CFL METERING STUDY

FINAL REPORT

Prepared for

Pacific Gas & Electric Company
San Francisco, California

San Diego Gas & Electric Company
San Diego, California

Southern California Edison Company
Rosemead, California

Prepared by

KEMA Inc.
Oakland, California

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1 EXECUTIVE SUMMARY

A compact fluorescent lamp (CFL) metering study was initiated in the summer of 2003 to update the savings assumptions associated with the 2002 California investor-owned utility (IOU) Statewide Crosscutting Upstream Residential Lighting Program (program).[1] In February of 2004, the IOUs authorized using the 2003 program evaluation budget to increase the metering study sample size and extend the monitoring period.

This report presents the results of that study, which was conducted in the service territories of Pacific Gas & Electric Company, Southern California Edison Company (SCE), and San Diego Gas & Electric Company. The metering period was July 2003–October 2004, and 369 homes across the state participated. The study attempted to monitor all interior fixtures in which a CFL was installed. To be included in the study, households were required to have at least one interior fixture with a CFL.

1.1 PROGRAM BACKGROUND

The California IOUs launched the California Residential Lighting and Appliance program (CRLAP) in late 1998 to address the California Public Utility Commission's (CPUC's) 1997 mandate that the purpose of energy efficiency programs should be to transform the market so that individual customers and suppliers in the future competitive market would make more rational choices. CRLAP was continued through 2001, providing support to retailers and manufacturers to improve the availability, promotion, and sales of energy-efficient residential lighting and appliances.

In 2001, the CPUC directed the IOUs to achieve immediate energy savings by introducing programs that emphasized customer incentives over longer-term market transformation strategies. The IOUs rebated over 8 million CFLs and bought down approximately 150,000 ENERGY STAR® torchieres and hard-wired fixtures in 2001 as part of the final year of CRLAP. The 2001 program discontinued the salesperson training initiatives that were offered in 1999 and 2000 and substantially scaled back co-operative advertising that was offered to retailers through CRLAP.

In 2002, the IOUs launched the Statewide Crosscutting Upstream Residential Lighting Program, which was designed to achieve energy savings by increasing the availability of ENERGY STAR-qualified lighting products in the marketplace and expanding the number of fixtures in each home that has energy-efficient lights. The 2002 program was intended to address three key

[1] The 2002 evaluation, which was published in October of 2003, also included an update on consumer and upstream market actor awareness, attitudes, and behaviors with regard to energy-efficient lighting. That evaluation continued the research that was conducted from 1998–2001 by the four-phased market effects study of the California Residential Lighting and Appliance program.

market barriers that are thought to exist in the lighting product market that limit ENERGY STAR lighting product market shares:

- **Awareness**: The program was designed to increase awareness among consumers and suppliers by coordinating extensively with retailers and manufacturers to increase product advertising.
- **Pricing**: The program was designed to increase demand and build on prior years' successes in lowering product prices to continue to fuel demand for the product in previously unreached portions of the market.
- **Availability**: The program was designed to increase the number of channels where ENERGY STAR products are available at promoted prices to increase consumer exposure.

The 2002 program attempted to strike a balance between the often competing objectives of market transformation and resource acquisition. The 2002 program ultimately was responsible for reducing the price of 3.6 million CFL products in 2002, saving more than 160 GWh and 21 MW. CFL bulbs accounted for 99 percent of the unit accomplishments and over 97 percent of the energy and demand savings. ENERGY STAR hard-wired fixtures, torchieres, and ceiling fans accounted for the remainder.

The program built on the successes of prior years' programs, through continuing partnerships with Costco, Home Depot, Lowe's, Sam's Club, and Wal-Mart and through the expansion of the successful point-of-sale (POS) incentive approach that was introduced in 2001. The IOUs delivered the vast majority of product discounts via the POS approach but still relied on the manufacturer buydown in order to include retailers that could not meet the POS reporting requirements. This approach kept administrative costs down by relying on the national big box stores to meet a significant percentage of the unit goals while still including smaller, independent stores to ensure that customers throughout the IOU service territories had access to the program.

The program coordinated with other consumer energy-efficiency education campaigns to raise consumer awareness of the benefits of energy-efficient lighting such as the EPA's fall Change a Light promotion and the State of California's Flex Your Power campaign. The IOUs' Crosscutting Marketing and Outreach program also included radio and print advertisements to support the program's product promotions. The program relied for the most part on participating retailers and manufacturers to promote the product discounts using in-store advertising, desirable product placement, and salesperson promotion.

The 2002 program marked the first time the IOUs specifically targeted hard-to-reach (HTR) customers by earmarking a certain percentage of the incentive budgets to be provided to retailers that target the HTR sector. In particular, the program allocated 15 percent of its incentive budget to retailers located in rural locations and 10 percent to grocery and drug stores.

The 2003 program was very similar to the 2002 program, with a slightly larger incentive budget. The program continued the successful POS approach with its retail partners and expanded the

use of tiered incentive levels in response to evaluation results on product pricing to maximize program benefits. The program again set HTR goals, equivalent to those set in 2002, to ensure participation among a broad mix of retailers and customers.

The utilities' 2004–2005 program continues the 2003 program but with some improvements to the market participation and rebate approach. The utilities have expanded the involvement of retailers, particularly in the grocery and drug store segment, to increase the reach of the program. The program has introduced rebate levels tied to lumen output of CFLs to encourage manufacturers of efficient products and to increase equity. The incentive levels have been adjusted again to account for supplier (e.g., based on manufacturing costs of the various wattages) and consumer market behavior (e.g., based on response to 2003 incentive levels).

1.2 RATIONALE FOR STUDY

The most current comprehensive assessment of residential lighting usage in California is the California Baseline Lighting Efficiency Technology Report conducted by Heschong Mahone Group in 1997. This study relied upon 3 studies conducted in the early 1990s that included an on-site lighting inventory of a random sample of 683 SCE households, metering of 1 fixture per household in over 400 of the 683 homes from the SCE lighting inventory sample, and metering of 80 percent of fixtures in over 200 homes in the Pacific Northwest. These prior studies reflect 10-year-old usage patterns, are not statewide, and do not focus specifically on CFL usage.

A number of CFL hours-of-usage studies have been conducted in California. We reviewed approximately 25 studies conducted primarily to support protocol-driven CFL program impact evaluations in the early to mid-1990s. From this review, we determined that many of these studies did not rely on on-site data collection, and even fewer involved collection of metered time-of-use data. Those that did were conducted to evaluate specific utility programs (i.e., not statewide). In addition, these studies were conducted over 7 years ago, reflecting different patterns of CFL use and saturation. Moreover, these studies were designed to meter only one CFL per home.

Our approach serves as an update to this prior research in a number of important ways. First, our sample was designed to represent key demographic and geographic differences across the state. In addition, we attempted to meter *all* interior fixtures containing CFLs, allowing us to reflect current saturation and usage patterns associated with newer and less expensive CFLs.

1.3 STUDY OBJECTIVES AND APPROACH

The primary objective of this study was to provide updated estimates of energy savings parameters in order to confirm or revise the program's existing deemed savings values. These values will be used for future program filings and will provide input to the Deemed Savings Database project. These values were not used to estimate the 2002 or 2003 program savings.

The key savings parameters that this study addresses are:

1. CFL hours of usage
2. CFL peak diversity factors
3. CFL Installation/retention rates
4. Pre-CFL wattage assumptions.

Note that this study did not address net-to-gross ratios due to the nature of the program (i.e., upstream) and the barriers to identifying participating customers. However, the final phase of the CRLAP evaluation (2001) qualitatively treated the issue of attribution of the various market effects measured over the program period.[2]

The secondary objective of this study was to provide an update on consumer CFL product knowledge and perceptions and CFL purchasing behavior. The 2002 evaluation and the four-phased market effects evaluation of CRLAP provided time series data covering the period of 1998–2003 to which these results may be compared. The study also explored the technical potential for CFLs.

The study approach was to install meters on interior fixtures containing CFLs in 375 homes across California and to administer an on-site survey with each study participant. Sites were screened based on the presence of at least one fixture inside the home that contained a CFL. Sites were clustered in seven distinct regions across the state, with the clusters chosen to represent the state's demographic and climatic differences. We attempted to monitor all interior fixtures that contained CFLs in each participating home, ultimately monitoring 891 fixtures.

The on-site survey was intended to collect:

- A detailed inventory of all the lighting fixtures inside and outside the home
- Respondent awareness, knowledge, and behaviors towards energy-efficient lighting
- Self-reported hours of usage (to compare to monitored data)
- Household demographics and dwelling characteristics.

1.4 STUDY RESULTS AND RECOMMENDATIONS

Below, we present a summary of the study's results organized by CFL hours of usage, installation patterns, and updated market information, then we summarize the recommendations developed in response to the study conclusions.

[2] See also "Addressing Attribution in the Wake of the California Energy Crisis," International Energy Program Evaluation Conference, Seattle, 2003; and International Conference on Energy Efficiency in Domestic Appliances and Lighting, 2003, T. Rasmussen, K. McElroy, and R. Rubin.

1.4.1 CFL Hours of Usage

- The average hours of usage per day per CFL for homes with CFLs installed is 2.28 hours. The 90-percent confidence bounds are 1.90 to 2.66. Including an estimate of outdoor CFLs, usage goes up slightly to 2.34.
- CFL usage varies by room type, with CFLs located in kitchens, living rooms, outside, and in garages being used the most and those in laundry rooms, bathrooms, and hallways being used the least. Other factors driving variation in CFL usage are fixture type (suspended, downlight, and torchiere fixtures are associated with higher usage mostly because they are installed in high-use locations), control type (use of timers/dimmers increases usage), and whether the CFL was purchased prior to 2001 (newer CFLs are used more often).
- Household, dwelling, and CFL characteristics that are not associated with variations in CFL usage are geographic location (e.g., northern v. southern latitudes), dwelling type, household composition, size of home, electric utility service territory, and CFL base type and wattage category. Customer experience with CFLs (such as when they became aware, when they first purchased, the number installed, etc.) does not drive CFL usage.
- Estimated CFL usage from this study is equivalent to the estimated hours of usage for all lamp types based on the most recent study on run time hours for residential lighting, the California Baseline Lighting Efficiency Technology Report, HMG 1997. When broken out by room type, CFLs are used more often in living rooms, family rooms, and garages and less often in laundry rooms, bathrooms, and hallways.
- In comparing self-reported CFL hours of usage to monitored hours of usage, we found that self-reported values were overestimated by a factor of one-third. The correlation coefficient between the two values was found to be 0.44, suggesting a moderately close relationship.

1.4.2 CFL Installation Patterns

- Upwards of 75 percent of CFLs purchased since 2001 are either installed or being stored for future use. A small percentage of recent CFL purchasers (13 percent) have had some of their recently purchased bulbs burn out.
- There is some evidence that as the number of CFLs installed increases, CFLs are more likely to be installed in lower-use areas of the home such as closets and hallways. However, the average hours per usage is not significantly different across homes with multiple CFLs installed.
- More than 90 percent of CFLs installed are in the 13-to-26-Watt range and have screw-in bases and integrated ballasts. The most common wattage range is the 13–17.

- CFLs that were purchased in 2001 or later are more likely to be in the 13–17 or 23–26 Watt range and are more likely to have an integrated ballast v. those that were purchased in 2000 or earlier.
- The majority of CFLs are replacing 60-Watt incandescent bulbs. The remainder are equally split between replacing 40-, 75- and 100-Watt incandescent bulbs.

1.4.3 CFL Market Update

- Most CFL users first learned about CFLs before the energy crisis but first tried CFLs during or after the crisis. Only a small fraction made their first purchase before the energy crisis, suggesting that CFL giveaway programs (e.g., the utilities' Low Income Energy Efficiency Program, the state's Powerwalk Program, utility targeted giveaway programs, utility refrigerator recycling incentive program, etc.) were many residents' first exposure to CFLs.
- The number of CFLs purchased per household has declined since the energy crisis. This result may reflect the decline in bulk sales that occurred at the height of the energy crisis and the accompanying energy-efficiency program and retailer promotions.
- CFL purchasers are more likely now to buy their CFLs at grocery stores and Costco and less likely to buy them at big box stores compared to 2 years ago. This is likely a reflection of the program's focus on grocery and drug stores and the continued involvement of Costco.
- Those with CFLs installed in their homes are aware that CFL availability in stores has increased and prices have declined. More than 75 percent are aware that CFLs cost $5 or less.
- Most CFL users either feel that CFLs have improved over time or have stayed the same. Those that are still dissatisfied with CFL performance cite early burnout, cost, and product style as reasons for not being satisfied.
- There is some evidence that rebates and in-store promotions are having more influence over the past year and a half than in 2002. This may reflect improved program communication with and support of retailers in their promotional materials and strategic rebate levels. The 2004–2005 program evaluation will likely include a comprehensive consumer survey that can more reliably address these issues.

1.4.4 Recommendations

- **Program Savings Estimate of CFL Hours of Usage.** The utilities should consider using the study's estimate of hours of usage for the program going forward (2.3 hours per day). The utility-specific estimates were not found to be statistically different, so we recommend that the utilities use the same value.
- **Other Savings Parameters.** This study was mainly focused on determining CFL hours of usage but also concerned itself with CFL installation/retention rates and pre-

wattage assumptions. This study provided insight into these other savings parameters; however, the 2004–2005 evaluation should more directly and comprehensively study these parameters.

- **Consumer and Supplier Market Data.** We recommend that the 2004–2005 evaluation include a comprehensive consumer study to more reliably determine current customer awareness and purchase rates of CFLs, satisfaction with CFLs, installation rates, and future purchase intentions. Likewise, such a study could explore barriers to adoption to help guide the program in terms of the size of the market that is using CFLs, not using CFLs (and the barriers such as awareness or attitude), and, for those using CFLs, what barriers exist to expanding their usage. The program would also benefit from upstream research to help guide the program in terms of product offerings, incentive levels, and retailer and manufacturer support and interest in the program.