short-life products. Consumers were promised long life, and we failed to deliver. Many CFLs failed to deliver longevity because of heat-related failure of the electronics that drive them, such as in downlights with vertical sockets that trapped the heat in the area of the CFL base that houses the heat-sensitive electronics. LEDs also are sensitive to heat, and their life is reduced significantly when they operate in hot environments.

6. Circadian rhythm effects. We have evolved over millions of years with no exposure to high levels of blue light at night. This has changed dramatically with the introduction of incandescent alternatives, which use radiation in the blue part of the spectrum to produce white light, either mixing it with radiation in the green and red parts of the spectrum, as in CFLs, or to excite phosphors, as in white LEDs. The absence of blue light at night is most important for our health and well-being and needs to be carefully considered in light sources intended for residential applications.

NATIONAL EFFORT

As specifications are developed, we must also refocus our efforts on defining real and measureable national goals for lighting efficiency and developing coherent strategies to realize those goals. “Measurable” is the operative term here, as we need to evaluate the success of these strategies, particularly with large public investments potentially at stake. These goals should be tied to timelines with strong incentives for industry and marketplace action. Establishing and achieving real energy reduction goals and deliverables is vital. The climate of vaguely defined goals and shifting priorities at a national level, coupled with the lack of any real oversight, has insulated efficiency programs from achieving any long-term market transformation, as no real incentives exist to push toward real change.

We also have a lot of damage control to do in convincing American consumers that the next generation of residential lighting technologies is going to be better than the last. Even when we have better technology, most consumers will be highly suspicious of both government and industry claims. Ideally, the product should be as good as, or better than, incumbent technology, but the reality is that it will be more expensive, and this difference needs to be addressed directly through clear and insightful consumer education efforts. We need to research this message carefully, so the value of good lighting will be clear to consumers.

Finally, we need to engage in a positive codes and standards effort, one that seeks to provide leverage and encouragement to a well-crafted, consumer-oriented specification for lamp products, built on solid research. Collectively, the energy-efficiency community, which includes federal and state agencies, regulatory bodies, utility organizations, and efficiency advocacy groups, has been reluctant to invest in the research needed to develop a fundamental, evidence-based understanding of consumer lighting preferences and product performance, but this understanding is desperately needed to support long-term market transformation in residential lighting. Without a forward-thinking, solid commitment to real change, and a research-based understanding of consumer lighting preferences, we risk repeating a whole host of costly mistakes and weakening our progress toward our climate change and energy independence goals.

With an explosive array of LED technologies and products entering the marketplace, uninformed enthusiasm from federal agencies will leave consumers overwhelmed and confused. Worst of all, the public could also be disappointed (yet again) by a light source that saves energy but fails to win them over in terms of lighting quality and amenity. We are currently at the very beginning of one of the largest market transformation events in history. Americans will eventually welcome LEDs into their homes as they recognize the new technology’s advantages over incandescent and CFL lamps. The question today is not whether it will happen, but when it will happen, and, most important, how difficult and expensive the process will be for Americans, as consumers and as taxpayers. If we want LED lamps to succeed sooner rather than later, then now is the time to invest in research.

Editor’s Note: The authors’ white paper, “Relighting American Homes with LEDs,” is available online at http://cltc.ucdavis.edu/images/documents/publications_reports/Relighting_American_Homes_with_LEDS_Siminizvich.pdf.

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