LIGHTING THE WAY TO ENERGY SAVINGS

HOW CAN WE TRANSFORM RESIDENTIAL LIGHTING MARKETS?

Volume 1

Strategies and Recommendations

NATURAL RESOURCES DEFENSE COUNCIL

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An NRDC Report
December, 1999
(second printing)

Acknowledgments

The authors wish to acknowledge the support, patience, and guidance provided by Noah Horowitz throughout the year-long process of creating and revising this document.

Noah's assistant, Evelyn Arevalo, also proved invaluable to the process of circulating drafts to reviewers and obtaining their feedback.

Greg Black of General Electric Lighting went to considerable effort to create the summaries of Point of Sale (POS) data he provided from AC Nielsen and Triad. His assistance was invaluable in allowing us to understand and convey the current product sales figures for light bulbs that appear in the report.

We are also grateful for the effort invested by numerous reviewers from academia, the lighting industry, government, utilities, market transformation organizations, and advocacy organizations, including:

Dana Banks (Consortium for Energy Efficiency)
Peter Banwell and Scott Thigpen (US Environmental Protection Agency)
Peter Bleasby (Osram/Sylvania)
Kathryn Conway (Rennselaer Polytechnic Institute)
Cheryl English (Lithonia Lighting)
Marvin Feig (Good Earth Lighting)
David Goldstein (Natural Resources Defense Council)
Steve Johnson and Jon Koomey (Lawrence Berkeley National Laboratory)
Ken Keating (Bonneville Power Authority)
Lori Murray (San Diego Gas & Electric)
Steve Nadel (American Council for an Energy Efficient Economy)
Bill Noel (US Department of Energy)
Marci Sanders (Northwest Energy Efficiency Association)
Brad Steele (Energy Federation Inc.)
Yon Sung (MaxLite)
Bruce Wall (Northeast Energy Efficiency Partnerships)
Ed Yandek (General Electric Lighting)
Dan York (Energy Center of Wisconsin)
John Zugel (General Electric Lighting)

We wish to thank Jody Moore and Linda Latham for the personal time they devoted to reviewing early drafts of the document and suggesting improvements. We also are grateful to Penny Cody and Mark Newton for their assistance in obtaining the images that appear in this document.

We also appreciate the ongoing support lent by the Consortium for Energy Efficiency (CEE) throughout the process of crafting this document. CEE provided forums for presentation and discussion of our key findings throughout 1999, and is graciously facilitating electronic distribution of this report in Adobe Acrobat (PDF) form at its website (www.CEEforMT.org).

Finally, we wish to thank the U.S. Environmental Protection Agency for its funding of the research, writing, and distribution of this report. The data and recommendations presented herein are not those of the US EPA; the authors bear the sole responsibility for the contents of this report.

Note also that the photographs and descriptions of individual lighting products in this report were provided strictly as examples and do not constitute endorsement by the authors of any particular products or manufacturers.

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Executive Summary

This two-volume paper reviews efforts over the last two decades to encourage the use of more energy efficient residential lamps and light fixtures. It identifies successful elements of past programs and recommends strategies to encourage the broader use of compact fluorescent lamps (CFLs) and energy efficient residential light fixtures in the United States. Volume One is mostly policy- and program-focused, while Volume Two is intended to provide an introduction to key residential lighting issues for program managers and implementers at utilities and other organizations.

Major findings from utility surveys, national sales data, and analysis are:

- The technology and marketing behind efficient residential lighting have been improving steadily for more than 20 years. Today's CFLs and fluorescent fixtures are brighter, more energy efficient, more attractive, more widely available, and more affordable than ever before.
- Sales of efficient residential lighting products have been increasing steadily, but remain low. Linear, circular and compact fluorescent lamps are about 10 percent of all residential light bulb units sold and fluorescent fixtures are about 15 to 20 percent of all residential fixtures sold.
- America's residential lighting electricity use is higher than ever before and continues to grow, driven by powerful demographic and economic forces. This growth increases national carbon dioxide emissions at a time when the U.S. is striving to reduce its contribution to global climate change.

Though current technology can still be further improved, the primary challenge today is finding ways to encourage more customers to purchase and use efficient lighting. Solutions will require the involvement, and in many cases the cooperation, of multiple stakeholders, including advocacy groups, builders, manufacturers, retailers, researchers, government agencies, utilities, regional market transformation organizations, regulatory commissions, and consumers.

Key recommendations at the national and state level include:

1. **Make new construction a priority -** Builders, manufacturers, utilities, and energy offices should collaborate to put better lighting technologies and designs into new dwellings. This would ensure long-term energy savings and avoid the need for future programs to undo current practices. The residential construction market has been a tough nut to crack, but promising approaches include demonstration programs and the modification of current home labeling programs, rating programs, and building codes to include consideration of efficient lighting.
2. **Use common specifications and improve them over time -** Local and regional efficient residential lighting promotion programs should adhere to common national specifications for product performance. The most obvious example is the national ENERGY STAR® specifications for CFLs and residential light fixtures. ENERGY STAR specifications should be revised in the future to more closely measure "real world" product performance, include a broader array of lighting products, and convey a consistent message.
3. **Develop a testing program for residential lighting products and act decisively on its findings -** The market transformation community should establish an infrastructure for the ongoing performance testing of ENERGY STAR qualified lighting products to verify manufacturer performance claims. It should publish the results widely and strongly support superior products in the marketplace. The ENERGY STAR program should take appropriate action to de-list non-qualifying products and utilities should drop those products from their programs.
4. **Target untapped regions of the country -** Stakeholders should work together to expand opportunities for efficient lighting promotion in regions like the Southeast and Southwest that have not traditionally

run active market transformation programs for residential lighting. By building national markets, these efforts can increase the effectiveness of labeling programs and partnerships with national retailers.

5. **Research and pilot-test promising emerging technologies -** Targeted R&D funding could help accelerate the adoption of promising technologies like white LEDs and encourage innovations such as universal ballasts to simplify lamp/ballast matching and reduce ballast cost. It may also help draw superior incandescent designs to market that could fill a useful niche between CFLs and existing incandescent bulbs.

Key recommendations for utilities and market transformation programs include:

1. **Change consumer preferences -** Market transformation programs should work more strategically to achieve particular market share and awareness goals over periods of five to ten years. This suggests an increasing emphasis on consumer education and marketing in program budgets. Price reductions (incentives) should be used selectively and early in program cycles to draw new products to market and encourage retailers to sell them. Over the long term, programs must shift consumers' focus from product *price* to product *value* in order to be successful. This probably requires a focus on other product attributes like longevity and convenience that seem to be more important to typical buyers than energy efficiency.
2. **Design multi-year programs around the lighting season** - Utility and market transformation programs promoting efficient lighting should operate with multi-year funding and be run in sequence with the peak of the sales cycle in the retail lighting market (September to April) rather than the calendar year.
3. **Leverage retailer and manufacturer capabilities -** Market transformation programs should utilize the existing retail infrastructure and work to expand it specifically in support of energy efficiency. This includes crafting a much more visible and attractive presence for efficient residential lighting products in retail outlets, educating retail sales staff about the advantages of the products, and nurturing opportunities for retailers and manufacturers to fund their own promotions. Program plans should be communicated to manufacturers in advance to obtain their input, synchronize with their long-term marketing and retailing strategies, and leverage their resources.
4. **Target specific product categories and markets** - A few key market segments would benefit from a strong near-term focus by utilities and market transformation organizations on increased product availability, improved quality, and reduced long-term purchase price. These include: dimmable and sub-compact CFLs, recessed fixtures (downlights), decorative porch lights and linear fluorescent fixtures, and lighting controls. Targeting incentives to these specific products makes more effective use of limited program budgets than providing broad incentives for all qualifying CFLs and fixtures.

With better lighting design in new and existing homes, enhanced marketing and education, and continued improvements in lighting technology, the nation's residential lighting bill can be cut by more than half with tangible improvements in consumer comfort and convenience. The implications are profound, and include potential electricity savings of more than $5 billion per year, and a potential reduction of nearly 2 percent in total national carbon dioxide emissions.

1 Introduction to Volume 1

While residential lighting is not the largest contributor to the nation's energy-related environmental problems, it is large enough to merit significant attention. Americans use more than a trillion kilowatt-hours (kwh) of electricity annually to power our homes—more than we use to operate businesses or industrial facilities.[1] Lighting is one of the principal components of residential electricity demand. Today, by one fairly conservative estimate, residential lighting accounts for up to 15% of national residential electricity use and about $11 billion per year of electricity bills. Its environmental impact is also substantial, representing 3% of all U.S. carbon dioxide emissions (the largest contributor to global climate change), 4% of SO_x (the leading cause of acid rain), and 2% of NO_x (the leading cause of urban air pollution).[2]

In order to curb emissions of carbon dioxide and other pollutants, efforts to reduce absolute electricity demand—even in the face of a rising population and a surging economy—will need to be more successful in the next decade than they have been in the last. Those new programs and policies will need to rest squarely on the shoulders of efforts to date, propagating what has worked best and modifying what has not.

There is great technical potential for the reduction of residential lighting electricity consumption. If currently available efficient lighting products were widely used, Americans could easily cut the amount of electricity used to light their homes in half. America's electric utilities, environmental organizations, government agencies and lighting industry have each taken steps over the last decade to realize this goal. Though that effort has yielded remarkable improvement in lighting technology, awareness, industry competitiveness, and program design, a simple fact remains: the nation is using more energy to light its homes today than at any time in its history. We are winning small battles but losing the war.

1.1 The Purpose of this Paper

In this paper, *residential lighting* is defined as lighting commonly (but not exclusively) used in dwellings. These include homes of all sorts, college dormitories, managed care facilities, hotels and motels, military barracks, and some correctional facilities. The concept encompasses *consumer lighting*—products intended perhaps for home use, but often found in small businesses and other institutions without professional energy managers or maintenance staff. The definition is important because residential lighting products are neither advertised nor sold along the lines that utilities (and their regulators) draw to segment their customers into residential, commercial and industrial customers. The operative focus of this paper is on *markets*—in this case, the U.S. national market for residential lighting products. Residential lighting products are generally sold through mass market retailers to consumers and through electrical wholesalers to builders or installers. Residential lighting products often, but not always, are distinguished from commercial and industrial lighting by lower prices, lower light intensity packages, wide retail availability, and designs intended for residential settings.

But why focus on residential lighting? Commercial lighting accounts for a larger share of national electricity consumption, so why not focus on it instead? This paper focuses on residential lighting for four very good reasons:

- Almost every American home uses electricity for lighting, so any improvement in residential lighting efficiency offers the potential to benefit the entire populace.
- Far less attention has been paid to energy efficient residential lighting than to energy efficient commercial lighting, leaving a substantial untapped opportunity for improvement.
- Residential lighting products are extremely important to the lighting industry. About 48% of all new light sources are produced for use in residential buildings.[3]

- The owners and operators of small commercial and institutional buildings often purchase the same lighting products at the same retailers as residential customers.

In 1998, the U.S. Environmental Protection Agency (EPA) funded the Natural Resources Defense Council (NRDC) to examine what has, and has not, worked with past residential efficient lighting programs and technologies, and to make recommendations regarding ways to improve the success of future efforts to reduce residential lighting energy use. Over the last year, NRDC and its contractors at Ecos Consulting have spoken with manufacturers, retailers, utilities, government agencies, market transformation groups, research laboratories, efficiency advocates, and third party implementers to glean as much useful information as possible. We have reviewed numerous market research documents and utility program evaluations as well. Finally, we have presented preliminary findings to dozens of stakeholders and incorporated as much of their feedback as possible.

This paper is the culmination of that process, and is based on the simple premise that it is impossible to change the current course of the U.S. residential lighting market without fully understanding it. The focus on key lighting technologies at various places in the paper should not distract the reader from the principal theme: the technological means to solve our most significant residential lighting challenges are already largely at hand. The primary barriers to success rest in the marketplace and in human behavior, not in the laboratory.

1.2 The Structure of this Paper

This research is presented in two volumes. Volume 1 summarizes the present U.S. residential lighting situation, noting how we light our homes, what kinds of lighting we buy, and how our behavior and technology combine to create our present level of energy consumption. Using the limited data available, it then projects anticipated increases in residential lighting energy demand and their consequences. Finally, it makes a series of policy and program recommendations to increase residential lighting energy efficiency. Readers already well versed in the residential lighting field may be interested primarily in Volume 1.

Volume 2 provides the foundation upon which the recommendations in Volume 1 are based. It reviews and summarizes the history of efforts to date to improve residential lighting efficiency and longevity. It illustrates the changes in residential lighting technology over time and analyzes how the markets for such products work. It provides a snapshot of what is known about current market conditions, and it briefly examines emerging lighting technologies that could provide significant benefits sometime in the future. This volume is intended to function largely as a primer, and may be of particular use to readers new to the residential lighting field or wishing to explore other dimensions of it.

1.3 Our Current Dilemma

As described in Volume 2 (Section 2.1), human progress from the earliest artificial light sources to the best current technology has been quite remarkable. Compared to early candles, today's best light sources are 600 times more energy efficient and last up to 6,000 times longer.[4] Moreover, in the lighting market as a whole, (residential, commercial and industrial sectors) the venerable incandescent light bulb appears to be losing ground to more energy efficient alternatives. Sales of incandescent lamps into all markets declined from about 82% of all lamps produced domestically in 1972 to 71% of lamps produced in 1994. On a dollar value basis, the drop was even more precipitous, from slightly more than half of all domestic shipments in 1972, to less than 40% in 1994.[5]

It is tempting, then, to conclude that there is little need for a coordinated effort to further improve residential lighting energy-efficiency. In fact, the opposite is true. Energy efficient light sources have enjoyed substantial success in the commercial and industrial marketplace, where their longevity and savings are appreciated, but remain a niche product in the residential marketplace.[6] They have yet to deliver even a fraction of their potential for reducing home energy bills. While lighting styles and tastes have changed in the 120 years since the invention of the incandescent light bulb, the basic technology used for lighting homes has stayed largely the same.

By disregarding the host of light sources not directly relevant to the residential lighting market, including commercial and industrial lamps, automotive light sources, street lights, etc., we can see how utterly dependent the U.S. residential sector remains on the incandescent lamp.

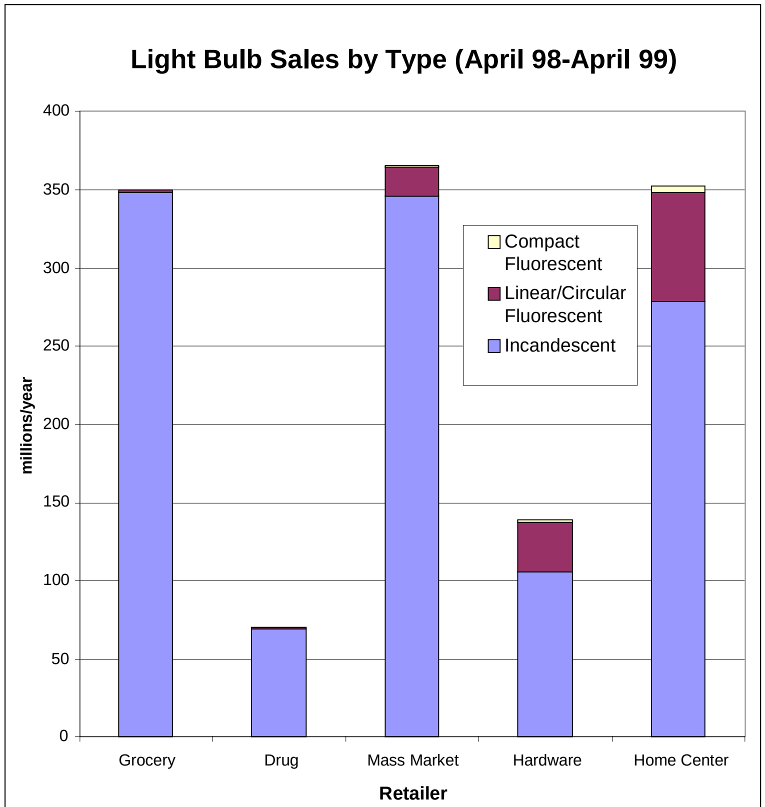


Figure 1 - Linear and circular fluorescents have made significant inroads in some mass market retailers, but compact fluorescent remain virtually irrelevant to the lighting sales of all retailers except home improvement centers. (AC Nielsen and Triad POS Data)

Light bulbs for residential use are most commonly sold through major retailers with computerized cash registers and inventory tracking systems. An analysis of national cash register data from grocery, drug, mass market discount, hardware, and home center stores indicates that roughly 1.53 billion light bulbs of all types (including fluorescent, incandescent and reflectorized models) are sold through major retailers each year. The average retail price of these light bulbs is about 90 cents, so total consumer expenditures are about $1.38 billion per year. Incandescent bulbs represent 92% of the total unit volume and 74% of total dollar volume. Excluding reflectorized lamps, incandescents represent about 90% of the light sources sold through five major retail channels (see Figure 1).[7]

Clearly we have a long way to go before fluorescent lighting becomes a dominant player in the residential marketplace. Linear, circular and compact fluorescent lamps together are only about 10% of the total number of light bulbs purchased by consumers each year. Utilities and market transformation organizations are currently spending over $23 million a year to try to shift $1 billion of consumer purchases from incandescent to compact fluorescent bulbs.[8] This is quite a challenge in a country where $100 million nationwide, TV-focused advertising campaigns are normally deployed to introduce new consumer products. Without more effective leveraging of advertising funding from manufacturers and retailers, this will continue to be an uphill battle.

1.4 How America's Homes Are Lit

To put energy efficient residential lighting to the overall context of all residential lighting, it is also useful to examine the actual population of light sources used in homes. The only readily available national survey of residential lighting usage was compiled by the Energy Information Administration (EIA) in 1993 and published in 1996. Its sample size was very small (only 474 households completed a detailed lighting survey). All of the data were self-reported, and are now about six years old. Nevertheless, EIA estimated from its

Table 1 –Dominant Residential Light Fixtures and Share of Total Household Lighting Energy Use, by Region

	California Households		Pacific Northwest Households	
Rank	Fixture Location, Type	Fraction of Lighting Energy	Fixture Location, Type	Fraction of Lighting Energy
1	Outdoor, wall-mounted	10.6%	Kitchen, closed ceiling	8.0%
2	Kitchen/dining room, suspended	8.3%	Living room, table lamp	7.6%
3	Living room, table lamp	8.1%	Bath, wall	7.5%
4	Kitchen/dining room, recessed	7.6%	Outdoor, wall	6.9%
5	Bath, wall	7.3%	Living room, floor lamp	5.3%
6	Kitchen/dining, surface	6.3%	Kitchen, recessed	4.8%
Total		48.2%		40.1%

survey responses that a total of 523 million light fixtures (about 5 per household) are used at least one hour per day or more. It concluded that 87% of those fixtures were incandescent.[9]

After comparing various utility surveys conducted between 1992 and 1996, researchers at Lawrence Berkeley National Laboratory (LBNL) concluded that America's 100 million households actually average 20 to 30 light fixtures apiece, and a total of 35 to 50 individual light sources (often with multiple light sources per fixture). It concluded that about 86% of residential lighting energy is used by incandescent bulbs of various types. LBNL found that about half of all the fixtures in a typical house are used less than one hour per day and therefore contribute very little to total lighting energy consumption.[10] By contrast, the six highest energy-consuming fixtures in a home appear to account for 40 to 48% of total lighting energy use (Table 1), and are thus the prime targets for replacement by energy efficient alternatives.[11]

So how much electricity use does this residential lighting represent? In 1996, the EIA estimated that the average household used only 940 kwh of electricity per year for lighting—about $83 worth. That reflected a belief that lighting was less than 10% of residential electricity use. The utility studies examined by LBNL suggested far higher numbers, ranging from 1,300 to more than 2,500 kwh per household or up to $220/yr. LBNL employed an estimate of about 1,400 kwh per household for 1998, which is now conservative in light of the recent growth in the popularity of energy-intensive residential fixtures like recessed lighting and halogen floor lamps.[12]

1.4.1 Slow to Switch

The most widely available and applicable efficient lighting option is the screw base compact fluorescent lamp (CFL), which is designed to replace standard incandescent bulbs (see Volume 2, Chapter 3). According to the EIA, only 9% of U.S. households in 1993 contained a CFL, though nearly half of all households surveyed were aware of them.[13] In parts of the country with active utility-funded lighting programs, such as southern California, 15% of households surveyed in 1997 and 1998 reported that at least one CFL was installed in their home.[14] In the northeast, a 1998 study revealed that about 51% of those surveyed had used at least one CFL in their homes at some point, and 30% were currently using them.[15] Based on this limited information, and considering the lack of large-scale utility programs in other parts of the country, it appears that at most only about 10 to 15% of U.S. households contain at least one CFL, though a higher percentage are likely to have tried one at some point. The penetration of other energy efficient residential lighting products is probably far lower.

Thus, although residential lighting technology has improved dramatically and efficient, long-lived lighting products are now widely available, it is also clear that the U.S. residential market has not purchased them in significant quantities. Many of the market barriers that remain have largely to do with enduring consumer perceptions about previous generations of fluorescent lighting products, and the nature of retail infrastructure itself.[16] The implications for future increases in residential lighting energy use are profound.

1.5 Where Are We Headed?

A few dominant economic and demographic trends are driving increases in residential lighting consumption. These include the obvious (population and economic growth) and the more subtle (changes in household size and housing stock). According to the Center for Resourceful Building Technology, the average U.S. residence in 1949 was less than 900 square feet, and housed 4.2 people. By 1991, it had grown to nearly 2,000 square feet (and climbing), but housed only 2.3 people. The result is somewhat astonishing: the average American lives in four times the square footage our grandparents did.[17]

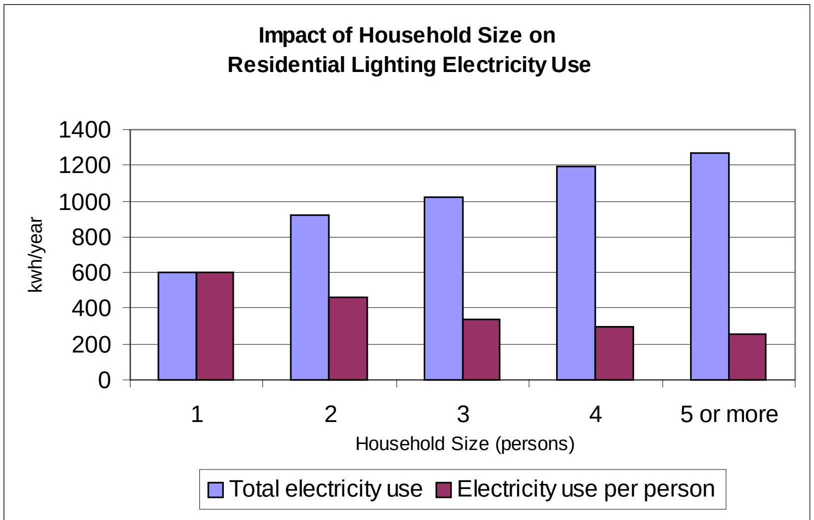


Figure 2 - Impact of Household Size on Residential Lighting Electricity Use (*Residential Lighting Use and Potential Savings*)

How important is the physical size of the home? In 1993, EIA conservatively estimated that homes with 8 or more rooms consumed an average of 1,420 kwh/year for lighting, while homes with 1 to 3 rooms averaged 497 kwh/year.[18]

Today's families are smaller than ever, and as average household size continues to fall, the number of total households is projected to rise even faster than the population as a whole. By 2005 the number of US households will reach 111 million—up from about 105 million in 1999 and each residing in a separate dwelling equipped with lighting.[19]. The implications for residential lighting energy use are profound—as average household size shrinks, lighting electricity use per person rises (see Figure 2). One-person households, in fact, use fully half as much electricity for lighting as four-person households.[20]

Income is positively correlated with residential lighting electricity consumption as well, and real average incomes are rising.[21] Households earning more than $75,000 per year averaged more than twice the lighting electricity use of households earning less than $10,000 per year. Lighting energy use rises with income even in homes with an identical number of rooms or household members.[22]

It also appears that the number of light sources per home is rising as well, though this is better documented regionally than nationally.[23] California researchers reported documenting a rise of 100 watts of installed lighting per home per decade.[24]

Yet another trend driving growth in residential lighting energy use is the aging of the population. Visual acuity declines with age, and brighter light is required to accomplish the same tasks effectively. In 1980, the average age of the U.S. population was 30 years. By 2025, it is projected to be 38 years.[25]

Overall, the EIA forecasts that residential electricity demand will grow by 1.6% per year between 1997 and 2020.[26] Curiously, EIA forecasts only a 0.6% annual growth rate in residential lighting electricity use—a slower growth rate than that of the national population alone.[27] EIA's optimism seems unwarranted based on what we know about the lighting market and demographic trends. However, it is difficult to respond effectively without far more detailed studies of national residential lighting energy use (see Volume 1, Section 3.2.4).

Given the factors detailed above, it seems plausible that residential lighting electricity use is growing at least as fast as overall residential electricity demand. This is especially so given the progress being made to improve the energy efficiency of other electrical end uses through manufacturer innovations, building codes, appliance standards, and various utility programs. Indeed, it is quite possible that lighting will be a major driver behind increasing residential electricity use, unless a coordinated effort is begun to reverse that growth.

This much is certain: the amount of electricity needed to meet our residential lighting needs has been rising inexorably and is continuing to rise, bringing with it increasing energy bills, air pollution, and emissions of greenhouse gases. Because of our lighting choices to date, we waste more money, discard more lamps, burn more fossil fuels, and emit more CO_2 and other pollutants than we need to.

However, lighting offers one of the best energy reduction opportunities of any residential end use. With greater use of existing lighting technologies and controls, better home lighting design, better attention to optics in fixtures, and more attention to controls, we could cut residential lighting electricity use by at least 50% and improve lighting service. Such improvements would cut annual household energy bills by at least $5 billion and the nation's total carbon dioxide emissions by nearly 2 percent. The alternative, as shown above, is not simply to stand still, but to continue losing ground.

2 Strategies for Change

The heart of this document is a discussion of how best to improve residential lighting energy efficiency. The ultimate goal is not simply to sell more fluorescent lighting, but to *decrease* total national demand for electricity to power residential lighting. To accomplish this, we must shift a substantial fraction of existing US residential lighting to more energy efficient alternatives (fluorescent or other sources), do a better job of matching particular types of lighting to specific tasks, and intelligently control lighting to operate when and where it is most useful. This market transformation goal is ambitious but achievable because currently available products allow national residential lighting electricity consumption to be decreased cost-effectively with no decrease in the quality of lighting service.

What strategies should be pursued to achieve this market transformation? The most promising strategies identify particular areas of market leverage and line up the most influential market players to focus on them. This paper focuses on six key areas of strategic intervention:

1. Financial Incentives – Where can market transformation funds best influence purchase decisions?
2. Public Relations, Marketing and Advertising – What messages will drive the transition from incentivized sales to largely self-sustaining markets for products?
3. Education – How can we create more knowledgeable consumers and purchase influencers?
4. Product Distribution and Placement – What changes are needed to increase retail product sales?
5. Product Quality Assurance – How can we help consumers feel confident that the efficient lighting products will perform as promised by giving labels like ENERGY STAR® more credibility and meaning through a system of product performance testing?
6. Standards – Once gains have been made in the marketplace through voluntary programs, what role should government play in eliminating the sale of the least efficient products?

2.1 What is Residential Lighting Market Transformation?

Current activities by utilities and regional organizations are largely clustered under the umbrella of *market transformation*—a term which means different things to different people. For the purposes of this document, residential lighting market transformation is defined as the process of systematically changing consumer purchase preferences, architect and builder practices, retailer stocking preferences, and manufacturer product offerings to consciously favor energy efficient lighting choices over inefficient choices. Implicit in this document is the assumption that markets can *be transformed* through deliberate, cooperative efforts by key stakeholders to demonstrate more efficient options, educate market players about them, and motivate changes in practice.

A number of metrics have been proposed to measure progress toward market transformation[28]:

- Energy efficient product share of residential lighting market
- Number of manufacturers offering efficient products
- Average retail price of efficient products
- The number and types of new efficient products introduced
- The number and types of retail stores devoting substantial shelf space to efficient products (or, alternately, the average amount of shelf space devoted to the products by a particular set of retailers)
- The percentage of customers aware of efficient lighting options
- The awareness by retail sales staff of these options and their benefits
- The amount of advertising devoted to efficient lighting products

- The amount of media coverage devoted to discussing efficient lighting products
- The extent to which efficient lighting is routinely installed in new construction (or, alternately, the share of contractors who routinely install efficient products)

These are useful signposts along the journey to market transformation, but they are a means to a greater end – absolute reductions in total residential lighting energy demand. The ultimate measure of whether market transformation has succeeded is the electricity meter. Consumers now have the option to purchase cost effective lighting that reduces energy use by 75 percent, and yet lighting energy use continues to rise. We have the tools to change this trend, but the transformation of the residential lighting market has only just begun.

2.2 When Will the Residential Lighting Market Be Transformed?

Considering a few of the key metrics listed above, some utility program managers have been tempted to declare that their residential lighting markets have already been transformed. Indeed, typical retail prices for CFLs have been dropping steadily, while product availability and performance have also improved. But absolute usage of the products in households remains chronically low, especially in comparison to usage in other countries.

A two-year study completed in June of 1996 found CFLs installed in 56% of households in the Netherlands, 50% in Germany and 46% in Denmark[29]. In the UK, penetration had reached 20% by 1997. Promotional efforts in these countries have been ongoing and today's levels are certainly higher. The Swedish government has set a national market transformation goal of 5 CFLs per household by 2005. By contrast (as noted in Volume 1, Section 1.4.1), only about 10 to 15% of U.S. households currently contain a CFL, and we lack a clearly defined national goal for increasing usage efficient residential lighting.

The reasons for the difference between the western European experience and the U.S experience are due to many factors, including national coordination of promotional efforts, different cultural attitudes about resource consumption and, to some extent, higher electricity prices. One particularly interesting example is from Poland, which has electricity rates similar to the US, but with much lower average household income. CFL penetration in Poland went from almost nothing in 1993 to over 30% nationally by 1998. The reasons appear to be a combination of broad manufacturer advertising and a national, market based, CFL promotion program. Despite national differences, there are valuable lessons from programs in other countries that can be incorporated into U.S. program designs (and are woven into policy discussions below).

2.3 Build Consumer Demand for Better Residential Lighting

We begin with a look at strategies that address the two main product classes of residential lighting: light bulbs and light fixtures. Although electric utilities sometimes operate separate and distinct energy efficient lighting programs for compact fluorescent bulbs and dedicated fluorescent (wired to use fluorescent lighting only) fixtures, both products have an important role to play in market transformation. Timers, sensors, and dimming controls also have a key role to play, but remain largely ignored by existing market transformation programs.

From a simple engineering standpoint, the optimal solution for energy efficiency and optical performance would be to replace all existing light fixtures in a residence with custom-designed, dedicated, energy efficient alternatives. Such fixtures are optimized to utilize efficient light sources and achieve the maximum possible energy savings. There is, however, no easy and quick process for compelling such a change and no reason to think it will happen spontaneously. Consumers change light fixtures when they find their existing fixtures unattractive, inconvenient, or inoperative, but rarely out of a singular zeal to cut electricity bills. Indeed, consumers have virtually no means of knowing how much a particular light fixture contributes to their total electricity bill.

This leaves bulb replacement in existing fixtures as the most viable immediate alternative for reducing energy use. However, it does not make sense to encourage consumers to put CFLs in fixtures whose shape, thermal characteristics, or optics are so poor that they waste most of the light, even from an efficient source, before it can ever reach its task. Therefore the screw base CFL should be considered a transitional product on the road to the longer-term solution of dedicated fixtures.

2.4 Selling CFLs

Most consumers are introduced to energy efficient residential lighting through the compact fluorescent lamp. This simple one-for-one replacement for traditional incandescent bulbs allows consumers to try energy efficient lighting for a relatively small initial investment and minimal hassle. While consumer demand has been building gradually for these products since their introduction in 1979, it remains disappointingly low. As the EIA remarked grimly in 1996, "Less than 1% of all household lights used 15 minutes or more per day are compact fluorescent."[30]

Figure 3 - Some of the newest CFLs are so small that they are called "sub-compact fluorescent lamps" (MaxLite)

A number of recent events and trends point toward a larger presence for CFLs in the near future. Probably most importantly, prices have fallen dramatically from the $25 to $35 levels prevalent in the mid-1980s, to below $5 for the least expensive models today, and an average of $11 to $12.[31] The variety of shapes and sizes of products now available is also impressive. Highly compact models are now available that are virtually the same size and shape as their incandescent counterparts (Figure 3), thereby eliminating one of the biggest barriers to consumer acceptance.

The US government's ENERGY STAR label for CFLs was launched in mid-1999, and 17 of the largest CFL manufacturers in the world have already signed on as partners.[32] This will bring much-needed brand recognition and consumer confidence to the family of products and help retailers and manufacturers market them more clearly and systematically.[33]

Likewise, distribution channels have been widened, eliminating much of the longstanding concern about product availability. About 80% of the U.S. population now resides in one of the nation's 271 metropolitan areas, all of which probably contain a number of retailers offering CFLs.[34] Now that stores like Wal-Mart and Kmart routinely stock compact fluorescents, even rural residents often have ready access to the products, or can purchase them by mail or through the Internet.

2.4.1 How mature is CFL technology?

Modern CFLs are a pretty good substitute for incandescent light bulbs.[35] In a key piece of CFL market research, later updated in 1994, researchers found that significant progress has been made towards removing the remaining technical barriers to consumer CFL purchase such as size, compatibility with dimmer switches, odd appearance, and delay in switch-on.[36] Today the most compact designs are often the most popular, with products utilizing three or four separate curved fluorescent tubes, or a spiral design, to minimize product length in the brightest models (see Figure 4).

Figure 4 – High output CFLs (Calwell)

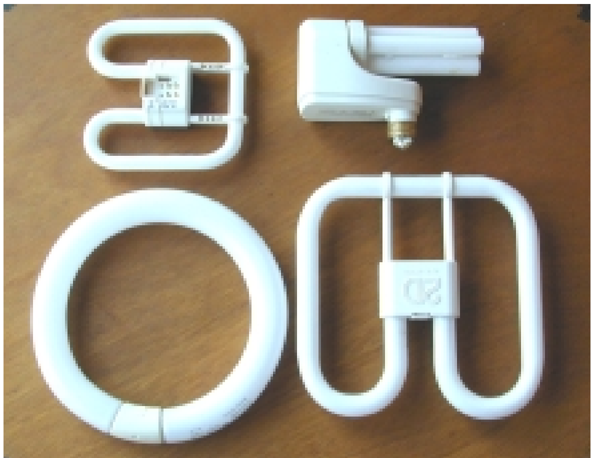


Figure 5 – Horizontal CFLs commonly used in table lamps (Calwell)

Two-piece, or modular CFLs with separable lamp and ballast appear to represent a smaller share of the marketplace than they once did, though the environmental and financial advantages of a reusable ballast remain substantial. However, few residential customers are necessarily willing to pay extra for a ballast that might last for three or more lamp lives, given the tremendous improvements that continue to be made in ballast size and performance with each passing year. Two-piece designs remain dominant in the highest light-output CFLs, however, which are increasingly gravitating toward a horizontal instead of vertical orientation (see Figure 5). Horizontally oriented CFLs fit better into the floor and table lamps typically used for reading and distribute more of their light downward toward the reading surface.

Most CFL marketing strategies to date have focused on the great similarity of CFLs to incandescent bulbs. This has probably been a mistake. If a product is so similar to what consumers already use and costs more, why should they bother switching? It may be time to use educational and marketing campaigns to celebrate the distinct advantages of energy efficient lighting, and the disadvantages of incandescent light bulbs. Incandescent bulbs have distinct disadvantages: high operating temperatures, short bulb life, and the inconvenience of more frequent bulb changes. There is also a style and design angle that can be explored. Incandescent bulbs create "hot spots" of light within fixtures and scalloping (alternating patterns of light and dark) on adjacent walls, while CFLs and especially linear fluorescents can provide a more diffuse, continuous light.

2.4.2 Is There a Role for Better Incandescent Bulbs?

While education and concerted activity by utilities and market transformation organizations can help promote fluorescent technologies, it is reasonable to ask whether efforts should be undertaken to bring better incandescent technology to market as well. The standard "soft white" incandescent light bulb is typically sold by one of the three major manufacturers to national retailers for about $0.11 to $0.13 apiece in quantities of millions.[37] They, in turn, resell the bulbs for about $0.25 to $0.50 apiece, earning a very profitable percentage margin on each unit sold. Retail stores also commonly offer a "house brand" incandescent bulb which is private-labeled for them by an overseas manufacturer and sold at a lower price than the major manufacturers' products.

Some manufacturers have sought to dislodge General Electric's firm grip on the U.S. incandescent bulb market by offering incandescent bulbs with added features and higher margins. Philips' Halogena bulb, for example, is smaller and slimmer than a typical bulb and guarantees a two year lifetime. However, it is no more energy efficient than a regular, incandescent light bulb and uses 3 – 4 times more electricity than a typical CFL. These heavily marketed halogen bulbs retail for about $4 apiece and appear to have been a success. Indeed, Philips' new marketing slogan, "Philips. Light Bulbs that Last," suggests a corporate belief that longer life may be more attractive to residential customers than energy savings or other product attributes.

Figure 6 – Mail-order bulbs made in Poland and sold by a Canadian company for under $1 apiece (Calwell)

Likewise, other companies have begun offering incandescent bulbs with stronger filaments, 130 volt ratings, or improved fill gases in order to achieve dramatically longer product lifespans. These products are often marketed directly by overseas manufacturers through mail order catalogs (Figure 6). But neither the Halogena nor the "SuperBulb" actually offers tangible improvements in the number of lumens of light provided per watt of power consumed. If anything, labeled efficacy may be slightly lower for these products that for regular light bulbs.[38]

Other screw base halogen bulbs available from General Electric and Osram Sylvania also offer slight improvements in efficacy over their incandescent counterparts (about 5 to 10 percent). But the theoretical maximum efficacy for incandescent lamps is about 200% higher than the efficiency of today's typical 100 watt bulb.[39] The most plausible ways to achieve significant improvements in incandescent efficacy involve the use of infrared-reflective coatings on the bulb or high-tech ceramic filament designs. But is there room in the marketplace for a significantly more energy efficient incandescent bulb?

Over the last three years, European procurement agencies and the U.S. Department of Defense both sought to encourage the development of such a product through competitive procurements. Unfortunately, neither effort generated a successful bid. Follow-up with manufacturers indicated that the range of wattages sought would be difficult to achieve, the desired price was too low, the potential market was too small, and the structure of the procurement was more cumbersome than they would have suggested if designing it themselves. It may also not be in the economic interest of manufacturers of highly profitable incandescent lamps, with fully amortized manufacturing lines, to create a new, more expensive alternative that might set the floor of future energy efficient regulation. A new entrant to the market would not face those disincentives, but would face formidable capital requirements and difficulty in securing retail distribution.

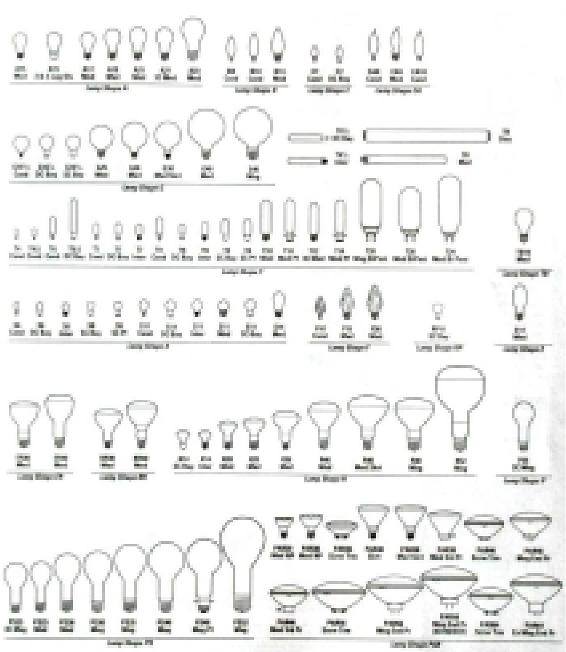


Figure 7 – Many incandescent bulb types have no CFL equivalent (General Electric Lighting, *Lamp Products Catalog*, 1999)

Continuing improvements in the performance and size of CFLs, including the ability for some models to be used with traditional dimmers, have narrowed the potential market for a significantly more efficient incandescent bulb. However, there remains a vast assortment of incandescent bulb applications (Figure 7) in which CFLs are unlikely to ever play a significant role, including automotive lighting, highly compact decorative bulbs, and various spotlights. Any improved incandescent filament technology could be widely applicable to those niches. Once established in those niches, it could also be tried in the familiar "A-line" bulbs, competing head to head with less expensive traditional incandescents and more expensive CFLs.

2.5 Recommended Strategies for CFLs

CFLs are a mature technology in the sense that many high quality products are now being made by a range of manufacturers and sold through a variety of retailers. Price competition is intense, and marketing campaigns successfully differentiate these products from each other. However, CFLs sales to the residential sector remain low because there is a lack of sustained consumer demand. Fostering that demand will take a new level of coordination between various stakeholders in the residential lighting market. As the following sections will discuss, past promotional efforts have focused almost solely on reducing product prices, giving insufficient attention to the useful role to be played by greater education, marketing, and application guidance.

Table 2 presents a summary of recommended actions to be taken by key market players to support screw base CFL market transformation. Each action identifies a lead (L) or supporting (S) role. Specific recommendations for market players are discussed in detail in *Chapter 3: Specific Recommendations for Action*.

Table 2 – Screw Base CFLs	**Utilities / MT Orgs.**	**Manufacturers**	**Retail**	**National Labs / LRC**	**ENERGY STAR**	**Regulators**	**Energy Advocates**
Financial Incentives							
Use financial incentives to further reduce prices of high lumen and very compact CFLs. Seek to sustain lower prices over the long term through larger sales volumes.	L					S	S
Use incentives to leverage additional contributions such as advertising, further price reductions, special promotions, etc. from manufacturers and retailers	L	S	S				
Shift away from the per-unit incentive structure. Replace with a lump sum negotiated incentive package that includes promotional value, improved pricing, advertising, and PR.	L	S	S			S	
Foster further innovations in product size, light output, and quality. Improve compatibility with dimmers, timers, and photocells.	S	L	S	S	S		S
Education							
Work with manufacturers to improve packaging for ENERGY STAR products ▪ Display the product more clearly (blister packs) ▪ Provide simple, direct information on applications ▪ Package multiple CFLs at promotional prices	S	L	S		L		
Feature CFLs at retailer product knowledge classes and staff training.	S	S	L		L		
Shift customer light selection from watts to lumens.	S	S	S		L	L	S
Product Distribution and Placement							
Work with retailers to obtain: ▪ Prominent placement of CFLs on end-caps and stand-alone stacks ▪ CFLs shelved with equivalent incandescent bulbs by application, not technology ▪ Point of purchase materials clearly showing applications ▪ In-store displays of lighted bulbs	L	S	L		S		
Experiment with new distribution models like grocery.	L	S	S		S		
Use tailored program design elements (master distributor, field support, etc.) to address the barriers specific to small markets and independent retailers.	L		S		S	S	
Public Relations, Marketing and Advertising							
Establish a national goal of CFLs in half of all homes by 2010.	L	S			L	S	S
Feature products in consumer advertising and printed circulars.	S	S	L				
Shift marketing message from price to value, based on product advantages: ▪ Long life/convenience/warranty ▪ Cool/comfortable/safe ▪ Environmentally preferred ▪ Soft, pleasant, attractive light ▪ Save energy/save money/efficiency	S	L	S		S		S
Work with ENERGY STAR to expand specifications to cover new products.	S	S		S	L		S
Develop consumer awareness campaign to bring CFLs into the mainstream. Focus on "new and improved" and use of high visibility media such as TV.	S	L	S		L		S
Testing							
Develop credible testing protocols to verify "real world" CFL performance. Make ENERGY STAR a widely recognized benchmark of product quality.	L	S		L	S	S	L
Standards							
Analyze existing lighting products to identify plausible candidates for phase-out through federal or state standards, especially where viable alternatives are already firmly established in the marketplace.	S			S		L	L

2.6 Selling Energy Efficient Lighting Fixtures

While virtually every household replaces numerous light bulbs each year, market research suggests that fixture purchases are decidedly less frequent—only 6 to 8% of households purchase a table or floor lamp each year, and the purchase rate for permanent (hard-wired) fixtures is likely even lower.[40] The market for residential energy efficient fixtures is also less mature than the residential CFL market. Lighting manufacturers have stated that the widespread availability of dedicated fixtures is a necessary precondition to the greater success of fluorescent lighting in the residential sector. As early as 1992, some manufacturers urged utilities to shift their incentive focus from compact fluorescent bulbs to dedicated fixtures.[41]

With incandescent fixtures, especially portable ones, the principal consumer choice involves one of décor or fashion. The actual lighting choice is not made until later, when a particular bulb is selected for use in the threaded socket of that fixture. If the choice is incorrect, only a small cost and inconvenience is associated with making another lighting choice.

By contrast, new fluorescent fixtures are permanently wired to utilize a particular fluorescent lamp or lamps. The ballast is already wired into the housing of the fixture and connected to a pin-based socket or lampholder that is usually designed to accommodate only one particular fluorescent lamp type and wattage. These dedicated fixtures usually force the purchaser to make a décor choice and a lighting choice simultaneously, which can be daunting to many purchasers. There are few options for customization by the user if the initial lighting choice is unacceptable (see Volume 2, section 5.1.2 for additional detail on this issue).

Of course, there are also obvious efficiency advantages to a product designed from the outset to use a fluorescent light source. The optical performance of the fixture can be optimized, and the fixture can be designed to achieve a particular aesthetic effect, without compromising lighting quality.

The US government's ENERGY STAR label for residential light fixtures was launched in 1997, and currently has 60 manufacturer partners, including some of the largest residential fixture makers in the U.S.[42] The ENERGY STAR logo now appears on light fixtures sold in retail stores across the country, creating brand recognition and consumer confidence that should help retailers and manufacturers market their energy efficient fixtures. Supporting ENERGY STAR and building consumer demand for energy efficient fixtures will require the same sort of coordinated approach outlined above for CFLs. Consumers who are receptive to energy efficient lighting need to understand the advantages of buying a dedicated fixture, instead of simply using the fixture they already have and possibly fitting it with a screwbase CFL. This has proved easier when the fluorescent fixture in question is replacing a fixture type that does not use conventional light bulbs, such as the halogen torchiere, or when the fluorescent fixture has no direct analogue in the incandescent world, such as the linear fluorescent. Not surprisingly, the standard shaded table and floor lamp are difficult to find in dedicated fluorescent versions except for occasional models aimed specifically at hotels and motels.[43]

2.6.1 Portable Fixtures

Portable fixtures offer the simplest way for people to try out a dedicated fluorescent fixture. Purchasers can try them in different locations of the house and often tailor the shades or diffusers to accomplish particular lighting effects. By contrast, permanent fixtures often require the services of an electrician and can only be placed in one location. Of the energy efficient portable fixtures on the market, compact fluorescent torchieres have probably enjoyed the greatest success so far, because of the sheer number of halogen torchieres in use and the safety advantages of cool-burning CFLs over very hot halogens. ENERGY STAR torchieres have already introduced nearly a million purchasers to the ENERGY STAR lighting "brand" since 1997, gaining an important foothold in the marketplace that should ultimately help other ENERGY STAR lighting products take root.[44]

2.6.2 Recommended Strategies for Portable Fixtures

The growing success of ENERGY STAR compliant torchieres in the residential lighting market creates a potential opportunity to open the door for other energy efficient portable fixtures. High-lumen light sources similar to those employed in torchieres are beginning to find their way into desk lamps and worklights that offer safety and longevity advantages over halogen alternatives. This further bolsters the market for replacement compact fluorescent tubes, encouraging retailers to devote shelf space to replacement tubes at the same time they begin offering the ENERGY STAR fixtures that use those tubes. The need remains for basic product development in other portable fixture areas as well, possibly through some sort of design competition linked to retail distribution agreements.[45]

Within the torchiere category, there is a need for continued improvement in product quality. CFL light sources are inherently fragile, and often break in the process of shipment and handling from factory to retailer to residence. Return rates have been higher than usual for some products due to early failure of tubes, ballasts, or switches. Consumers remain concerned about the availability and cost of replacement tubes, and frequently express disbelief that the ENERGY STAR torchieres will provide light output equivalent to the halogen models they are familiar with. The color of light provided by most compact fluorescent torchieres remains discernibly different from that of halogen, especially when dimmed, which discourages some first-time buyers from making subsequent purchases. Torchieres with threaded sockets for regular incandescent bulbs have taken up much of the market share lost by halogen torchieres in response to concerns about safety. These incandescent torchieres typically consume 150 or more watts and represent a substantial energy efficiency opportunity of their own.[46]

Dedicated table lamps present an outwardly attractive opportunity for improved energy effiicency due to their large share of total residential fixture sales (See Vol 2, Section 4.6). Unfortunately, the vast array of styles and product types makes it very difficult to develop a dedicated fluorescent solution that is appropriate across the broad range of table lamps. Currently available screwbase CFLs, however, are often an ideal match for table lamps, allowing the consumer to choose a light of appropriate size and brightness for their needs.

As with screwbase CFLs, it is now necessary for other stakeholders to help build sustained demand. Prices have come down significantly since the first models appeared, and the emphasis of some incentive programs is gradually shifting toward marketing and education. Safety messages have been emphasized heavily, and with substantial success, but more can be done to test the response to money-saving, convenience, and environmental messages as well.[47]

Table 3 presents a summary of recommended actions to be taken by key market players to support market transformation for portable fixtures. Each action identifies a lead (L) or supporting (S) role. Specific recommendations for market players are discussed in detail in *Chapter 3: Specific Recommendations for Action*.

Table 3 - Portable Fixtures	**Utilities / MT Orgs**	**Manufacturers**	**Retailers**	**National Labs / LRC**	**ENERGY STAR**	**Regulators**	**Energy Advocates**
Incentives							
Decrease per-unit torchiere incentives as sales volume rises, shift emphasis to marketing and education by 2001.	L	S				S	
Encourage insurance companies to modify rate structures to reflect safety risk of halogens.	S			L	S		L
Introduce incentives for other ENERGY STAR portable fixture types, possibly through a design competition.	L	S	S			L	S
Education							
Incorporate efficiency message in regular PR from CPSC and state safety agencies.					S	L	S
Publicize safety benefits of ENERGY STAR vs. halogen torchieres to mass media, fire safety experts, retail.	S	S		S	S	L	L
Product Development							
Encourage more widespread use of smart, universal ballasts, to provide greater flexibility for fixture purchasers to choose lamp types.	L	S		S	L		S
Product Distribution and Placement							
Work with Retailers to Obtain: ▪ Prominent placement of ENERGY STAR portable fixtures on end-caps and free-standing stacks ▪ Point of purchase materials clearly showing advantages and benefits of ENERGY STAR portable fixtures ▪ Newspaper circulars and other advertising regularly featuring ENERGY STAR portable fixtures ▪ Sales floor staff training and product knowledge classes on ENERGY STAR portable fixtures	L	S	L		S		
As retailers (Home Depot, Wal-Mart, etc.) discontinue halogen sales, promote this change to other retailers.	L	S			S	S	L
Public Relations, Marketing and Advertising							
Set a goal for Energy Star torchieres to represent 10% of new torchiere sales in 2000 and 25% in 2001.	L	S	S	S	L	S	L
Develop safety-focused torchiere turn-in promotions to recycle halogen portable fixtures and cross-market other efficient lighting. Offers highly visible public service role to fire departments, retailers and utilities.	L	S	S		S		S
Create high profile replacement events with organizations that use large numbers of portable fixtures. Leverage the resulting public relations to the consumer marketplace.	L	S			S		S
Support portable fixtures with marketing and POP materials at retail.	L	L	S		S		
Highlight local and regional fire incidents and relevant pending litigation in public relations efforts.	S			S	S	S	L
Testing							
Conduct "real world" testing of halogen, incandescent and ENERGY STAR fixtures to verify product performance claims.	L	S		L	S	S	L
Standards							
Utilize existing state and federal authority to more stringently regulate floor lamp safety.	S			S		L	S
Discourage or bar use of halogen torchieres in government-owned housing and offices.	S				S	L	S
Crack down on false efficiency and environmental claims for halogen and incandescent portable fixtures.	S	S				L	S
Urge UL to further tighten its standards and encourage existing halogen torchiere manufacturers to switch to inherently safer fluorescent sources.	S			S	S	L	L

2.6.3 Hard-wired Fixtures

Permanent or hard-wired fixtures are extremely important to the new construction and renovation markets. Downlights or recessed fixtures are worthy of particular emphasis because of their widespread use and enormous market share (see Volume 2, section 4.4.1). The ENERGY STAR program has yet to stimulate the development of an affordable, qualifying downlight, though efforts underway among utilities in New England are working to change that.[48]

The other key area of focus for hard-wired fixtures should be increasing the options for the use of full-size linear fluorescent technology in the residential market. Linear fluorescents are more energy efficient than CFLs, last longer, are inexpensive to replace, and permit the use of a wide variety of color temperature choices.

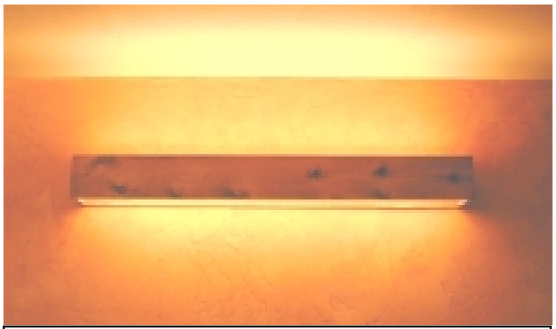


Figure 8 – Fluorescent valence fixtures provide even illumination (Calwell)

The Lighting Research Center at Rennselaer Polytechnic Institute recommends that linear fluorescents be incorporated into the architecture of residential spaces during new construction or remodeling.[49] They can be used very effectively to graze light across walls and ceilings, provide eye-catching indirect illumination, and create other sorts of architectural effects (see Figure 8). They can be readily dimmed with a variety of new ballast designs, and represent a size and shape already familiar to most consumers.

Indeed, the average household is already likely to have at least four times as many linear fluorescent lamps as CFLs.[50] A greater marketing emphasis on linear fluorescents could well increase that number further. Compact fluorescent fixture manufacturers have largely dominated the ENERGY STAR fixture program to date. However, the recent addition to the program of Lithonia Lighting, the largest manufacturer of linear fluorescent residential fixtures in the country, represents a very hopeful sign. The company will offer at least 150 separate qualifying models through its vast array of retail partners.[51]

Outdoor fixtures normally afford more flexibility with regard to lighting color, warm-up times, hum, flicker and other attributes that were drawbacks of early fluorescent designs. In addition, because outdoor fixtures are often on for long hours and sometimes installed in inconvenient locations, frequent incandescent bulb changes can also make them prime candidates for fluorescent replacement. Metal halide and high pressure sodium fixtures also offer a compelling alternative for outdoor applications, where high light output, energy efficiency, and long life are often more important considerations than starting time or lighting color.[52]

2.6.4 Recommended Strategies for Hard-wired Fixtures

Strategies for hard-wired fixtures should concentrate on remaining technical challenges, but also on expanding awareness of the difference between ENERGY STAR fixtures and the vast array of hard-wired fluorescent fixtures that have been on the market for years. Consumers at the moment lack a clear sense of the difference between standard fluorescent technology and the higher quality components utilized in ENERGY STAR designs. As a result, those already predisposed to purchase fluorescent lighting often select cheaper alternatives to ENERGY STAR, while those with a longstanding bias against fluorescent lighting may be unaware of the differences an ENERGY STAR model offers.

The target audience for hard-wired fixture strategies also spans far beyond residential customers, and must include a central focus on those who influence fixture purchases and actually install the equipment. This includes architects, lighting designers, interior decorators, builders, electrical contractors, and maintenance staff in multi-family buildings.[53] This audience is particularly crucial for increasing the usage of linear fluorescent fixtures, which require special design and construction considerations.

Table 4 presents a summary of recommended actions to be taken by key market players to support market transformation for hard-wired fixtures. Each action identifies a lead (L) or supporting (S) role. Specific recommendations for market players are discussed in detail in *Chapter 3: Specific Recommendations for Action*.

Table 4 – Hard-Wired Fixtures	**Utilities / MT Orgs**	**Manufacturers**	**Retailers**	**National Labs / LRC**	**ENERGY STAR**	**Regulators**	**Energy Advocates**
Incentives							
Tailor program incentives to address: 1. Key sales channels (home improvement, wholesale, lighting showrooms/designers) 2. key project types (new construction, remodel, redecorate) 3. key customer segments (single family, multi-family, institutional)	L					S	
Support product with substantial incentives that decline as sales volume rises. Target new fixture types that offer the greatest energy savings.	L	S				S	S
Leverage incentives with manufacturers and retailers to obtain cost-sharing with advertising, further price reductions, special promotions, etc.	L	S	S				
Transition from per-unit incentives to performance-based incentive packages that encourage promotions, lower pricing, and prominent advertising and PR.	L					S	
Education							
Renew focus on best applications for linear fluorescent fixtures and provide appropriate education for retailers, builders and designers.	S	S		L	L		S
Build regional demonstration homes featuring highly efficient, well-designed lighting packages. Educate builders, retailers, and purchasers to seek such options as upgrades in new or remodeled homes.	L	S		S	L		S
Develop Residential Lighting Design Guide, drawn from LRC Pattern Book and other design examples. Use as a training tool with retailers and an education tool with consumers. Create web-based version.	S			L	S		S
Product Development							
Encourage more widespread use of smart, universal ballasts, to provide greater flexibility for fixture purchasers to choose lamp types.	L	S		S	L		S
Work in 2000 through national labs to develop residential IC rated recessed can that is price competitive.	S	S		L	L		
Product Distribution and Placement							
Develop and implement program component focused on improved availability of replacement bulbs for fixtures.	L	S	S		S		
Encourage more widespread availability of replacement pin-based lamps at discount retailers and grocery stores.	L	L	S		S		
Encourage the use of ENERGY STAR recessed and outdoor fixtures in homes labeled or rated by federal and state efficiency programs.	S	S		S	L	S	L
Public Relations, Marketing and Advertising							
Establish a target penetration of ENERGY STAR outdoor fixtures in new homes of 25% by 2005.	L	S			L	S	S
Provide Point of Sale materials, retail training, support and merchandising.	L	S	S		L		
Consider further use of interactive information kiosk concept for home improvement centers currently under development with NYSERDA funding.	L		S	S	S		
Feature efficient fixtures in product knowledge classes at retailers.	L		S		L		
Expand ENERGY STAR presence and utility implementer presence at key lighting trade events (Dallas Market, Hardware and Housewares Shows, LightFair).	L	S			L		S
Testing							
Develop credible testing protocols to verify "real world" fixture light output, lifetime, and efficacy. Make ENERGY STAR a widely recognized benchmark of lighting product quality.	L	S		L	S	S	L
Standards							
Pursue addition of efficient indoor and outdoor fixtures to Model Energy Code.	S			S		S	L
Encourage California to require the use of ENERGY STAR outdoor fixtures in its Title 24 residential building standards.	S			S		L	L

2.7 Work with Industry to Meet the Demand for Better, More Energy Efficient Residential Lighting

Open competition in the lighting industry has driven a good deal of the innovation evident in energy efficient lighting today. However, there are aspects of further progress on efficiency that will require the cooperation and support of the broader market transformation community to achieve. While the industry has been able to develop some internal benchmarks of quality, such as Certified Ballast Manufacturers (CBM) and the "Circle E" ballast, these terms have virtually no meaning to a typical residential customer.

The federal ENERGY STAR labels for CFLs and residential fixtures, on the other hand, pay explicit attention to certain benchmarks of quality that are not directly related to energy efficiency, but help ensure that labeled products will satisfy the great majority of their purchasers. Indeed, the ENERGY STAR label now brings an imprimatur of independent validation to various product claims, which is quite valuable when consumers are confronted by a host of conflicting or confusing statements on product packaging. ENERGY STAR means that consumers don't need to know what CRI or luminous efficacy means – the label assures them the product is, for all practical purposes, "good."

Consumers have legitimate concerns and complaints about fluorescent lighting and manufacturers need to work to improve the performance and track record of the products. The utility survey results on this point are crystal-clear: some consumers feel they have been misled in the past by energy efficient lighting product advertising, which has made them very skeptical about current product claims.

2.7.1 The Need for Testing

At the moment, the performance information that qualifies products for the ENERGY STAR labels is provided entirely by manufacturers. EPA and DOE have taken an important first step toward improving that situation by asking manufacturers to furnish copies of in-house or independent laboratory data validating key aspects of product performance. For CFLs, these laboratories must be certified by the National Voluntary Laboratory Accreditation Program (NVLAP), which helps to assure that particular testing procedures are conducted in accordance with standard protocols, regardless of who does the testing.

However, NVLAP-certified test results for particular product samples chosen by the manufacturers themselves are no assurance that the products actually purchased by consumers in stores will perform similarly. Independent follow-up testing of randomly chosen product samples from stores is a crucial next step, extending the very valuable work begun by the Lighting Research Center's National Lighting Product Information Program (NLPIP).[54] The next question, of course, is how to treat products that testing shows have failed to comply with the ENERGY STAR specifications.

ENERGY STAR and other forms of certification, endorsement or reward for residential lighting products will succeed to the extent that testing is applied and to the extent that some kind of enforcement lends meaning and credibility to the label. A label that appears on poor quality products or products with exaggerated performance claims does not mean much.

Utilities and market transformation organizations can play a vital role in the enterprise – they provide independent credibility, the financial resources for brand-building, and an anchor for the all-important process of testing product performance and publishing findings. Utilities should press hard for stringent testing, hold manufacturers to performance claims that can be independently validated, and be decisive in withholding marketing support for products that fail to meet critical, objectively measured, testing benchmarks.

2.8 Make Energy Efficient Lighting the Norm in New Residential Construction and Renovation

Most energy efficient residential lighting programs to date have served primarily to retrofit existing inefficient lighting. This is obviously a costly and wasteful approach compared to installing efficient lighting when a building is originally constructed. Lighting retrofits are inevitably compromises, since they must work with existing building materials, windows, and the building orientation itself, rather than being holistically designed in parallel with those elements from the beginning.

As noted earlier, one of the key steps in improving the energy efficiency of residential lighting will be the systematic substitution of ENERGY STAR qualified downlights for the incandescent downlights now employed so heavily in new buildings. But hardware substitutions only scratch the surface of what is possible. There are crucial elements of design and system integration that are equally important.

The goal of reducing electricity consumption in the home can be accomplished by two equally valid means: reducing power consumption for each hour the products are operating, and reducing the number of operating hours. Good lighting design recognizes that appropriate switching means not all the lights in a particular room need to be on at once, and that individual lights accomplish different and separate purposes and need to be located where they can be the most useful. It also recognizes that lights serve no purpose illuminating empty rooms, and applies motion sensors, timers, dimmers and switching to allow occupants to tailor lighting to their needs and automatically shut down unneeded lights. Finally, energy efficient residential construction acknowledges the useful role that daylighting can play in a home, and works to admit daylight to interior rooms in a way that minimizes glare and undesirable heat gain.

Key institutions will also play a vital role in ensuring that efficient lighting becomes a standard feature of residential new construction. Banks have begun offering energy efficient mortgages (EEMs) that allow home purchasers to finance the cost of energy efficiency upgrades. Those mortgages are not yet configured to include energy efficient lighting upgrades, but should be encouraged to do so.

The Home Energy Rating Systems (HERS) that often form the methodological basis for efficient mortgages (and the national ENERGY STAR labeling program for new homes) also do not include lighting (or appliance) consumption, focusing instead on the building shell, water heater, and HVAC system. A straightforward revision to the software used by most HERS programs would solve this problem, but at the moment no organization has stepped forward to fund such a change, which the software companies are understandably reluctant to undertake on their own.

The ultimate means of institutionalizing efficient lighting in new construction is of course to incorporate it into state building codes and the national Model Energy Code. This is discussed further in Volume 1, Section 3.3.3.

2.9 A Market Strategy

While the market transformation community has shown broad support for working together to improve residential lighting efficiency, it has faced some internal dissent about the best means of accomplishing that goal. Perhaps the best way to unify the various players around a common goal is to orient the entire effort toward lighting *markets* rather than utility service territories, states, or regional boundaries. This is a bottom-up approach that begins by asking consumers what they want from lighting, and then marketing energy efficient lighting in a way that features those attributes.

2.9.1 Improving Communication

It may be tempting for researchers, regulators and utility program managers to believe that customers share their interests in energy issues, costs, and technologies. In reality, energy rarely makes it onto the average individual's radar screen when shopping for lighting products. It is not, by itself, a compelling reason for most people to choose one residential lighting product over another.

However, energy efficiency carries with it a number of attendant values and considerations that do matter greatly to various groups of consumers. The key is not necessarily to overwhelm the audience with six to eight reasons to prefer an energy efficient light over a standard one, but to target messages to particular audiences, which will vary by region, age, gender, income, education, etc. Energy efficient lighting needs to solve a problem that customers feel they have or convey a benefit they feel they need. For some people that will be financial savings associated with lower energy bills. For others, it will be the environmental benefits of reduced fossil fuel consumption. For others, it will be convenience and a virtual end to bulb-changing hassles. For still others, it will provide a measure of safety and security, especially if they have small children at home. Others may find the diffuse, soft light a source of comfort compared to the sharp lines, stark shadows and glare of pinpoint light sources like incandescent bulbs.

Manufacturers have gotten better at addressing the interests of the residential market. In a recent national consumer survey cited by Philips, for example, longer life rated highest in the attributes consumers were seeking from their lighting purchases, exceeding their desire to purchase "a major brand," to get a "good value" for their money, or to purchase a "high quality" lamp. This did not persuade Philips to stop marketing CFLs; it told them to give greater attention to the longevity of its products with marketing slogans like "EarthLight: The 5 Year Light Bulb." The message is simple and straight out of Business 101: "listen to your customers and give them what they want."

Philips also learned through market research that only 30% of light bulb buyers enter a store knowing exactly what they want. The remaining 70% make that decision at the store, which drove Philips to revamp its point of purchase displays entirely to segment its products by application and purpose rather than by technology or wattage.[55] Osram Sylvania made a similar change in its displays even earlier, and General Electric's displays are also become more application-focused. Now a customer can go to the store seeking a bulb for a reading lamp, for example, and be presented with good/better/best options that correlate to longer product life and greater energy efficiency. This should increase CFL sales compared to the older strategy of placing all CFLs in a single part of the store, regardless of their light output, shape, or application.

2.9.2 Planning for Market Transformation

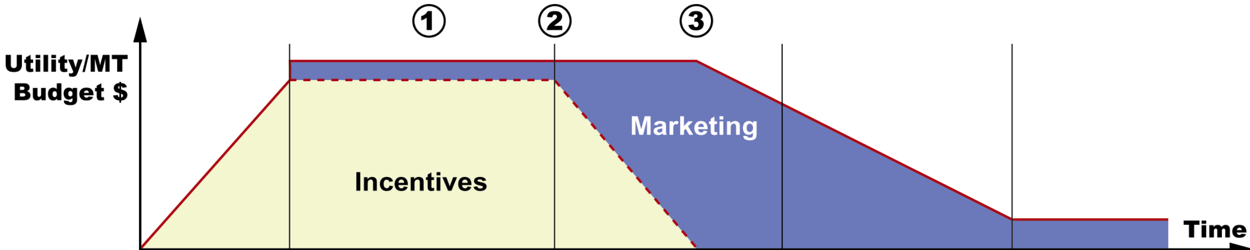
On the utility or market transformation organization program side, a market-based strategy for energy efficient lighting should work from clearly defined goals with definite beginnings and ends. Thus funding decisions for residential lighting programs might stem from an eight or ten year plan that measures progress toward a product market share goal. Each year, incentive levels, marketing expenditures, and overall program budgets should be determined primarily by how the targeted product progresses in the marketplace, rather than by perpetuating the previous year's incentive level until the budget is exhausted, or by simply renewing the previous year's budget plus inflation.

This means getting serious about ramp-down strategies and making planned, deliberate progress towards products that can succeed independently of programs. The focus on meeting short-term unit sales goals and the absence of honest ramp-down strategies in utility lighting programs remains a great challenge. Individual utilities leashed by regulators and consumer advocates to annual unit sales goals are understandably reluctant to stray too far from a time-honored formula: pay rebates to entice people to buy products. However, these start-and-stop efforts rarely ratchet toward a long-term change in consumer preference. If anything, they only prove that everybody loves a sale, and that many people are willing to wait for the next one before buying again. Whether utility rebates are paid to purchasers, retailers or manufacturers, is by itself less important. Utility programs need to mesh with larger marketing efforts undertaken by manufacturers and retailers in order to succeed.

In general, current market conditions suggest that utility residential lighting programs should be shifting resources from product incentives to marketing investments for most CFLs and, to a lesser extent, also for residential lighting fixtures. This means that utilities, manufacturers, retailers, and the government must work together to steadily build a message of *value* instead of *price* in customers' minds. It suggests a strong preference for program designs that provide some flexibility for retailers or manufacturers to direct incentive dollars toward cooperative advertising, point of purchase displays, promotions, or salesperson training instead of merely to reducing purchase price.[56] Each of these non-price steps is an investment in an *infrastructure of efficiency*—one the keeps on paying dividends in the future. Over time, the investment in marketing should exceed the investment in price reductions (see Figure 9), clearing the way for energy efficient lighting products to stand by themselves as valued consumer purchases. Remaining long term expenditures by market transformation organizations would be to publicize the availability and advantages of such products, rather than to permanently subsidize their price.

It is perhaps not too much of a simplification to note that the last 12 years of program activity by utilities have been undertaken to close the gap between the price manufacturers are willing to sell a CFL for and the price most consumers are willing to pay for one. However, we always need to remember that such a gap can be closed by movement in either of two directions: driving down the long term price manufacturers need to

Five Key Phases of Residential Lighting Market Transformation



Phase	PILOT	FRONTAL ASSAULT	TRANSFORM	POPULARIZE	MAINTAIN
Goal	Experiment	Secure distribution & sales	Build value message	Mass adoption	Support market
Methods	Give away, direct-install	Per-unit incentives, basic marketing	Declining incentives, marketing blitz	Innovative marketing, training & field support	Recommend, refer, inform

Figure 9 – Utility incentives are the key driver in the first two phases, while marketing becomes the key driver in the third and fourth phases, paving the way for an exit of utility investment in the fifth phase.

charge for the products to make a profit, and elevating the price consumers perceive CFLs are worth and are thus willing to pay for them. We have made tremendous progress on the first, but very little on the second.

The numbers above the figure provide an approximate indication of the market transformation progress attained by various efficient lighting products so far. “1” corresponds to the status of ENERGY STAR hard-wired fixtures, which have only been available in retail stores for about 12 to 18 months. Financial incentives are still required for these products, both to introduce consumers to a new family of lighting products and to lure new manufacturers and product types to the market. Education and marketing efforts that are directed specifically at these fixtures are still rather modest, but should logically increase as their presence in the market grows and the need for financial incentives declines.

“2” is ENERGY STAR torchieres, which currently receive rebates of $10 to $20 apiece through market transformation programs in at least 10 states. With strong marketing and educational support, these products are poised to succeed in the marketplace with reduced financial incentives. Their advantages over halogen torchieres in terms of safety, comfort, and convenience are compelling, and justify their higher price.

“3” corresponds to the status of most CFLs—a mature product whose natural market price has already dropped considerably. CFLs will prosper with a reallocation of resources from financial incentives to highly visible marketing efforts that focus on the value of their benefits and features. As noted in Volume 1, Section 2.4.1, incentives are still important for key niche CFL products like highly compact or dimmable models, provided that they meet quality and performance requirements.

2.9.3 Looking Ahead

Beyond the residential lighting market transformation needs of the present, there will be future opportunities presented by new residential lighting technologies. A number of these emerging technologies are considered in detail in Volume 2, Chapter 5. As these technologies are commercialized, there will be a role for energy efficiency programs to play in nurturing new products and putting them before consumers. Once again, the most effective strategies will be those that augment or accelerate natural market trends. Utility or public money will never make a residential lighting product successful unless it meets a need that consumers feel they have. What effective, well managed market transformation programs can do is compress the phases of market transformation, and capture opportunities that would otherwise be lost by getting larger numbers of energy efficient products into the market sooner than would have otherwise been the case.

Compact fluorescent technology is usually at least three times more efficient at converting electricity to visible light than the incandescent technology it is designed to replace. It also requires a shift in the residential lighting paradigm from incandescent to fluorescent. Advances in residential lighting technology currently on the drawing board (at least for the near future) are likely to be more incremental. Technologies that are either appearing now or that will appear soon, such as Light emitting diodes (LEDs), are not much more efficient than fluorescent technologies, but they may allow high efficiency lighting to be used in residential applications that fluorescent lighting options cannot serve.

3 Specific Recommendations for Action

Many of the general strategies discussed in the previous chapter have particular elements that apply to one or more market transformation players. In this chapter, we examine the key roles that each group of stakeholders can play in bringing about residential lighting market transformation. Each has a vital contribution to make in accomplishing the goal of reducing residential lighting energy consumption.

The specific policies and programs recommended here are drawn from interviews with the various stakeholders, research into the findings of various program evaluations and surveys, and dialogue at broad-based meetings of the market transformation community. The intent is not to give "marching orders," but rather to collect and characterize from a wide array of proposals, a coherent view of how each part of the market transformation community can bring its strengths to the table. We will not succeed without coordinated, national action to transform residential lighting markets.

3.1 Develop a common language of lighting

One of the lessons that emerges from years of market research is that consumers frequently attach negative connotations to the word "fluorescent" (see Volume 2, section 3.8). Indeed, many energy efficient lighting manufacturers have gone out of their way to avoid the use of the word "fluorescent" on product packaging, using phrases like "electronic light bulb" or "energy saving bulb" instead. The challenge remains how to educate consumers about the clear advantages of lighting their homes in a fundamentally different way.

We must always keep in mind what the public knows and does not know about lighting. Light bulb packaging may furnish federally required information about lumens, watts, and hours of life, for example, but there is no common awareness by consumers of what lumens mean. Sadly, the phrase on packaging, "choose the light output you need" implies a level of pre-existing knowledge that simply is not there. The average consumer has no idea whether a higher number of lumens is good or bad, and certainly no sense of the number of lumens typically needed to light a room of a particular size and shape. By contrast, consumers know the difference between the light output of a 100-watt and a 60-watt incandescent bulb, and can readily describe which they need or prefer for particular light fixtures in the home.

According to a 1995 survey of 1,000 consumers, 62% stated that wattage measures the brightness of a light bulb. Another 11% believed that either amps or degrees measure brightness, while only 27% correctly stated that lumens measure brightness. An astonishing 42% of those surveyed did not even know the difference between incandescent and fluorescent bulbs.[57] In total, these observations suggest the need for even more basic education by manufacturers, retailers, and the regulators who oversee their marketing claims. At the very least, consumers need to know the difference between lumens and watts and need to know the meaning of lumens per watt (see Volume 1, Section 3.2.3).

Utilities, manufacturers, and retailers should think carefully about the language used in marketing and educational pieces. What is technically correct may not always be meaningful to the average reader. All parties attempting to translate the complex world of efficient lighting for typical consumers with printed brochures, point of purchase displays, and product packaging should attempt to convey those concepts as simply and visually as possible.

3.2 Action Items for the Federal Government

3.2.1 Expand and Strengthen ENERGY STAR

It is important to realize that the success of ENERGY STAR labeling programs is crucial to meeting the goals of the nation's Climate Change Action Plan. The government is seeking to achieve nearly a third of its residential and commercial sector goal and more than 10% of its total national goal for greenhouse gas reduction from the sale of a variety of ENERGY STAR-labeled consumer products, including lighting.[58] One important step towards the achievement of this goal has already been taken: a formal and largely functional agreement between the U.S. Environmental Protection Agency (EPA) and U.S. Department of Energy(DOE) to work together to encourage the sale of ENERGY STAR residential fixtures and CFLs (respectively).

However, in their two programs the two agencies have defined the ENERGY STAR brand in slightly different ways. EPA's light fixture program sought to recognize not just fluorescent fixtures, but ones that employed particular quality and performance advantages over traditional models. At the time the program began, very few fixtures already for sale in the residential marketplace were able to qualify, but the pool of qualifying products has grown remarkably in the interim. By contrast, DOE's screwbase CFL specification is somewhat more inclusive of the existing range of available CFLs (a more mature market than fixtures), based on the reasoning that all compact fluorescents are more energy efficient than their incandescent counterparts. The CFL specification "weeds out" a few products, but allows the vast majority of existing CFLs to qualify. As both ENERGY STAR specifications are revised in future years, the two agencies may wish to gravitate toward one message with both programs to avoid confusing the marketplace about the meaning of ENERGY STAR.

The programs have shown substantial success in balancing the importance of customer-driven issues, such as light output and start time, with issues of greater societal importance, such as efficacy and compliance with FCC noise and interference specifications for residential applications. For example, though noise shielding may increase consumer cost in the short term, it helps prevent efficient lighting from causing problems in the home that might discourage its long term acceptance. Likewise, the evolution of both the revised fixture specification and the final CFL specification away from the high power quality requirements that were common in utility programs during the last decade, recognizes and important fact. Some things are better handled through international standard-setting bodies than through voluntary pollution prevention programs.

EPA should work with DOE to continue expanding the readily recognizable ENERGY STAR label into other arenas of energy efficient residential lighting as well. At the moment, for example, a consumer can buy an ENERGY STAR hardwired or portable fixture, or screw base CFL, but not an ENERGY STAR pin-based compact fluorescent lamp for use in an existing ENERGY STAR fixture or two-piece CFL. This leaves the program somewhat incomplete, since the use of a mismatched or incorrect light source with an otherwise high quality ballast could negate many of the lighting quality and efficacy benefits ENERGY STAR seeks to provide.

Likewise, DOE's recently developed ENERGY STAR specification for compact fluorescent bulbs still faces some crucial challenges. The specification allows two-piece designs for circular and square lamps where the lamp and ballast are sold together by one manufacturer, but does not allow two-piece designs in more traditional vertical orientations, even if the lamp and ballast are sold together by one manufacturer. With high lumen products like circular and 2D lamps, modular designs remain the norm, and the modular approach is also popular in some new and very compact models that at the moment are ineligible for the label (see Figure 10). The specification should be modified to include such products.

Figure 10 – This model can function as a normal lamp or as a "bug light" for outdoor use in summer (Calwell)

ENERGY STAR labeling programs also do not yet extend to spotlights (reflector or PAR incandescent lamps), of which some 136 million units were sold in 1994.[59] It is very common for consumers to face a choice between 150, 120, 90, and 60 watt reflectorized lamps in both incandescent and halogen versions at line voltage and countless low voltage halogen models ranging from 20 to 71 watts. Some designs are far more energy efficient than others. With only manufacturer labeling at present to help them choose

Figure 11 – Sample ENERGY STAR display in a Pacific Northwest home improvement store (Penny Cody)

among the array of competing options, consumers would benefit from ENERGY STAR labeling to clearly identify the most energy efficient options.

Similarly, night lights currently have no standardized labeling to differentiate products on the basis of efficiency, even though cash register data indicate sales of at least 76 million units per year. These products range from at least 7-watts down to 0.03-watts—a more than 200-fold difference in power consumption for products designed to serve a similar function. Product lifetimes also vary enormously, and that variation will continue to grow as more electro-luminescent and LED-based products (see Volume 2, sections 5.2.1 and 5.2.4) enter the marketplace. Longevity and efficacy could be recognized in ENERGY STAR labeling to encourage more energy efficient purchases.

There is also an urgent need over the next two years to steer both existing ENERGY STAR residential lighting programs toward more "real world" performance measures for products. For simplicity, both specifications were designed initially to measure product efficacy with nominal, catalog-based values. But testing by the National Lighting Product Information Program (NLPIP) has consistently shown that both bulbs and fixtures tend to provide less light in actual operation than their nominal ratings indicate, often reducing measured efficacy as well. With ceiling-mounted fixtures in particular, NLPIP found that actual light output from the fixture is frequently only a third to half of the rated light output for the lamps inside.[60]

By asking manufacturers to provide test data in its revised ENERGY STAR Memorandum of Understanding for residential light fixtures, EPA has taken an important first step toward solving this problem. The DOE specification for CFLs also breaks new ground by requiring stated light output to correspond to the actual tube and ballast combination employed rather than the tube with an optimized "reference" ballast. The next iteration of both the bulb and fixture specifications should utilize actual light source and luminaire efficacy values, even if it means lowering the specification levels that need to be met, to capture information more relevant to what purchasers will actually experience.

EPA and DOE should also continue to work very closely with utilities and other market transformation organizations to build awareness and use of the ENERGY STAR label. The ENERGY STAR program has provided a platform for co-branding that was urgently needed by utilities (Figure 11). They can link marketing messages to an overarching one, and exploit synergies in their various local and regional efforts.

However, ENERGY STAR also needs the utilities because there is currently minimal consumer awareness of ENERGY STAR lighting outside of utility programs. It is no accident than many manufacturers ship ENERGY STAR products first to regions of the country where utilities are offering financial incentives and marketing resources, and only later to other regions without such support. EPA and DOE have limited resources they can invest by themselves to build a consumer brand. Everything EPA and DOE can do to encourage partnerships with utilities, feature their program successes in newsletters to manufacturers and retailers, and provide a spokesperson presence at their public events will help leverage the valuable resource of utility program dollars into greater success for ENERGY STAR.

Finally, both agencies should continue seeking opportunities to link ENERGY STAR lighting to labeling or recognition programs for new and existing homes. While some home buyers may be willing to consider energy efficiency generally at the time they buy a house (and possibly seek an energy efficient mortgage to pay for upgrades), the number who are willing to expend a special effort thereafter, just to improve the efficiency of lighting is much smaller. Therefore, anything that can be done to "bundle" lighting upgrades with larger capital measures like furnaces and air conditioners will likely improve the installation rate of efficient lighting in new and remodeled homes. EPA's ENERGY STAR program for new homes does not currently consider lighting efficiency, and the agency has been reluctant to add measures to its list of requirements that would make it more difficult for participating builders to earn the label. As the ENERGY STAR Homes program continues to grow, EPA should consider incorporating existing ENERGY STAR lighting specifications as a supplement to its current requirements.

3.2.2 Encourage and support the development of a national performance testing program for residential lighting products

As noted earlier, the ENERGY STAR label will have far greater meaning in the marketplace if it reflects the evaluation of measured performance data instead of self-reported manufacturer claims. While such an effort would not in all likelihood be led by a government agency, it would benefit greatly from input and encouragement from the government. Its goals should be similar to those pursued by many consumer magazines that cover technical, fast-moving products like computers or audio:

- compare products consistently against broadly accepted test methods and metrics of performance
- publish those results frequently and as widely as possible
- interpret the results for a lay audience, but include all findings for those with enough expertise to assess the raw data.

In addition to encouraging the development of a national testing effort, however, EPA and DOE need to be willing to utilize the data generated to exert pressure on manufacturer partners in the ENERGY STAR programs to correct deficiencies. The more closely the ENERGY STAR program becomes linked to utility incentive and marketing efforts, the higher the stakes will be for manufacturers whose products fail to meet ENERGY STAR specifications when tested.

3.2.3 Further coordinate federal government resources to encourage residential lighting efficiency

The US EPA and DOE have lead much of the federal effort to date to encourage the use of more efficient residential lighting. While their ENERGY STAR labeling programs and public education efforts are showing signs of success, the agencies have significant unrealized opportunities for partnerships with other federal agencies that could accelerate progress.

More could be done to elevate awareness and purchasing of these products within Housing and Urban Development (HUD), which could help circulate the information to energy engineers in the buildings it manages. HUD also wields substantial influence over the energy and lighting decisions made at many state and local low income housing authorities, and has an active financial interest in lowering the energy bills incurred by occupants of those facilities. There are also opportunities for HUD to work with utility low-income programs. The Federal Energy Management Program (FEMP) and the General Services Administration (GSA) also play a vital role in procurement efforts. FEMP in particular should take a strong lead role in driving large volume purchases of ENERGY STAR-labeled fixtures and bulbs for use in federal housing, barracks, dormitories, and other federally funded residential buildings.

Perhaps the agency that can contribute the most to the success of efficient lighting efforts is the Federal Trade Commission (FTC). The FTC is chartered with federal authority over false or misleading product claims, and has used it successfully to push window manufacturers to be more honest and systematic in their claims of window energy efficiency. Unfortunately, the FTC has been rather less active in reviewing and policing misleading claims by lighting manufacturers. Claims made by some manufacturers about the dollar value of electricity savings from their products are particularly optimistic and frequently unsupported. Given the difficulty manufacturers face in policing claims by their competitors, an opportunity exists for third parties to petition the FTC to formally review such claims when they arise.

Manufacturers often claim their products will save hundreds of dollars, even though such savings would only occur if the product electronics last longer than typical product lifetime and replacement lamps continue to be widely available. Claimed energy savings are often based on unrealistically high electricity rates and atypically long duty cycles. Claims of environmental benefits are routinely made by incandescent and halogen torchiere manufacturers, although those products do far greater environmental harm than ENERGY STAR alternatives.

The FTC has made an important start on this effort by implementing standardized labeling language regarding light output (lumens), power consumption (watts), and operating lifetime (hours) on light bulbs.[61] What is missing is the fourth, and perhaps most meaningful metric, lumens per watt—a very useful measure of product efficiency. Although manufacturers recommended that lumens per watt information be included in lamp labeling, this was rejected by a Federal Trade Commission rulemaking in the early 1990s.[62] When these labeling guidelines are revised in the future, lumens per watt information should be added, recognizing that such labeling changes are costly to manufacturers and should only be made infrequently.

Efficiency could be conveyed by a simple message appearing on product or displays as follows:

WATTS = ELECTRICITY USE	Lights with higher wattage consume more energy.
Lumens = light	High lumens means bright light. A 2800 lumen light typically used for reading is twice as bright as a 1400 lumen light, as might be used in a hallway or ceiling fixture.
Lumens per watt = energy efficiency	High lumens per watt means energy savings. Lights that offer 60 lumens per watt are four times more efficient than lights that offer only 15 lumens per watt.

This message works directly to dispel the persistent belief that wattage measures light output, and helps consumers understand the negative consequences of high power use. Federal public service announcements about such a labeling change would also help, and provide utilities with a tool to further their own educational efforts.

The FTC has also required the use of particular efficiency language on light bulbs: “To save energy costs, find the bulbs with the light output you need, then choose the one with the lowest watts." This language is not yet required on dedicated fluorescent fixtures, pin-based replacement lamps, or even on the bayonet-shaped halogen lamps used in work lights, outdoor fixtures and torchieres.[63] However, this information would be very helpful to educated consumers weighing a dedicated fluorescent or halogen fixture against a standard fixture that could accommodate a variety of uniformly labeled light sources.

At the moment, however, there appears to be little enforcement of even the three basic metrics (lumens, watts and hours) noted above, leading to inconsistent manufacturer claims.[64] Some products have far higher failure rates than others, yet claim virtually identical operating hours on their packaging. CFL lifetime continues to be reported on the basis of total operating hours, though number of starts may be often a better predictor of product lifetime. Some manufacturers report average light output after 40% of rated life, while others report initial light output. Some products perform far differently in one physical orientation than another, yet provide best case performance claims, regardless of the orientation in which the products are most commonly used. Manufacturers routinely project lamp lifetimes based on testing under ideal conditions and with a reference ballast, rather than with the actual ballast. Consumers will be more satisfied with products that perform as advertised, and the FTC is in the best position of any federal agency to ensure that happens.

3.2.4 Set an ambitious agenda for residential lighting research by national laboratories and academic institutions

There are three key areas in which national labs and universities can help accelerate residential lighting market transformation. The first is by helping to develop the next generation of efficient lighting technologies. Lawrence Berkeley National Laboratories research helped incubate technologies like the electronic ballast, compact fluorescent portable fixtures, and infrared-reflective halogen bulbs. Continued funding for both pure and applied research, including technical assistance for manufacturers seeking to optimize efficient lighting products, is critical.

Secondly, it is clear that the laboratories and universities can help inform development of future specifications through their experience measuring and monitoring the performance of existing products. Their input should be actively cultivated whenever labeling specifications are being revised.

Third, the national laboratories should assist DOE in the development and ongoing updates of a national residential lighting baseline. At the moment, the most current official federal survey of residential lighting energy use dates to 1993, and is based on a general survey answered by 7,111 households nationwide and a specific lighting survey based on only 474 households nationwide.[65] This sample size is smaller than that frequently used by individual utilities to understand lighting use within a particular region of one state. The DOE/EIA study also was not published until approximately three years after its data were gathered, is based entirely on self-reported information, and was apparently a one-time project, having no funding to be updated. If a systematic national lighting survey or inventory can be put in place, it will be invaluable in future efforts to determine a baseline, identify trends, and form a basis for policy recommendations.

3.2.5 Consider establishing federal efficiency standards for residential lighting products

The Energy Policy Act of 1992 states clearly that DOE must consider additional energy efficiency standards for fluorescent tubes and incandescent bulbs shortly after the turn of the century.[66] These standards, like other DOE standards, would be based on a rationale of minimizing product lifecycle cost. Both the lighting industry and advocacy groups have recently joined forces through electronic ballast negotiations to recommend that DOE commit the resources to study carefully the residential lighting standards opportunities presently available, particularly in outdoor lighting and night lights. DOE should follow through on that analysis and pursue cost effective standards opportunities that emerge from it.

3.3 Action Items for State Energy Offices

State energy offices often represent the “front lines” of residential energy efficiency, because of their numerous connections to procurement agencies, state housing organizations, utilities, and the local construction industry and energy offices can play an important role in making wider initiatives work on a state or local level.

3.3.1 Facilitate procurement of energy efficient lighting products through public housing authorities and other state agencies

With assistance from various state agencies, the New York City Housing Authority (NYCHA) was able to launch a recent large-scale procurement of energy efficient apartment-sized refrigerators. This in turn grew to include numerous other public housing programs from cities and states around the country. A similar model could be employed with lighting, particularly with the kinds of fixtures most commonly utilized in low income housing. NYCHA is currently working with the New York Power Authority (NYPA) to conduct a pilot procurement of CFL torchieres. State energy offices are the logical party to bring energy efficiency considerations to the table, and to be sure that efficiency criteria are given prominent consideration by other state agencies with other agendas.

3.3.2 Facilitate and fund pilot demonstrations of innovative lighting technologies

The California Energy Commission has been particularly active in funding basic research and demonstrations of advanced lighting technologies. Under the current regulatory structure in California, that role is likely to expand further in the future, and is already poised to accelerate the development of lower-cost compact fluorescent downlights. Other state energy offices are encouraged to take a similar tactic in helping to drive innovations in residential lighting efficiency.

3.3.3 Include energy efficient lighting in state residential building codes

Because the national Model Energy Code (MEC) is virtually silent on residential lighting, the majority of states who follow its lead should take additional initiatives to require better lighting in new construction and major remodeling projects. For some states, such as California, the opportunities to go beyond what has been done to date are substantial, and can help encourage future changes in the MEC. California's Title 24 residential building code has demonstrated greater success with stimulating the use of efficient lighting in kitchens and bathrooms than is often acknowledged.[67]

The Northwest Energy Efficiency Alliance has already stated that its exit strategy for ENERGY STAR fixtures will be the incorporation of those fixtures, after 5 to 7 years of regional incentive funding, into the various state residential building codes of the region. Likewise, the California Energy Commission continues to evaluate a recommendation made by consultants to its statewide Lighting Efficiency Advisory Group to incorporate an ENERGY STAR outdoor lighting provision in its statewide residential building standards.

California and other states should utilize the building codes and standards process as a valuable complement to other incentive-based processes and as an integral component of exit strategies for its utility incentive programs. Codes are the capstone of market transformation – making efficient products the default in particular applications and building types.

3.4 Action Items for Public Utility Regulators

3.4.1 Support market-based program initiatives

After more than 15 years of utility-funded residential lighting initiatives, a few essential guidelines for successful programs have emerged. Most are in the purview of public utility regulators. The utilities and market transformation organizations can also pursue them, but are often powerless to implement without the approval of regulators. In reality, utilities are often reluctant to change from established practice and adopt more effective program approaches, but can be persuaded to do so by proactive regulators.

The first is to ensure that utilities and their implementers collaborate on a market (or at least state- or region-wide) basis in all major aspects of technical program requirements and program design. Nothing is more frustrating to manufacturers and retailers—who would otherwise be interested in being part of a market transformation program—than to discover that different utilities within the same market employ different rebate amounts, qualification levels, budgets per store or customer, or dates of eligibility. Indeed, if one utility in a region-wide program provides significantly less funding than the others, or worse yet imposes a different product specifications on products in their service territory, it can put a limit on program impacts across the entire market. A commitment to work within markets means exactly that – presenting a unified front to the market as a whole.

The second is to require utilities to employ common product specifications and labeling in their programs whenever possible. The arrival of ENERGY STAR labels for both bulbs and fixtures has simplified this challenge enormously, but many regulators remain unaware of the full extent of possible linkages to ENERGY STAR. Regulators should also be acutely aware of the negative market impacts of individual utilities adding supplemental requirements beyond ENERGY STAR when others in their region do not, and work to assure that utilities agree on a common approach *before* seeking participation from manufacturers and retailers.

Third, it is difficult for manufacturers to gear up to produce a greater volume of efficient products without an assurance that programs will run beyond a single year. Moreover, the bulk of residential lighting products are sold from October through March. Many utilities spend January through April wrapping up the previous year's program and preparing for the next year. This eliminates fully half of the peak lighting-buying season from program participation, and makes the other half (October to December) unnecessarily frenzied.

Regulators should first require utilities to commit to funding residential lighting programs for at least three years. Regulators should also require utilities to run programs from September of one year to April of the next and shift program wrap-up and design to the late Spring. Utilities need to be able to give manufacturers enough time to plan effectively for utility programs in advance of the lighting season. The regulatory review schedule should take this need into account.

Finally, regulators should work with their colleagues in neighboring states to overcome differences in philosophy and approach to residential lighting market transformation. When regulators in states that share a market set opposing policies, it dooms utility programs in both states to failure. It is often better to negotiate a common approach, even if it is not considered optimal by any one state. This applies particularly to evaluation. Differences in evaluation goals and approach make it difficult to compare program results across state lines.

3.4.2 Remove regulatory barriers to market transformation

Regulatory requirements for specific information on individual purchasers of products through residential lighting programs often creates a barrier to the market-transforming impacts they are trying to achieve. Not only is it costly to obtain name, address, and telephone information for each purchaser of a CFL or fixture in participating retail stores, but the administrative requirements can preclude the use of proven, highly cost-effective promotional approaches like manufacturer incentives. Regulators should balance the desire for precision in verification with a concern for overall program success and cost effectiveness.

It is often possible to obtain highly useful program participation information from a statistical sample of program participants without verifying each and every purchase. Likewise, the advent of electronic cash register data eases the verification of sales of rebated products.

3.4.3 Budget utility programs to achieve market goals

As noted earlier in Volume 1, Section 2.9.1, it is all too common for utilities and their regulators to simply carry over incentive levels or overall program budgets from a previous year when designing the next year's program. This makes no sense in the market transformation context. A market transformation program's budget should be driven by measures of market share, product availability, and program cost-effectiveness. Each year, regulators should ask program managers to measure their progress against originally stated program goals, establish goals for the coming year, and propose budget totals and allocations (incentives vs. marketing) that can honestly achieve those goals. Failure to achieve goals should result in program redesign.

3.4.4 Consider program design in the context of current trends in the utility industry

An examination of utility program results for efficient residential lighting leads to an interesting conclusion: Utilities in only 15 to 20 states are actively working to reduce residential lighting energy use. A rough estimate of total U.S. utility expenditures on residential lighting efficiency exceeds $23 million for 1999. However it is also true that many U.S. utilities are spending substantial amounts of money promoting outdoor security lighting as a load building technique. It is vital that regulators recognize that utilities often experience conflicting incentives that encourage them to work to both reduce and increase electricity consumption for residential lighting.

The Lamp Division of Westinghouse noted as early as 1939 the operating principle that drives fluorescent lamp markets even today. When a customer buys a fluorescent light instead of an equally bright incandescent, the typical utility's earnings drop while the earnings of the lighting installer and retailer rise.[68] The reason that some utilities in progressive states are actively pursuing residential lighting energy efficiency is incentive regulation that has de-coupled profits from electricity sales. These utilities often stand to make substantial profits by helping their customers invest in energy efficiency. Unless incentive regulation is implemented in more states, U.S. utilities as a whole will be a force for greater, rather than less, residential lighting energy use.

The restructuring of utility markets is leading to additional new dimensions. Some utilities now wish to provide lighting efficiency services as a means of retaining customers who would otherwise seek lower electricity rates, more services, or both, from another power provider. Indeed the first changes in utility regulatory mindset in the early 1990's caused many utilities on the east and west coasts to move from simply giving away CFLs to more innovative, successful program designs. However, regulators should not forget the main lesson of the last few years. In the late 1990's electric utilities have substantially reduced total program budgets for energy efficient residential lighting as part of their broad-based cost-cutting response to industry restructuring. In fact, according to a recent report, all utility energy efficiency investments dropped by about $736 million between 1993 and 1997, and 42 utilities stopped funding efficiency programs entirely.[69] While only some of these reductions affected residential lighting programs, they may have been significant enough to slow the national growth of CFL sales.

Regulation compelling utilities or third party providers to operate energy efficient residential lighting programs might counteract that trend modestly in the near term. However, over the long term, it offers far less promise than rules that financially reward program operators in proportion to the cost-effective, societally beneficial *outcomes* of such programs. Regulators should not let energy efficiency programs, and results-based mechanisms for funding them, be swept away in the restructuring tide.

3.4.5 Study what has and has not worked in other jurisdictions to optimize programs toward winning designs

There are substantial differences in market transformation program performance between U.S. utilities and regulators need to be actively aware of how similar programs are doing in other regions. Especially as program results begin to be collected and compared by a central organization (see above), regulators should redouble their efforts to understand the successes and failures of other programs and apply those findings during regulatory proceedings in their own states.

3.5 Action Items for Energy Efficiency Advocacy Organizations

3.5.1 Organize, summarize, publish and target residential lighting market transformation information

Advocacy organizations, because they often have broad national or even international perspectives, are in a unique position to infuse new information into local and regional discussions about market transformation program design. Advocacy organizations should play an active role in discussions about residential lighting program funding levels, objectives, design, and evaluation. Advocacy groups are financially disinterested and therefore can help broker consensus positions and resolve conflicts. For example, the Natural Resources Defense Council (NRDC) and the National Electrical Manufacturers Association (NEMA) were at the forefront of resolving the longstanding conflict between utilities and manufacturers regarding concerns about power quality and CFLs. As a result, the ENERGY STAR specifications are now being widely adopted by utility residential lighting programs, establishing a truly common technical specification for the first time.

Until recently, virtually all relevant market research has resided exclusively in the hands of lighting manufacturers and retailers. Both the Northwest Energy Efficiency Alliance and the New England Energy Efficiency Partnership have launched significant market research efforts of their own in recent years, including focus groups and interviews with manufacturers and retailers. This information, along with similar items publicized in trade magazines and made available by manufacturers and retailers should be categorized, abstracted, and distributed by a central organization. Also, many other countries enjoy substantially stronger markets for energy efficient residential lighting than does the U.S. (see Volume 1, Section 2.2) Further international research and comparisons are urgently needed, and advocates are in an excellent position to glean those results and share them with other parties who can put them into practice here.

3.5.2 Work to include energy efficient lighting in state and regional Home Energy Rating Systems (HERS)

As noted above, the Home Energy Rating System (HERS) only addresses lighting in a cursory fashion. The political and process hurdles to getting lighting incorporated into these labeling and rating programs are substantial. There is a great deal of inertia behind the existing methods used by builders and home energy raters. The software programs used to automate the rating process need to be modified at considerable expense, and raters need to be trained in rapid methods of classifying existing lighting and efficient lighting by wattage. The HERS programs of Vermont and Indiana have expressed interest in pilot testing the rating of lighting and appliances, if software tools to assist the process could be devised. Because HERS programs are typically run by non-governmental organizations, advocacy groups are in a unique position to work with them to motivate program changes.

3.5.3 Encourage collaboration between future market transformation evaluation activities on a state and regional basis

Utilities are usually required to submit evaluations of their residential lighting energy efficiency programs to state regulators. However, there is often no requirement that these evaluations use consistent methodologies or be so designed as to allow them to link together to provide a market-wide perspective. Advocacy organizations should encourage regulators and utilities to look beyond local jurisdictions when planning and executing program evaluations. Collaboration on market research reduces the cost and time required as well as lowering the burden on manufacturers and retailers.

3.5.4 Look beyond the geographical areas of established efficiency programs and develop links to new regions

CEE’s membership consists largely of organizations from the regions most traditionally active in market transformation: California, the Pacific Northwest, the Upper Midwest, and the Northeast. People from these regions are most likely to attend program design and evaluation conferences, and most likely to establish regional market transformation organizations. Based on research NRDC conducted in 1998, there are substantial, very promising opportunities to partner with “hub” organizations in the Southeast, Midwest, and Southwest, as well as Alaska and Hawaii, to accelerate additional market transformation.[70] In addition, we need to acknowledge that national market transformation for residential lighting will not occur until more of the country is engaged.

3.5.5 Make the case for residential lighting energy efficiency when new program resources become available

Within a world of scarce program resources, the technological promise of efficient lighting (50 to 80% energy savings potential) is a powerful advantage. However, that advantage is not always immediately obvious to the managers and regulators charged with weighing various residential efficiency program options. Advocates wishing to further the cause of residential lighting market transformation need to be diligent about conveying the cost effectiveness and market breadth advantages of lighting programs over other types of residential efficiency programs in order for them to receive the funding levels that will be needed to achieve transformation. The $25 to $35 million currently being invested each year to drive greater use of efficient residential lighting is sufficient to catalyze a good deal of activity in particular regions, but national funding levels will need to be substantially increased to achieve our ultimate objectives.

3.5.6 Advocate for sound policies at the local or regional level

State regulators and regional utility consortia need help to:

- Develop meaningful metrics
- Propose and apply incentive regulation structure

- Collaborate between utility program designers and evaluators.
- Communicate between the MT community and retailers and manufacturers.

Organizations like NRDC, ACEEE, CEE and others are uniquely positioned to help utilities and regulators perform these important tasks.

3.6 Action Items for Electric Utilities and State/Regional Market Transformation organizations

Utilities need to be realistic about the influence they can hope to exercise on the residential lighting market. They need to understand the markets for residential lighting products they are trying to promote, and they need to tailor their programs to work with those markets. In almost all cases, this means partnering with neighboring utilities and developing common program designs to address natural markets whenever possible. It also means participating in efforts, like ENERGY STAR, to identify and encourage energy efficient lighting products that are worth promoting.

The total 1999 U.S. light bulb advertising expenditures by major lighting manufacturers are less than $30 million per year. The total amount that U.S. utilities spent on all residential lighting program activities in 1999 is above $23 million. Therefore, the resources offered by utilities are enough to cause a substantial impact on the residential lighting market, but only if those resources are used in an effective, and coordinated manner.[71]

3.6.1 Participate in the residential market as a market player

For many manufacturers, distributors and retailers, utility program requirements and program restrictions are difficult to understand and implement. Many potentially influential mass merchandisers have great difficulty participating in local programs, especially if utility boundaries are significantly different than the natural market and each utility specifies a slightly different product.

Matching program offerings to natural markets increases the attractiveness of the offering to market players and improves the likelihood of long-term market transformation. A common program design implemented across many utility programs also provides consistency to the lighting industry and helps it to better meet utility expectations. For example, the Pacific Northwest represents approximately 5% of the national market for residential lighting, but by joining with California under a common program approaches their effective market share rises to nearly 20 percent. Manufacturers and retailers are considerably more interested in participating in, and contributing to, larger programs.

Sometimes the most valuable resource a utility can bring to a residential lighting program is its good name. Consumers often consider their utility to be an authority on energy use and conservation. However, many utilities are giving their customers a mixed message by encouraging additional electricity consumption at the same time as they encourage energy efficiency. Over the last two summers, for example, Commonwealth Edison in Illinois faced substantial criticism for continuing to fund residential lighting load building activities, (for example, distributing free or low-cost inefficient incandescent bulbs to its customers) while its power system strained to meet peak demand.

3.6.2 Design programs that reflect targeted markets

Program resources need to be tailored to the different sales channels (home improvement, wholesale, lighting showroom, grocery, mass market), to key types of residential project opportunities (new construction, remodeling, redecorating) and to key customer segments (single family, multi-family, institutional). The main purpose of incentives should be to leverage even greater participation and contribution from manufacturers and retailers. This means that incentives should be applied flexibly and appropriately and not necessarily as rebates for retail price reduction. In any given market incentives may be most effective as cooperative advertising, marketing, media placements, special promotions or other activities. As central cities give way to a suburban fringe and in turn to surrounding rural areas, the mix of retailers serving each area changes dramatically as well. Utility programs must be flexible enough to meet the needs of these different retailers, and the different ways in which they serve their markets. For instance, Wal-Mart, K-Mart, and Target use only large distribution centers, with little control over product going into a specific region, let alone a specific store. Ace/TruServ stores are franchised and have local control, but have significant incentives to purchase through the franchise distribution centers, even when it is not price competitive.

As Figure 1 showed, grocery stores do account for a large share of incandescent light bulb sales. Grocery stores utilize a completely different distribution system than hardware or home improvement stores, and have a number of characteristics that make it difficult for them to successfully handle CFLs. They have limited shelf space for specialty lighting products and high margin requirements. Grocery store staff generally do not have much in the way of lighting expertise. Incandescent light bulbs are a low price, high volume commodity while CFLs are a relatively high priced appliance. Therefore, grocery stores have a hard time carrying CFLs for the same reason that they carry disposable razors, but generally not electric shavers.

To maximize sales of CFLs and circular fluorescents in the short term, utilities should focus heavily on home improvement and hardware stores. Consumers appear to associate home improvement and hardware stores with greater expertise and variety in energy efficient lighting. To the extent customers are coming to those stores with specific questions about fluorescent lamp performance, applications, and economics, sales staff should be trained to answer such questions capably.

3.6.3 Get serious and creative about market transformation

Although most utilities now ascribe to market transformation philosophies for their energy efficiency efforts, there are fewer that actually field programs based on market transformation designs. Utilities cannot (and indeed should not) try to buy markets for products or create unsustainable demand for products. Manufacturer motivations should be clearly appraised during program design with an appreciation for the differences between small and large, new and established industry players. Programs should have discrete goals, strategies for reaching them and specific actions to be taken over specific time frames as discussed in Volume 1, Section 2.9.1. Failure to meet market transformation goals should cause program redesign.

Utilities should start by defining the needs of the market and the potential utility financial and non-financial resources that can be brought to bear. Next, they can consider barriers created by regulatory constraints and invent ways to work with or around them. For example, it may be possible to work with lighting retailers to come up with mutually agreeable product tracking systems that meet regulatory requirements, while not requiring a complete record of the customer transaction. Like any market participant, utilities should also appreciate and exploit lighting market dynamics and trends. This means both leveraging the positive publicity around new energy efficient products and appropriately highlighting problems with wasteful ones. Low-income program resources can be leveraged for broader impacts in the retail marketplace as well.

Even utilities without incentive regulation that allows them to profit from energy efficiency programs may be able to realize financial benefits from targeted investments in energy efficiency. “Distributed utility” analysis may help identify opportunities to defer capital investments in local distribution system upgrades through improvements in residential lighting efficiency. Utilities need to reflect all of the above in budget reallocations that fund appropriate and effective market transformation activities and discontinue excessive rebates and other wasteful practices.

3.6.4 Think new construction

If virtually all program resources continue to be directed at retrofitting energy inefficient products in existing structures, we will never get ahead of the problem. Programs must shift over time to develop a substantial component for new construction if we ever wish to transform the market for efficient lighting products.

Incentive programs that have traditionally been focused solely on homeowners and renters will likely be more successful in the new construction market if directed at the builders and electrical contractors who make many of the key fixture choice decisions in new homes. The winning strategy is likely to be a sequential one, including the following elements:

1. Begin by demonstrating well-designed efficient lighting in model homes and marketing it as a lighting upgrade package for the new home buyer.
2. Provide incentives to the builder or electrical contractor, so they can make the upgrade package a tantalizing choice for buyers.
3. Work with manufacturers and distributors to assemble turn-key Energy Star lighting packages for particular rooms and home types that minimize the hassle for a builder to utilize them.
4. Offer promotional or co-branding opportunities to the builders that achieve the highest success rate with lighting upgrades.
5. Work with the ENERGY STAR homes program and lending institutions to make attractive financing opportunities available to those who wish to purchase better lighting for new homes.
6. Begin shifting incentives from builders and contractors to the distributors and retailers who offer qualifying products to their customers, and then steadily reduce those incentives as sales volumes increase.

3.7 Action Items for Lighting Manufacturers

The ENERGY STAR programs offer an opportunity for the first time for residential lighting products to be marketed under a broad quality and energy efficiency brand. However, if the benefits of wide consumer recognition and acceptance of the brand are to be realized, manufacturers must both produce ENERGY STAR compliant products and commit to using the ENERGY STAR brand in promotional efforts. This should include the development of ENERGY STAR-compliant fixtures to serve the full spectrum of the residential market.

3.7.1 Improve consumer education materials and advertising

Most ENERGY STAR products are now placed on the shelves with no point of purchase materials, attractive displays or promotion. Manufacturers should coordinate with utilities and the government to develop and distribute effective sales support materials. This coordination may also allow access to new advertising media, such as television. While neither manufacturers nor utilities may be able to afford TV advertising on their own, it may be affordable with pooled resources.

3.7.2 Solve remaining technical problems

Compact fluorescent fixtures suffer from a distinct disadvantage compared to incandescent fixtures, because it is not now as easy to buy and install appropriate fluorescent tubes as it is buy and install incandescent light bulbs. A wide range of pin configurations have been developed by manufacturers (and formalized by NEMA) to ensure that lamps and ballasts are matched appropriately and safely, which can be confusing to some residential customers (Figure 12).

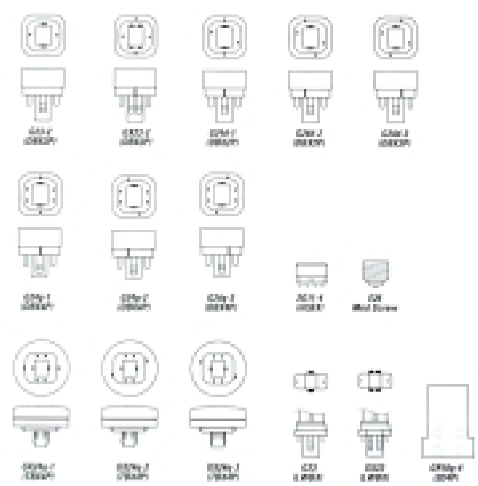


Figure 12 – CFL base types available from General Electric (GE Lighting, Lamp Products Catalog, 1999)

However, it is also true that the standard Edison base and socket poses numerous safety risks and disadvantages that would likely prevent its adoption as a standard means of connecting lamps today. It may be possible for lamp and ballast manufacturers to work together to facilitate greater communication between lamps and ballasts about power requirements and end of lamp life detection. If so, it would be possible to use a far smaller number of different ballasts to drive a vast array of lamp types, which would reduce ballast costs and increase consumer acceptance.

Manufacturers can also help to standardize product performance labeling conventions by working with the FTC and other federal government agencies. Manufacturer participation will be important in the development of residential lighting product test procedures and improved product test methods (specifically accelerated life test for CFLs). Finally, manufacturers also have considerable remaining technical opportunities to improve fluorescent light color and performance, and should be encouraged to pursue them.[72]

3.7.3 Compile industry-wide data on unit sales

Although NEMA currently compiles some internal information on product sales by its lamp, ballast, and fixture manufacturer members, this information is not widely published. Moreover, the federal government no longer collects detailed information on the sales of such products in the U.S., making it difficult to monitor sales trends over time. The lighting industry should identify a means of collecting sales information from all industry players, whether NEMA members or not, and of compiling the data confidentially into industry-wide totals that can be published and analyzed.

3.8 Action Items for Lighting Retailers

The advent of the ENERGY STAR brand means that consumers can purchase energy efficient residential lighting with confidence. Retailers should carry ENERGY STAR compliant products and participate with manufacturers and utilities in ENERGY STAR brand promotional efforts.

3.8.1 Demonstrate and sell efficient lighting to customers

ENERGY STAR residential lighting products are still new to many consumers and should be prominently displayed on end-caps, wing stacks, and in high traffic areas of the store. Energy efficient lighting products should be grouped together with conventional lighting products by style, rather than being segregated by light source. This will allow consumers to compare products side by side without having to search out the efficient models. When possible, ENERGY STAR products should also be included in model room displays.

Figure 13 – Sample interactive CFL displays from Philips Lighting (Calwell) **and Osram Sylvania.** (Osram Sylvania)

Operational displays (Figure 13) can also effectively show efficient lighting performance.

3.8.2 Integrate efficient lighting into sales force training and consumer classes

Retailer sales staffs are regularly given product updates, product training and sales techniques for specific products. The lighting and ENERGY STAR component of training sessions should be developed or expanded. Retailer classes for consumers should discuss the various types of lighting, appropriate applications and selection criteria. Lighting design seminars should incorporate approaches using both compact fluorescent and linear fluorescent fixtures. Offering classes and training sessions in partnership with the local electric utility can also help to convey the message.

4 Conclusion

As the year 2000 approaches, many in the efficient lighting community have expressed a sense of frustration about the pace of progress in the residential lighting sector. Some have begun to question whether we should be continuing to promote efficient residential lighting at all, or whether consumers should simply make their own decisions. After more than a decade of work to change consumer preferences, with much farther left to go, this weariness is understandable. But, as this document highlights, today there are a great many reasons to take up the effort with renewed vigor, enthusiasm, and prospects for success.

First, residential efficient lighting products themselves are vastly improved over the early compact fluorescent lamps and fixtures that many utilities have spent years trying to convince their customers to buy. Today's products can routinely provide equivalent or better lighting service than incandescent lighting, while also improving safety, comfort, and convenience. There is also, at long last, an easy way for consumers to find efficient lighting and to differentiate better products from the rest – ENERGY STAR. This program has simplified the marketing challenge for the rest of the efficient lighting community enormously. With the market transformation community largely united around the ENERGY STAR brand, terrific synergies are possible in expanding consumer awareness and interest.

Figure 14 – Home improvement stores have begun giving ENERGY STAR high visibility (Calwell)

Retailers are also beginning to awaken to the possibilities offered by ENERGY STAR. They have shown a willingness to make energy efficient lighting the dominant and most obvious marketing message in their stores during particular promotional periods (see Figure 14). They have seized upon efficient lighting as a way to increase average transaction amounts and perhaps even improve profit margins.

Manufacturers and utilities are also showing new signs of interest in a more collaborative approach. The Consortium for Energy Efficiency and regional market transformation organizations are reaching out to the manufacturers as never before, and are identifying ways to leverage manufacturers' existing marketing and retail training activities.

Manufacturers demonstrated a strong degree of interest in providing background information for this document and in reviewing early drafts. The sales data and insights they provided were invaluable to obtaining a complete picture of the market's current status and prospects for continued growth. Their detailed knowledge of consumer preferences could also prove invaluable to improving future program designs, if we maintain an open dialogue.

Heightened competition in the manufacturer and retailer environments has made participation in market transformation programs more important than ever to many market players. The sheer number of manufacturers now enrolled in the ENERGY STAR CFL and fixture programs is tremendously encouraging, and market transformation programs are demonstrating substantial success at increasing the percentage of those companies that materially participate in their programs with each passing year.

Finally, there is a new degree of sophistication and discernment emerging in the wielding of program resources by utilities and regional organizations. Both have become far better at working within existing markets and employing savvy marketing strategies to accomplish for less money what was once done almost solely through product rebates and giveaways. This suggests a certain wisdom in mature programs, which, far from growing weary, now stand to demonstrate the advantages of years of experience and refinement.

In 2000 an opportunity may emerge for a massive national ENERGY STAR awareness campaign, which interested parties could fund in exchange for co-branding opportunities and visibility within particular regions or segments. Such a campaign would serve the common interests of all who have struggled for more than a decade to give consumers a powerful reason to purchase efficient alternatives to standard lighting.

In the new year we can also expect to see an additional emphasis on product quality and verified performance, which is a very healthy step for the efficient residential lighting market. Many manufacturers have shown an interest in better policing themselves and providing verification of product performance claims. EPA, NRDC and other interested parties are working on a rigorous testing program for residential lighting products to be implemented over the coming months, building on and extending the work already begun by the National Lighting Product Information Program.

A prime opportunity awaits the entire market transformation community to halt the growth in residential lighting electricity use. If better residential lighting becomes the norm, we can expect to make tangible progress toward preventing global climate change, save billions of dollars worth of wasted electricity, and make the American home a better-lit, more comfortable, and more convenient place to live.

5 Notes Volume 1

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2 Kate Conway and Monik Mehra, "Lighting market opportunities: Reconciling consumers' purchasing behaviors with environmental values," *Journal of the Illuminating Engineering Society*, Volume 27, Number 2, 1998; and Diana Vorsatz, Leslie Shown, Jonathan Koomey, Mithra Moezzi, Andrea Denver, and Barbara Atkinson, *Lighting Market Sourcebook for the U.S.*, Lawrence Berkeley National Laboratory, December 1997, p. 6 (assuming $0.08 per kwh for residential electricity).

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7 Triad POS Data (July 13, 1999) and AC Nielsen POS Data (June 2, 1999), summarized by Greg Black, Consumer Marketing, General Electric Lighting, and analyzed by Linda Latham and Chris Calwell.

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9 *Residential Lighting: Use and Potential Savings*, Energy Information Administration, DOE/EIA-0555(96)/2, September 1996, p.5

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11 *Lighting Market Sourcebook for the U.S, p.* 20; Heschong Mahone Group, "Residential Lighting Baseline," *Lighting Efficiency Technology Report*, CEC Contract #400-95-012, March 7, 1997, p. III.

12 *Lighting Market Sourcebook for the U.S*, pp. 4-6.

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16 See, for example, Brent Haddad, "Why Compact Fluorescent Lamps are Not Ubiquitous: Industrial Organization, Incentives, and Social Convention," *Proceedings of the ACEEE Summer Study on Energy Efficiency in Buildings*, California, 1994, pp. 10.77-10.83.

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18 *Residential Lighting: Use and Potential Savings*, p. 35.

19 Energy Information Administration, *Annual Energy Outlook 1999*, U.S. Department of Energy, p. 60.

20 *Residential Lighting: Use and Potential Savings*, p. 34.

21 U.S. Department of Commerce, *Statistical Abstract of the United States*, 1996, p. 461.

22 *Residential Lighting: Use and Potential Savings*, pp.34-35.

23 *Residential Lighting Baseline*, p. 43.

24 Heschong Mahone Group, *Lighting Efficiency Recommendations*, CEC Contract #400-95-012, March 7, 1997, p. 9.

25 *Statistical Abstract of the United States*, p. 14.

26 *Annual Energy Outlook 1999*, p. 60.

27 *Lighting Market Sourcebook for the U.S*, pp. 4, 6; and *Statistical Abstract of the United States*, 1996, p. 9.

28 See for example, Northeast Energy Efficiency Partnerships, *Northeast Regional Residential Lighting Initiative Market Transformation Plan*, Draft 2, August 5, 1999, pp. 15-17.

29 Casper Kofod, DEFU, "Large CFL Potential in European Homes", IAEEL newsletter issue no. 15, vol. 5 3,1996.

30 *Residential Lighting: Use and Potential Savings*, p. 5.

31 Chinese-made CFLs were offered and heavily promoted by retailer IKEA in the fall of 1999 for $3.95 per unit. Average prices computed from Triad and Nielsen POS data, with average prices for grocery, drug, and mass market discount stores assumed for hardware and home center sales.

32 For more details, see www.energystar.gov/products/cflpartners.phtml.

33 ENERGY STAR is a voluntary program whose specifications create a floor for how the community defines efficient products, while also making it easier for consumers to shop for more efficient products. The key parameters in the CFL specification are fast start time, no flickering, minimum efficiency levels of 60 lumens per watt, a minimum lifetime of 6,000 hours, and a one year manufacturer warranty.

34 U.S. Department of Commerce, *Statistical Abstract of the United States 1996*, October 1996, p. 39.

35 General Electric's Ed Yandek noted in his review comments that there is much that can be done to improve the attractiveness of CFLs as well as their acceptance by the public. He sees substantial opportunities to improve the way CFLs render color, and make products look "less like science experiments," and able to reach higher lighting levels more rapidly.

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37 Personal communication, Steve Goldmacher, Philips Lighting, Director of Public Affairs, October 26, 1999.

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48 Calwell, *Halogen Torchiere Market Transformation*

49 Russell Leslie and Kathryn Conway, *The Lighting Pattern Book for Homes*, Lighting Research Center, 1993.

50 *Residential Lighting Baseline*, p. 17.

51 Personal communication, David Zizzy, Lithonia Lighting, July 12, 1999.

52 For more information, see *The Lighting Pattern Book for Homes*, pp. 141-142, 185-186; and Russell Leslie and Paula Rodgers, *The Outdoor Lighting Pattern Book*, Lighting Research Center, pp. 165-169, 175-189.

53 For more information, see Chris Calwell, Chris Granda, Charlie Stephens, and My Ton, *Energy Efficient Residential Luminaires: Technologies and Strategies for Market Transformation*, May 13, 1996.

54 See www.lrc.rpi.edu for more information.

55 Philips Lighting Company, *The Lighting King: Light Bulbs That Last*, advertising flyer from National Hardware Show, McCormick Place, Chicago, August 1999, pp. 7, 8, 20.

[56] Many of the manufacturers commenting on a review draft of this paper expressed a continued preference for incentive-oriented market transformation programs, while others noted either in CEE forums or in comments to the authors a preference for a marketing focus by utilities and market transformation organizations. We conclude simply that there is a range of opinion by manufacturers on *methods*, but that all appear to be grateful for the infusion of resources by outside parties to help them achieve greater sales.

[57] Chris Calwell, Chris Granda, Charlie Stephens, My Ton, *Energy Efficient Residential Luminaires: Technologies and Strategies for Market Transformation*, May 13, 1996, p. 22 (citing Philips consumer survey that was summarized in "How Bright Is Your Light?" *Colorado Country Life*, April 1996, p. 12).

[58] U.S. Department of State, *Climate Action Report: 1997 Submission of the United States of America Under the United Nations Framework Convention on Climate Change*, July 1997, pp. 12-13.

[59] E SOURCE, *Lighting Technology Atlas*, 1997, pp. 78-79 (R lamps and PAR lamps accounting for 8.5% of incandescent bulb production, which was approximately 1.6 billion units).

[60] NLPIP, *Energy-Efficient Ceiling-Mounted Residential Luminaires*, Specifier Reports Volume 7, Number 2, September 1999; and NLPIP, *Screwbase Compact Fluorescent Lamp Products*, Volume 7, Number 1, June 1999.

[61] Part of the actual labeling language states, for example, "Energy used: 100 watts." This, at best, confuses the issue, since energy is normally expressed in kilowatt-hours and power in watts. Energy is power demand over time.

[62] Peter Bleasby, *Review Comments*, Osram Sylvania, November 16, 1999, pp. 2-3.

[63] It is true that a particular fluorescent lamp's light output can vary according to the ballast factor of the ballast driving it. However, the same is true of wattage, yet fluorescent lamps are routinely labeled with a nominal wattage.

[64] "Compact Fluorescents Come of Age," *Consumer Reports*, January 1999, pp. 36-37.

[65] *Residential Lighting: Use and Potential Savings*, Energy Information Administration, DOE/EIA-0555(96)/2, September 1996.

[66] See 42 USC Sec. 6295(i4), noting that the Secretary of Energy shall initiate a rulemaking to consider additional fluorescent and general service incandescent lamp efficiency standards no earlier than October 24, 2000 and publish it no later than April 24, 2002, with standards taking effect 3 years thereafter.

[67] Heschong Mahone Group, *Residential Lighting Baseline*, CEC Contract #400-95-012, October 21, 1996, pp. 58-59.

[68] Wiebe E. Bijker, "The Majesty of Daylight: The Social Construction of Fluorescent Lighting," in *Of Bicycles, Bakelites and Bulbs: Towards a Theory of Sociotechnical Change*, MIT Press, 1995, p. 228.

[69] Environmental Working Group and World Wildlife Fund, *Unplugged*, September 1998, www.ewg.org/pub/home/reports/unplugged/unplugpr.html

[70] Ton, My, "Regional Efficiency Opportunities in the Midwest, Southwest, and Southeast: The Key to National Market Transformation", Ecos Consulting for NRDC, January 1999.

[71] Personal communication, Steve Goldmacher, Philips Lighting, Director of Public Affairs, October 26, 1999.

[72] Ed Yandek, General Electric Lighting, Manager - Worldwide Industry Standards, *Review Comments*, November , 1999.