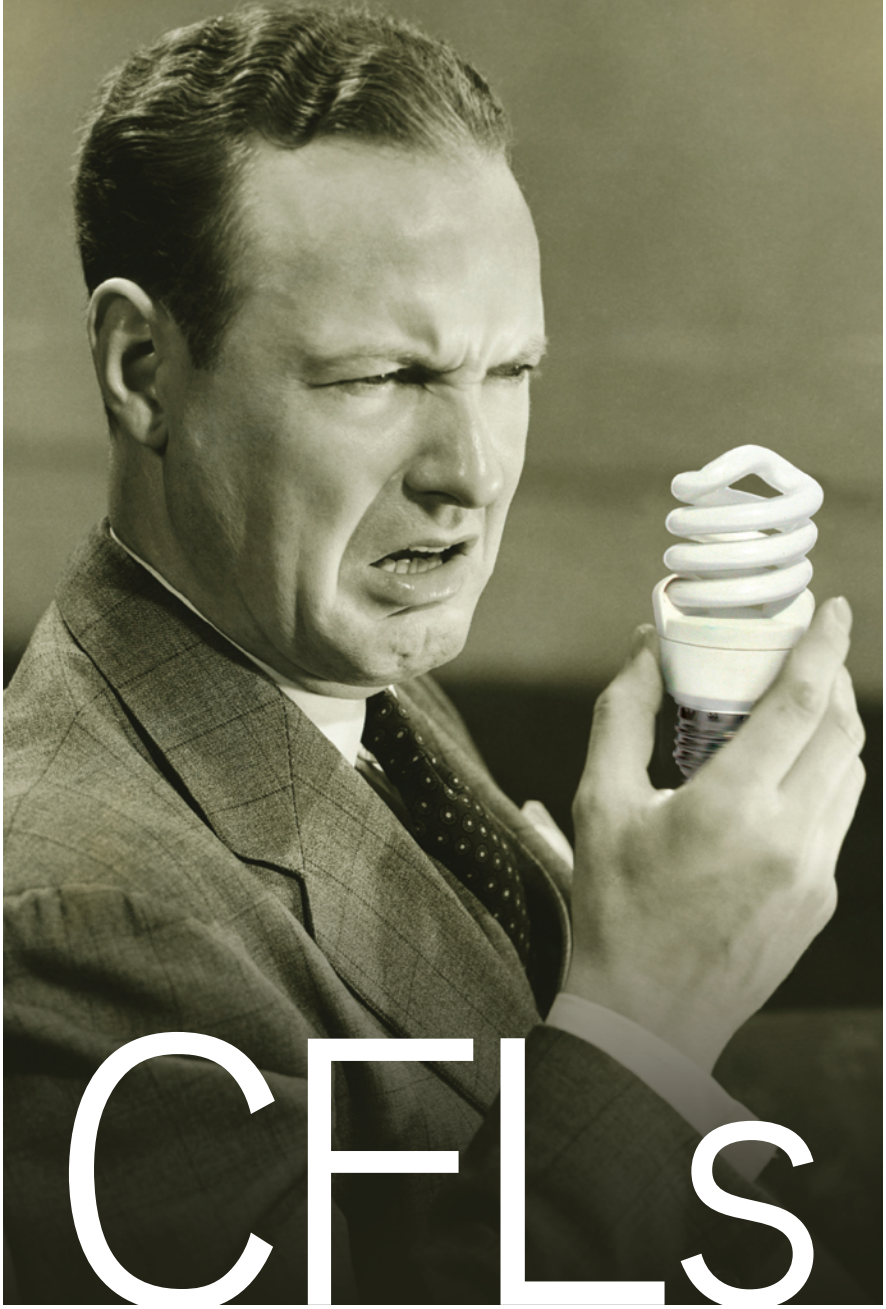

CFLs IN AMERICA: LESSONS LEARNED ON THE WAY TO MARKET

The burgeoning solid-state lighting community can learn much from compact fluorescent's rocky road to consumer acceptance

BY JAMES BRODRICK

More than 30 years after compact fluorescent lamps (CFLs) were first introduced, they are only recently starting to gain a significant share of the U.S. lighting market. Why such slow market acceptance of a product that lasts up to 10 times longer than standard incandescent bulbs and uses at least two-thirds less energy to provide the same amount of light?

A recent report from the U.S. Department of Energy (DOE), *Compact Fluorescent Lighting in America: Lessons Learned on the Way to Market*, provides an analysis of the market introduction of CFLs, with an emphasis on identifying lessons that could be applied to the introduction of other new lighting technologies, such as solid-state lighting (SSL).

The DOE report, prepared by Pacific Northwest National Laboratory (PNNL), is based on:

- Extensive review of CFL literature, including utility program evaluations and market assessments;
- Interviews with CFL manufacturers regarding their experiences with CFLs, and how those experiences might apply to the market introduction of SSL technology for general illumination;
- PNNL's own experience with DOE's CFL market introduction programs.

NOT QUITE READY FOR PRIME TIME

Key findings from the report offer clear lessons for the SSL industry, utilities and government and pri-

vate-sector energy efficiency programs. The first lesson, in a nutshell, is that the early CFLs were simply "not quite ready for prime time." For one thing, ordinary fluorescent lighting, a precursor to CFLs, had gained a bad reputation for emitting light that was harsh and unattractive and for its tendency to buzz and flicker. Thus, in the consumer's mind, "fluorescent" became associated with eye strain, noise, greenish skin tones and institutional settings. CFLs not only inherited this bad reputation, but magnified it with numerous faults of their own.

For starters, early CFLs were very expensive compared with incandescent bulbs, with retail prices of $25 to $35 per CFL bulb common in the mid-1980s. In study after study, consumers pointed to price as their number-one obstacle to purchasing a CFL. What's more, due in part to various promotions carried out by utility companies, CFL prices varied widely. A 1997 study conducted by Southern California Edison found that the same model of CFL at five different stores carried five different prices, ranging from $6.97 to $19.99. This wide variation in price made it difficult for consumers to put a value on the new product.

Another major problem with CFLs involved size and fit. In 1990, they were still so big and bulky that consumers found they had to replace lampshades and make other modifications to make the bulbs fit in some fixtures. A 1993 study showed that even with modifications, CFLs still wouldn't fit in more than 60 percent of the fixtures in an average home. On top of this, there were various performance issues, which included humming, buzzing and flickering; delayed start; lack of dimmability; problems in outdoor settings; plus the fact that CFLs didn't emit enough light and also gave poor color rendition—that is, they made colors look "off." As if this weren't enough, they were also subject to early bulb burnouts, which was especially vexing in light of the claims that CFLs had longer life than ordinary bulbs. Because of all this, it's hardly surprising that many early consumers who installed CFLs ended up removing them.

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MARKETING PROBLEMS

The early technological problems and limitations of CFLs were compounded by a number of marketing problems. Chief among these was the widespread early confusion about CFLs, their use and their advantages. A 1995 survey by Philips found that 42 percent of consumers didn't know the difference between incandescent and fluorescent bulbs. Some consumers expressed concerns about the safety of CFL lighting in general and its potential impacts on their health. Many were unaware that CFLs could be used in typical incandescent fixtures, and most were unsure about the distinction between the terms "watts" and "lumens," and thus did not appreciate how much energy CFLs could save and how long they lasted. Even as late as 2006, "lumens versus watts" was still a confusing issue for consumers, with many of them wondering if they could replace incandescents with lower-wattage equivalent CFLs.

Adding to the confusion was the fact that some consumers who had already tried CFLs weren't even aware that they had done so, owing to the lack of a common name. Various manufacturers referred to CFLs as CFBs, SL-lamps, triple tubes, biax bulbs, triple CFLs, triple biax lights, quad tubes, Earth Light SLs, cf bulbs, SL-lamps and PL-lamps. According to a 1994 study presented at the American Council for an Energy-Efficient Economy (ACEEE) Summer Study, lack of consumer awareness and misperception about CFL performance, along with lack of retail availability, may have proven bigger obstacles to CFL adoption than physical limitations.

This misinformation and lack of awareness on the part of consumers was mirrored by retailers. A 1992 Electric Power Research Institute study of lighting retailers found that many saw CFLs as a temporary technology that would be replaced by something else within the decade, and that chain-store lighting department managers were no more knowledgeable about CFL technology than were their customers. Five years later, a study by the California Energy Commission found that the majority of retailers regarded CFLs as having low light output and other negative characteristics, such as humming noises and poor light color. There was no awareness of the major changes that had occurred to address these problems.

In a 1999 report on the Northwest LightWise program, 60 percent of the retailers interviewed said they still didn't feel they had enough information about CFLs to adequately sell the product. Overall, they felt unprepared to explain CFL benefits, wattage conversions and so forth. So it's not surprising that they didn't devote much shelf space to the new technology. A 1999 Natural Resources Defense Council (NRDC) report noted that even in parts of the country where utilities had funded efficient residential lighting programs for nearly a decade, CFLs still occupied only 4 percent to 7 percent of the retail shelf space for household light bulbs, and less than that in grocery stores. A 1998 evaluation of the LightWise program for the Northwest Energy Efficiency Alliance found that many retailers did not stock CFLs on a year-round basis, mainly because they didn't see the product as profitable and thus were hesitant to devote the necessary shelf space in their stores.

As if these missteps in marketing CFLs weren't enough, some manufacturers exaggerated life-span claims for the product, and some overstated equivalency claims comparing CFLs to incandescent bulbs–for example, saying that a 13-W CFL was equal to a 75-W incandescent bulb. Not surprisingly, consumers weren't satisfied with the light output of the CFL. In addition, the product wasn't easy to find, as CFLs weren't sold in grocery stores and other outlets where people normally bought light bulbs. And where they were sold, they were rarely displayed in use as a way to address consumers' natural wariness of new technology.

SSL: The Anatomy of a Product Launch

Successful market introduction of SSL products depends on the ability of government, industry, utilities, energy-efficiency programs and others to incorporate lessons learned from CFLs into their future plans. DOE is assisting this process in a number of ways, as part of its comprehensive commercialization support plan for SSL:

- LEDs differ significantly from traditional light sources, and new test procedures and industry standards are needed to measure their performance. DOE provides leadership and support to accelerate the standards development process, facilitating ongoing collaboration among standards-setting organizations and offering technical assistance in the development of new standards. Significant progress is being made, and new standards are scheduled to be issued in 2007. See *www.netl.doe.gov/ssl/standards_dev.html* for more information.
- Energy Star is a voluntary energy-efficiency labeling program that helps consumers to identify products that save energy, relative to standard technology. In December 2006, DOE released draft Energy Star criteria for labeling SSL products for general illumination. The draft specification is currently in review; see *www.netl.doe.gov/ssl/energy_star.html* for more information.
- To provide reliable, unbiased product performance information, DOE conducts independent testing on commercially available SSL products. The test results guide DOE planning for Energy Star and technology procurement activities, provide objective product performance information to the public and inform

Small wonder, then, that the bad reputation CFLs earned at the outset has been hard for them to overcome, and early consumer experience still defines today's attitudes, even though the technology has greatly improved since CFLs were first introduced.

FUTURE ROADMAP

Based on the experience with CFLs, the DOE report identifies a number of lessons learned that provide a roadmap for the market introduction of SSL technologies for general illumination. DOE has structured its SSL commercialization support activities to heed the following lessons:

Smart timing, coupled with credible information, are the keys to minimizing the kind of market disaffection that plagued CFLs. Early-model CFLs were "not quite ready for prime time," with a host of technical challenges–including bulkiness, low light output and inconsistent performance that compared unfavorably with incandescents, especially considering the price premium. As a result, many consumers were disappointed with their first experiences with CFLs, making them reluctant to buy them again and leading to negative word of mouth.

While market introduction of SSL–like CFLs–is likely to be marred by less-than-perfect consumer experiences that will dampen demand to some degree, DOE will provide consumers, utilities, retailers and other stakeholders with the credible information needed to clearly distinguish quality factors, through Energy Star labeling, independent testing, demonstrations and support for industry standards and test procedures. DOE's SSL commercialization support activities are closely coordinated with research progress to emphasize appropriate application of SSL products and to avoid buyer dissatisfaction and delay of market development.

The right education and promotion can make a significant difference. While CFLs still have only about 2 percent of the national market share in terms of sockets in use (**Figure 1**), they have achieved higher market penetration in California (as much as 8.5 percent) and the Pacific Northwest (as much as 12 percent), both of which are areas that have been proactive in consumer education and promotional programs for many years. CFL ex-

the development and refinement of standards and test procedures for SSL products. To request detailed test reports, visit *www.netl.doe.gov/ssl/comm_testing.htm*.

- DOE's Technical Information Network shares information and updates on SSL technology, performance and appropriate applications with builders, retailers, lighting contractors, building owners and managers and others. The network—comprising energy-efficiency program sponsors, utilities, lighting researchers and designers and others—will meet regularly to share technical information about SSL and to provide feedback from the market on market needs and barriers. To stay apprised of Technical Information Network activities, see *www.netl.doe.gov/ssl*.
- Recognizing excellence in energy-efficient residential light fixtures is the purpose of the "Lighting for Tomorrow" design competition, sponsored by DOE in partnership with the American Lighting Association and the Consortium for Energy Efficiency. In 2006, a solid-state lighting competition was added to the existing program, which focused on CFLs. Learn more about the 2007 competition at *www.lightingfortomorrow.com*.
- In 2007, DOE will begin demonstrations of SSL products in appropriate applications, both residential and commercial. DOE will verify performance of the selected SSL products, including measurement of energy consumption, light output, color consistency and interface/control issues. Demonstration results will inform DOE technology procurement activities and provide buyers with reliable data on product performance. For ongoing updates on DOE SSL demonstrations, visit *www.netl.doe.gov/ssl*.

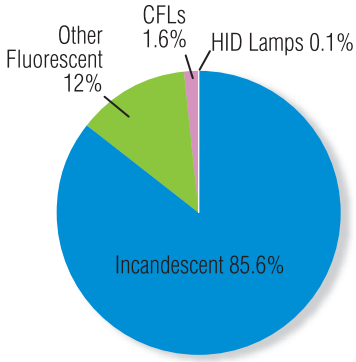

Figure 1. 2002 Market Share By Sockets
Source: Ecos Consulting

perience suggests that consumer education and promotional efforts should 1) be sustained over several years; 2) include training for retailers and other key purchase influencers; 3) use media campaigns, public events, rewards and other vehicles to build awareness of SSL technologies; and 4) avoid the logistical pitfalls and negative misperceptions associated with some CFL approaches (e.g., giveaways or deep discounts that condition consumers against full-price purchases).

DOE will support educational and promotional programs by contributing technical expertise and information for programs targeting end users and marketing influencers (e.g., training for retailers, builders, lighting designers and students). The Department also will assist in planning educational and promotional activities with "market transformation" partners (utilities, state energy offices and regional energy-efficiency organizations) who will have the primary role in implementation.

Collaboration reduces consumer confusion. The wide disparity of energy-efficiency program specifications for CFLs caused confusion and complication. The DOE report recommends that manufacturers and energy-efficiency groups coordinate to establish minimum performance requirements for SSL, and that manufacturers join forces in national energy-efficiency programs such as Energy Star. Nationally coordinated programs work well, since expenses are lower and market signals are clearer.

Performance is more important than appearance. Although early market research indicated that consumers wanted CFLs to look similar to an incandescent lamp, they eventually were very accepting of the "twister" style lamp, which looks very different from the standard light bulb. These "twister" lamps delivered sufficient light output, attractive color and fit most standard fixtures. This is an important lesson for SSL, since the emerging products do not look like a standard light bulb. CFLs may have conditioned consumers to consider a light bulb that looks much different, but delivers superior performance.

Finding the right niche markets will pave the way for greater acceptance. The DOE report recommends that SSL first be introduced in niche markets where tangible benefits are clearly defined and consistent with buyer needs–that is, where consumers will likely be quite satisfied with their purchase. Inappropriate applications undermine a technology's reputation, so it's important to be clear about appropriate applications, being sure to mention good ones as well as bad.

The main thing is to focus on applications where SSL can meet or exceed expectations. For early CFLs, this could have been porchlight applications in moderate-temperature climates, where performance drawbacks such as buzzing, flickering, color rendering and fit might have been less of an issue. Early use of CFLs in table lamps may also have been acceptable, but use of early-generation CFLs for general illumination in high-use areas such as kitchens, for example, would have commonly met with consumer dissatisfaction. This early dissatisfaction often resulted in a consumer who was unwilling to try the product again–even once performance had improved.

TO LEARN MORE

A PDF version of the complete DOE report, *Compact Fluorescent Lighting in America: Lessons Learned on the Way to Market*, is available for download in the Publications section of the DOE Solid-State Lighting website at: *www.netl.doe.gov/ssl.*

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