CFL METERING STUDY

FINAL REPORT

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LIST OF TABLES

LIST OF FIGURES

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.

2 INTRODUCTION

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.

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The remainder of this section provides an overview of the program, the rationale for the study and its objectives and approach.

2.1 PROGRAM DESCRIPTION

Below, we describe the history of the IOUs' lighting programs, beginning in 1998 with the California Public Utilities Commission's (CPUC's) market transformation policy directive. Then we provide a summary of the goals and accomplishments of the 2002 and 2003 IOU Crosscutting Lighting Programs, followed by the 2004–2005 program goals.

2.1.1 Background

The California IOUs launched the California Residential Lighting and Appliance Program (CRLAP) in late 1998 to address the 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.

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2000 and substantially scaled back co-operative advertising that was offered to retailers through CRLAP.

2.1.2 The 2002 Program

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[2] The 2002 program evaluation report includes a section describing the program in detail, with a summary of the program's unit and energy goals and accomplishments, by lighting product.

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.

2.1.3 The 2003 Program

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.

Table 2-1 shows the 2003 program's unit and energy savings goals. As in prior years, the predominant measure from both an energy-saving and unit perspective was CFL bulbs.

Table 2-1
2003 Program Goals

ENERGY STAR Product	Unit Goals	Incentive	Incentive Budget ($1,000)	Energy Savings (Net MWh)	Demand Savings (Net kW)
CF Bulb - 14 Watt	1,563,300	$ 1.00	$ 1,563	73,523	9,117
CF Bulb - 20 Watt	1,438,700	$ 2.00	$ 2,877	80,901	10,032
CF Bulb - 25 Watt	1,158,500	$ 2.00	$ 2,317	76,989	9,547
CF Bulb - 32 Watt	128,400	$ 2.00	$ 257	8,927	1,107
55 W Torchiere	14,100	$ 5.00	$ 71	1,946	241
70 W Torchiere	25,800	$ 10.00	$ 258	3,165	393
Indoor hard-wired CF fixture - 16 Watt	17,200	$ 5.00	$ 86	774	96
Indoor hard-wired CF fixture - 32 Watt	32,600	$ 10.00	$ 326	2,266	281
Exterior hard-wired CF fixture - 13 Watt	19,000	$ 5.00	$ 95	1,676	208
Exterior hard-wired CF fixture - 27 Watt	19,000	$ 10.00	$ 190	3,307	410
Ceiling Fan with CFLs	2,000	$ 20.00	$ 40	52	6
Total	4,418,600		$ 8,080	253,526	31,437

Source: PY2003 Utility Fourth Quarterly Reports

Table 2-2 shows the 2003 program accomplishments. As shown, the program exceeded both its unit and energy savings goals. CFL bulbs were rebated in higher numbers than planned, as were exterior hardwired fixtures. Torchieres and indoor hard-wired fixtures were rebated in fewer numbers than planned.

Table 2-2
2003 Program Accomplishments

ENERGY STAR Product	Units	Incentive	Incentive Payments ($000)	Energy Savings (Net MWh)	Demand Savings (Net kW)
CF Bulb 13-19 Watt	1,785,121	$1.00	1,785	87,114	10,711
CF Bulb 20-24 Watt or 18W >1,100 Lumens	3,051,124	$2.00	6,102	165,005	16,598
CF Bulb 25-30 Watt	972,906	$2.00	1,945	69,504	8,561
CF Bulb 32-55 Watt	1,210	$2.00	2.42	109	13.6
55-64 W Torchiere	628	$5.00	3.14	84	10.4
65-70 W Torchiere	4,502	$10.00	45	564	69.9
Indoor hard-wired CF fixture - 16 Watt	222	$5.00	1.11	7.7	1.1
Indoor hard-wired CF fixture - 32 Watt	14,311	$10.00	143.11	1,056	131
Exterior hard-wired CF fixture 7-18 Watt	6,062	$5.00	30.31	547	67.9
Exterior hard-wired CF fixture 20-70 Watt	58,646	$10.00	586.46	13,465	1,670
Ceiling Fan with CFLs	1,924	$20.00	38.48	49	6.16
Total	5,896,656		10,682	337,505	37,840

Source: PY2003 Utility Fourth Quarterly Reports

2.1.4 2004–2005 Program Plans

The utilities' 2004–2005 program continues the 2003 program but with some improvements with regard to 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).

Table 2-3 shows the changes in incentive levels from 2003 to the current program year. Note that ceiling fans are no longer included in the program.

Table 2-3
Changes in Program Incentive Levels from 2003–2004/2005

Measure	Incentive	
	2003	2004 / 2005
ENERGY STAR (ES) CFL 450 to 799 Lumens	$0	$1
ES CFL 800 to 1,099 Lumens	$1	$1.50
ES CFL 1,100 to 2,599 Lumens	$2	$2
ES CFL 2,600 Lumens or Greater	$2	$2.50
ES Int./ or Ext. Fixture Less Than 1,100 Lumens	$5	$5
ES Int./ or Ext. Fixture 1,100 Lumens or Greater	$10	$10
ES Torchiere < 65 Watt	$5	$10
ES Torchiere > 65 Watt	$10	$10
ES Ceiling Fan with ES Light Kit	$20	$0

Table 2-4 shows the 2004 program goals. Although the incentive levels are set by lumen level, the utilities' workbooks and savings calculations are based on wattage categories.

Table 2-4
2004-2005 Program Goals

ENERGY STAR Product	Unit Goals	Energy Savings (Net MWh)	Demand Savings (Net kW)
CF Bulb < 20 Watt	3,281,239	160,460	21,662
CF Bulb 20-24 Watt	3,286,704	221,984	29,041
CF Bulb 25-30 Watt	1,415,933	103,384	13,621
CF Bulb > 30 Watt	28,944	1,485	215
Torchiere	51,410	6,739	952
Interior hard-wired CF fixture < 25W	335,834	13,712	1,279
Interior hard-wired CF fixture >= 25W	256,821	21,654	1,537
Exterior hard-wired CF fixture < 25W	77,064	9,522	0
Exterior hard-wired CF fixture >= 25W	106,190	29,142	0
Total	8,840,138	568,081	68,307

Source: PY2004-2005 Utility Program Implementation Plans

Table 2-5 shows the program's accomplishments through the third quarter of 2004.

Table 2-5
2004 Program Accomplishments [Through November]

ENERGY STAR Product	Units	Energy Savings (Net MWh)	Demand Savings (Net kW)
CF Bulb < 20 Watt	1,716,938	91,044	11,766
CF Bulb 20-24 Watt	1,470,804	91,762	12,775
CF Bulb 25-30 Watt	471,662	33,911	4,888
CF Bulb > 30 Watt	160	11	1.8
Torchiere	7,569	945	119
Interior hard-wired CF fixture < 25W	13,162	697	91
Interior hard-wired CF fixture >= 25W	44,032	3,722	507
Exterior hard-wired CF fixture < 25W	4,319	524	0
Exterior hard-wired CF fixture >= 25W	7,962	12,382	0
Total	3,736,608	234,998	30,147

Source: Utility 2004 November Monthly Report

2.2 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.

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- Self-reported hours of usage (to compare to monitored data)

[3] 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.

[4] Note that the time series analysis is based on the 275 homes that were added in the spring of 2004 since the initial 99 homes included in the 2002 study were surveyed at the same time that the 2002 consumer survey was fielded (in the summer of 2003).

- Household demographics and dwelling characteristics.

It is important to note that this study does not attempt to isolate "program CFLs"—those bulbs that were discounted by the program. One obvious reason for not doing so is that the program's design is such that no customer data is available to be able to generate a participant sample. More importantly, however, the program was designed to generate effects in the broader market for energy-efficient lighting by increasing availability and exposure and decreasing the cost of all CFLs, not just those discounted by the program.

2.4 REPORT ORGANIZATION

The remainder of this report consists of the following sections and appendices:

- ***Section 3: Study Methodology***—detail on the methods used to conduct the study, including a detailed description of the study's sample characteristics
- ***Section 4: CFL Hours of Usage***—average hours of usage results based on metered data and compared to self-reported hours of usage and CFL load profiles
- ***Section 5: CFL Installation Patterns***—installation/retention rates of CFLs, installation locations, pre-CFL wattage assumptions, CFL technical potential
- ***Section 6: CFL Market Update***—consumer awareness, knowledge, and behavior with respect to energy-efficient lighting, satisfaction with CFLs, and influence of program advertising and rebates on CFL purchases
- ***Section 7: Conclusions***—the study conclusions and recommendations
- ***Appendix A: Survey Forms***—on-site survey instrument and screener
- ***Appendix B: Survey Disposition***—detailed survey disposition tables.

3 METHODOLOGY

This section describes the methods used to conduct the metering study. First, we provide a summary of the research approach. Next, we discuss the sample and on-site survey development, followed by the on-site monitoring and survey implementation process. Then we describe data analysis (i.e., seasonality adjustment and weights) and the final sample disposition. Finally, we discuss the sample's demographic and lighting fixture characteristics and how the study sample compares to other surveys with CFL users and the general population.

3.1 OVERVIEW OF RESEARCH APPROACH

The study sample was developed in two phases. The first phase of the metering study was initiated in the summer of 2003 as part of a broader evaluation of the 2002 program. The first sample included 100 homes, and meters were installed on all interior fixtures containing compact fluorescent lamps (CFLs) (where installation was feasible) for 6 months.

The second phase of the metering study began in the spring of 2004 when the investor-owned utilities (IOUs) authorized use of the 2003 program evaluation budget to augment the metering study sample size and monitoring period. A total of 78 of the first phase's sites agreed to extend their monitoring period an additional 6 months, for a total monitoring period of 1 year. An additional 275 sites were recruited, and their interior fixtures with CFLs were monitored for 6 months.

3.2 SAMPLE DEVELOPMENT

3.2.1 Phase 1

The sample frame for the phase one sample was drawn from the 2002 program evaluation lighting purchaser survey database, which included a random sample of households with CFLs in their homes. The sample was geographically clustered to control for survey implementation costs. Four clusters were selected that represented the major rural/urban and geographic distinctions within the IOU service territories. Sites located in any of the 4 clusters were drawn from the master database, and 25 sites per cluster were ultimately screened and recruited by KEMA phone surveyors. Table 3-1 presents an overview of the phase 1 sample.

Table 3-1
Phase 1 Sample

Cluster	Geographic Region	Number of Sites
1	San Francisco Bay Area	25
2	Fresno	25
3	Los Angeles and Orange Counties	25
4	San Diego County	25
Total		100

3.2.2 Phase 2

We selected an additional three geographic clusters for the second sample so that phase 2 sites would be drawn from a total of seven clusters (including the four clusters selected in Phase 1). The sources for the second sample were the first sample's recruitment database, and a new database of homes that were "soft-recruited" by a survey research firm using random-digit dialing within the seven geographic clusters.

Table 3-2 describes the Phase 2 sample.

Table 3-2
Phase 2 Sample

Cluster	Geographic Region	Number of Sites
1	San Francisco Bay Area	50
2	Fresno	25
3	Los Angeles and Orange Counties	25
4	San Diego County	25
5	San Bernardino	50
6	Chico/Red Bluff	50
7	Bakersfield	50
Total		275

Table 3-3 shows how the combined phase 1 and 2 sites were distributed across the seven clusters. A total of 125 sites were located in Northern California, 150 in Southern California, and 100 in the Central Valley, with 175 sites located in Pacific Gas and Electric territory, 150 in Southern California Edison territory, and 50 in San Diego Gas & Electric territory.

Table 3-3
Total Study Sample

Cluster	Geographic Region	Region of State	IOU Service Territory	Number of Sites
1	San Francisco Bay Area	Northern	PG&E	75
2	Fresno	Central Valley	PG&E	50
3	Los Angeles and Orange Counties	Southern	SCE	50
4	San Diego County	Southern	SDG&E	50
5	San Bernardino	Southern	SCE	50
6	Chico/Red Bluff	Northern	PG&E	50
7	Bakersfield	Central Valley	SCE	50
Total				375

3.3 On-Site Survey Development

During the on-site survey, the following information about the home and its lighting fixtures was collected:

- House type (i.e., single-family detached, single-family attached, apartment, etc.)
- Use area or room type (i.e., living room, kitchen, etc.)
- CFL wattage, fixture and bulb type (e.g, 20-Watt CFL ceiling fixture)
- Control type (dimmer switch, dual switching, occupancy sensor, etc.)
- Self-reported wattage and type of previous bulb (e.g., 100-Watt incandescent).

The on-site survey was based on similar recent surveys of homes such as those used for the IOUs' Residential New Construction Program Evaluation. A detailed instruction form with survey guidelines was developed to accompany the survey, and auditors were trained on the guidelines, both in a classroom setting and in the field. KEMA's experienced senior field staff conducted the training and participated in the first 2 weeks of field visits to ensure a quality data collection process.

3.4 On-Site Monitoring and Survey Implementation

3.4.1 Recruitment

Phase 1—Initial Recruitment

The sample for on-site data collection was recruited as part of the 2002 program evaluation consumer survey effort in June and July of 2003, which identified homes with CFLs. Upon completion of the consumer surveys, we determined whether customers who reported that they had CFLs in their homes were located in one of the four geographic clusters selected for the study. If the customer resided in the one of the study's clusters, a KEMA phone scheduler attempted to recruit the customer and offered a $50 incentive to participate in the study for 6 months.

Phase 1—Monitoring Extension

In March of 2004, each of the first sample of participants was contacted via mail and telephone to determine if they would extend their participation in the study another 6 months. Participants that were interested would receive an additional $25, and KEMA's phone schedulers made appointments with those participants so that an auditor could download data from the meters at this time. For participants who were not interested in extending their participation in the study, the scheduler made an appointment for the auditor to remove the equipment or mailed the participant a stamped envelope and instructions for removing and mailing back the loggers.

Phase 2

We used a combination of the phase 1 recruitment database (i.e., customers who had not yet been recruited) and a second recruitment effort to populate the phase 2 sample. A survey research firm, Gilmore Research, was hired to develop a database of households with CFLs located in the study geographic clusters who were interested in participating in the study. KEMA telephone surveyors used both databases to recruit an additional 275 homes to participate in the study. As in phase 1, potential participants were offered a $50 incentive to participate in the study for 6 months.

3.4.2 Monitoring Period

Phase 1 meters were installed in June–July 2003 and were either removed in March–April 2004 (Group A) or remained until September–October of 2004 (Group B). Phase 2 meters were installed in March–April 2004 and were removed in September–October 2004 (Group C). Table 3-4 shows the monitoring period by phase and group. Crosshatched cells indicate the installation and removal periods.

Table 3-4
Monitoring Period by Phase/Group

			2003							2004									
	Phase	# Sites	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
A	1	22																	
B	1	78																	
C	2	275																	

3.4.3 Equipment

To monitor the selected CFL fixtures, we used time-of-use (TOU) lighting loggers. The loggers recorded all on and off switches with a time and date stamp during the monitoring period. All loggers employed a photocell to sense the presence of light. No household electrical wiring was disturbed during the installation, removal, or monitoring process. All loggers had variable sensitivity to avoid capturing light from sources other than the intended fixture.

We initially used a smaller logger model, the HOBO, by Onset Computer Corporation, that fit easily into most light fixtures. During the first phase of the study, problems were discovered with this model as flickering lights caused the unit's memory too fill up too quickly. We switched to a logger model by DENT Instruments to eliminate the problem. To compensate for its larger size, a flexible fiber-optic light tube was an installation option to sense light from fixtures with difficult access.

Each logger model had its own proprietary software package for logger setup, data retrieval, and initial data manipulation and analysis.

3.4.4 Logger Installations

On arrival at participating households across the state, auditors briefly interviewed the resident, performed a complete lighting inventory of the home, and then installed a TOU logger to monitor the usage patterns of qualified CFL fixtures. Loggers were installed by a variety of means, depending on the type of fixture. Magnetic strips, zip ties, tape, Velcro, rubber bands, twist ties and other fasteners were used as necessary.

Though our intent was to monitor all CFL fixtures in the target home, a variety of barriers made this impossible. Many respondents required the logger to be out of sight and reach for privacy and child safety concerns. Some fixtures could not accept a logger in a safe, well-ventilated manner.

3.4.5 Logger Removals

As program participants exited the study, they were offered the choice of either having pre-stamped padded envelopes sent to them for self-removal or setting up an appointment for an auditor to return and remove them. Once the loggers were returned, the dataset was downloaded from the logger to a hard drive, cleaned, and then analyzed.

Aside from those ending their participation in the study for various reasons, there were two periods of logger removals. Phase 1 participants who chose not to continue on to phase 2 had loggers removed in March and April of 2004. Phase 2 loggers were removed in September and October of 2004.

3.4.6 Data Quality Assurance Procedures

To ensure cost-effective data collection, data quality assurance procedures were conducted throughout the survey implementation process.

On-site survey guidelines

We developed a detailed document with guidelines for the auditors to follow when conducting the on-site survey. These guidelines were based on procedures developed for other residential on-site studies and were customized for this CFL study.

Auditor recruitment and training

Auditors were recruited for this project from a pool of experienced KEMA auditors. KEMA had recently completed several large-scale residential on-site studies and, consequently, had an experienced group of auditors ready to deploy. The auditors were provided with the on-site survey guidelines and were trained by the project manager on how to fill out the survey.

KEMA's in-house metering equipment expert worked with the on-site survey manager to develop a training session on how to install meters on CFLs in residential homes. Training took place in three phases. First, auditors learned in the classroom how the meters worked and how they should be installed. Second, they went to practice homes (KEMA employee homes) to learn hands-on how to install the meters. Finally, as each auditor visited their first few real sites, they were accompanied by an experienced KEMA auditor to ensure proper survey implementation and logger installation.

Monitoring quality control

In conjunction with another on-site project, KEMA auditors checked on the disposition of each logger across most of the phase 1 sites about 1 month into the monitoring period. Almost all loggers were found to be installed correctly.

At the time of the phase 1 study extension, KEMA auditors visited every phase 1 site and downloaded the metering data to check its quality. As mentioned above, we found that one of the meter brands (HOBO) was overly sensitive and in some cases recorded "flickering," or series of on/offs. We were able to clean flickering episodes by deleting on/offs that occurred within 2 minutes. Thus, the data were salvageable, except in some cases where the loggers ran out of memory; the HOBO logger can only store 2007 on/off series. As a result, we purchased the costlier yet more reliable brand of loggers (DENT) for the second phase of the study.

Meter data quality control

Once we retrieved loggers from a site, we recorded the serial number of the logger and matched the logger to a site and an on-site survey. The metered data were then downloaded using logger software (SMARTware for DENT loggers, BoxCar Pro for HOBO loggers), and a SAS dataset was created containing a series of on/offs for each fixture along with the date and time each on/off occurred. A SAS program was created to turn the on/off time stamps into percent on for each hour. Then, the average was taken over each day of the percent-on variable, which was the average hours per day each fixture was on. We then analyzed the data a number of ways to identify logger failures. We compared the average usage for each fixture with the self-reported usage to help determine whether high-use or low-use reads were valid (i.e., whether the logger stopped recording due to failure or whether the light was truly left off or on during the period in question). We also looked at the mean across the monitored fixture compared to its weekly mean usage values to identify any periods where the logger may have not been operating (e.g., prior to installation and subsequent to removal). Based on these routines, we dropped fixtures where we believed the logger failed the entire time and dropped sections of reads where we believed the logger was not operating temporarily. The cleaned values were then used to generate load shapes and run-time hours for the various segments of interest and across the entire sample.

Survey Data Quality Control

The survey data were entered into a customized Access database. The hard copy forms were reviewed by a senior auditor before data entry to ensure consistency and quality of responses. Then the data were exported into SAS, and cleaning code was developed to fix erroneous and inconsistent responses.

3.5 ANALYSIS

After cleaning the data, we adjusted it to account for seasonality, created weights, and accounted for outdoor lighting usage.

3.5.1 Seasonality

Due to the study design, with additional funding being authorized mid-way through the study, there were two phases of monitoring. The first phase included 100 participants over a 6-month period beginning in the summer of 2003. The second phase included 275 new participants for a 6-month period beginning in the spring of 2004. Additionally, 78 of the participants in the first phase agreed to extend their monitoring period by 6 months.

Figure 3-1 shows how our sample was distributed over the monitoring period. In March 2004 the figure shows the drop in phase 1 participants from 100 to 78 and the addition of 275 new participants. Note that we have included more detailed disposition tables and figures in the next section and in Appendix B, which show the impact of installation and removal periods (i.e., not all 100 phase 1 sites were operating at the beginning of the installation period.)

Figure 3-1
Monitoring Period by Phase– June 2003 through September 2004

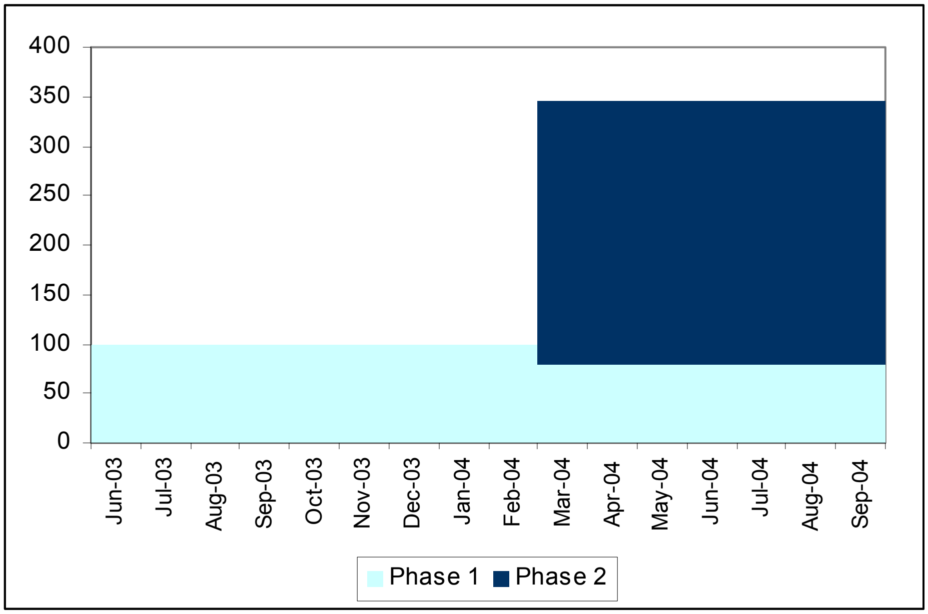
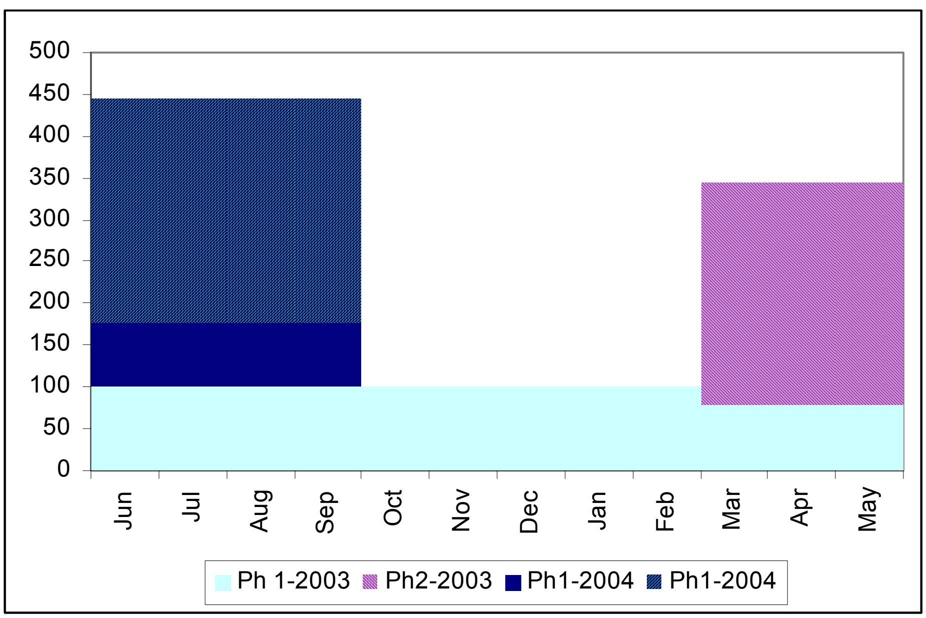


Figure 3-2 shows the distribution of the sample over a calendar year from June through May. Note that over the spring, summer, and part of fall, 350+ fixtures were monitored, while in late fall and winter 100 fixtures were monitored.

Figure 3-2
Monitoring Period by Phase and Year—June through May



For fixtures in a given month that were either monitored for less than half the month or not monitored at all, we applied seasonality factors to impute the missing monthly usage values (average hours per day and percent on per hour). We ran a regression that determined the increase in CFL usage as a result of an increase in daylight hours. We ran separate regressions by day type (weekend v. weekday) and room type (sensitive to daylight hours: kitchen, dining room, living room v. not sensitive: bathroom, bedroom, hallway).

Table 3-5 shows the regression results for the four models. As expected, changes in daylight hours causes much smaller changes in CFL usage in not-sensitive rooms than sensitive rooms. For example, a 1-hour increase in daylight would result in less than 5 minutes per day additional CFL usage in a bathroom, bedroom, or hallway, while it would result in more than a 15-minute increase per day in CFL usage in a living room, kitchen, or dining room.

Table 3-5
CFL Usage as a Function of Daylight Hours Regression Results

Location Type	Day type	Intercept	T stat	Parameter	T stat	Adjusted R^2
Not sensitive	Weekend	0.80	1.75	0.08	1.94	0.13%
Not sensitive	Weekday	0.85	2.12	0.06	1.78	0.10%
Sensitive	Weekend	-0.24	-0.39	0.29	5.36	1.44%
Sensitive	Weekday	0.64	1.06	0.21	3.93	0.74%

We then used the parameter estimates to develop CFL usage shares across 12 months. For each day type and room type combination, the imputed monthly value for a fixture was calculated as follows:

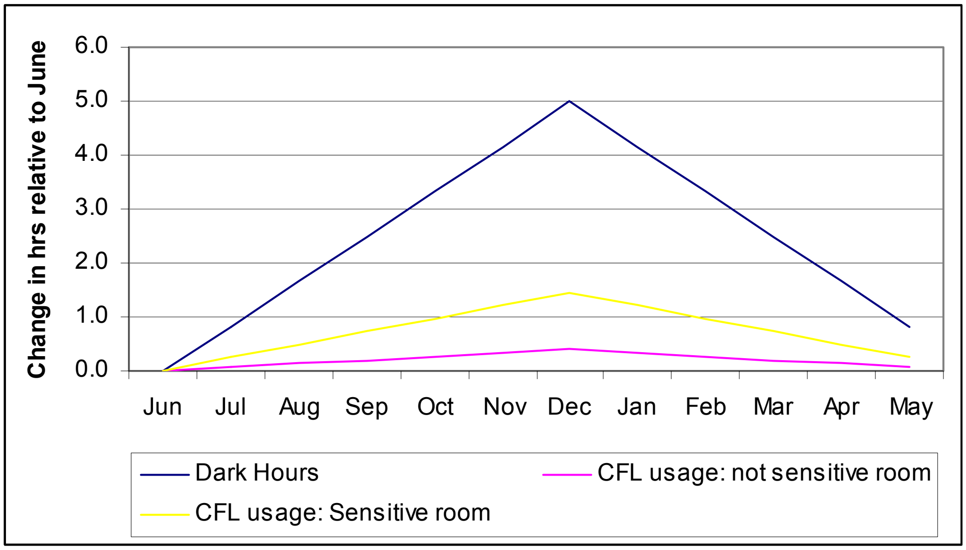
$$m_{xi} = (M_x / S) * s_i$$

where:

m_{xi} = imputed usage value for month i and fixture x
M_x = the sum of monthly monitored usage values for fixture x
S = the sum of the seasonal factors that correspond to M_x
s_i = Seasonal factor (one set per day type/room type combination) for month i

Figure 3-3 shows the relationship between CFL usage and dark hours as estimated by the regression analysis. The y axis shows the change in hours relative to June. In December, there are approximately 5 more dark hours per day than in January. Over this same period, CFL usage increases on average about 1/2 hour in not-sensitive rooms and by 1-1/2 hours in sensitive rooms.

Figure 3-3
Relationship Between CFL Usage and Dark Hours



3.5.2 Weighting

The logger data were collected at the fixture level and were weighted by the number of lamps associated with that fixture.

We also applied weights to the final cleaned dataset by room type to adjust for the fact that the monitored sample differed slightly from the CFL inventory with respect to the distribution of CFLs by room type.[1] In our analysis, we found that the major driver of the variation in CFL usage is the location of the fixture. Since a detailed inventory was captured at every home, we were able to compare the monitored sample against the actual distribution of CFLs across all participating homes. We found slight differences and, as such, developed adjustment weights. Table 3-6 shows the adjustment weights.

We did not weight the data by geographic location or other demographic variable, as our sample was designed to be representative of the combined IOU service territories both demographically and geographically. Section 3.7 discusses the sample characteristics in detail in comparison to the state's population in general (using the 2000 Census) and to other samples of CFL users from prior studies.

[1] While we attempted to monitor all interior fixtures with CFLs installed, for a variety of reasons (e.g., infeasibility, respondent complaint regarding aesthetics, etc.) there were many fixtures that were not monitored. However, the inventory that was taken of each participating home captured detailed information on every interior and exterior lighting fixture.

Table 3-6
Adjustment Weights

Location	Monitor sample		Inventory		Weight
	Frequency	Percent	Frequency	Percent	
Bedroom	199	20%	669	27%	1.3
Bathroom	181	18%	400	16%	0.9
Family room	93	9%	194	8%	0.8
Garage	27	3%	72	3%	1.0
Hallway	61	6%	184	7%	1.2
Kitchen/dining room	170	17%	484	19%	1.1
Living room	204	21%	342	14%	0.7
Laundry/utility room	27	3%	68	3%	1.0
Other room	21	2%	94	4%	1.8

3.5.3 Outdoor Lighting

Our monitored sample explicitly excluded outdoor CFLs since the meters employed for the study operate on the presence of light. That is, meters installed on outdoor fixtures would capture daylight in addition to the light emitted by the fixture. We adjusted our results to account for exclusion of outdoor CFLs in the sample by applying results from the California Baseline Lighting Efficiency Technology Report, HMG 1997[2] to our inventory sample on outdoor fixtures with CFLs.

The 1997 study provided average run-time hours for outdoor fixtures by fixture type and control type based on adjusted self-reported data. We applied these values to our inventory data on outdoor CFLs and calculated an overall average run time hour of 3.1 hours per day for our sample. We then adjusted our run-time hour results by including the inventoried outdoor CFLs in the analysis. In our results, for the most part we focus on indoor lighting only since outdoor lighting results are estimates and may not be reliable.

3.6 SAMPLE DISPOSITION

Appendix B contains the detailed sample disposition, but we provide three summary tables here to provide an overview of the final disposition. The study sample includes 369[3] participating sites, with 891 monitored fixtures containing 1167 CFLs. Table 3-7 presents the final study

[2] This prior study analyzed data from 3 studies, including an SCE study with 477 time-of-use light meters installed in a balanced sample of homes in SCE territory, 1 fixture per household. (Due to attrition, malfunctions, and missing data, the final usable sample was 359 meters.) The meters ran for 4 to 8 months each, from the winter or spring to fall of 1993. Self-reported data on a larger sample were adjusted based on comparisons between the metered data and the self-reported data on the smaller sample.

[3] Six sites dropped out of the study during the first month of monitoring.

disposition. Note that 33 sites did not return their loggers after repeated phone calls, mailed correspondence, and auditor on-site visits.

Table 3-7
Disposition of Monitoring Sample Sites, Fixtures, and CFLs

Disposition Category	Number of Monitored Fixtures	Number of Monitored CFLs
Initial sample	891	1,167
Dropped out	12	23
Unreturned loggers	57	71
Logger failure	70	90
Included in analysis	752	983

Tables 3-8 and 3-9 show the number of fixtures and CFLs included in this analysis by utility service territory and room type.

Table 3-8
Number of Monitored Fixtures/CFLs in Sample by Utility Service Territory

	Monitored Fixtures		Monitored CFLs	
Utility	Number	Percent	Number	Percent
PG&E	419	56%	572	58%
SCE	227	30%	281	29%
SDG&E	106	14%	130	13%
Total	752	100%	983	100%

Table 3-9
Number of Monitored Fixtures/CFLs in Sample by Room Type

	Monitored Fixtures		Monitored CFLs	
Room	Number	Percent	Number	Percent
Living room	174	23%	204	21%
Bedroom	152	20%	199	20%
Bathroom	103	14%	181	18%
Kitchen/Dining room	122	16%	170	17%
Family room	79	11%	93	10%
Hallway	54	7%	61	6%
Garage	27	4%	27	3%
Other room	15	2%	21	2%
Laundry/utility room	26	3%	27	3%
Total	752	100%	983	100%

3.7 SAMPLE CHARACTERISTICS

3.7.1 On-Site Sample Demographics

Table 3-10 shows the breakdown of dwelling type across the study sample. We attempted to oversample multi-family dwellings, but due to the high cost and the additional time required, we scaled back the oversample goals, and the multi-family sector (including mobile homes) comprised 10 percent of the study sample. A total of 72 percent of the sample owned their home, and the average number of residents per home was 2.8. The average home size was around 1,500 square feet, with three bedrooms and two bathrooms.

Table 3-10
Number of Monitored Fixtures/CFLs in Sample by Dwelling Type

Dwelling	Monitored Fixtures		Monitored CFLs	
	Number	Percent	Number	Percent
Detached, Single Family	588	78%	782	80%
Attached, Single Family	87	12%	103	10%
Multi-Unit	55	7%	70	7%
Mobile Home	22	3%	28	3%
Total	752	100%	983	100%

3.7.2 On-Site Sample Comparability

We compared our on-site sample of households with CFLs installed to three other sources to determine whether and how it differs from the underlying population in general and the population of CFL users.

We used both the 2002 California Residential Appliance Saturation Survey (RASS) and the 2000 Census to compare our sample to the underlying population in general. While the Census is a more reliable representation of the state's demographics, the RASS has additional variables that the Census does not collect.

We used the 2002 evaluation of this program, which included a telephone survey of CFL users, to see how our on-site sample, which reflects households willing to participate in both a short telephone survey and an on-site survey, compares to a telephone survey of CFL users, which reflects only those households willing to participate in a phone survey. We also compared our sample to the 2002 evaluation phone survey with the general population.

Table 3-11 shows how the on-site sample compares to the other survey samples and the Census. In general, the on-site sample is fairly close to the general population phone survey conducted as part of the 2002 evaluation of this program, while homeowners and single-family residents are substantially overrepresented in all of the samples as compared to the Census. That is, the telephone plus on-site survey method did not capture a very different group of CFL users than telephone alone, and moreover, CFL users who are willing to participate in a telephone and/or on-site survey are not very different from households in general who are willing to participate in a telephone survey. However, households in general, including CFL users, who are willing to participate in a survey of any kind are different from the underlying population.

The reader should draw two main conclusions as a result of this comparative analysis. First, households that do not have CFLs installed in their home are very similar to households that currently do have CFLs installed. As such, these study results are applicable to homes that may install CFLs in the future. However, as CFL saturation increases over time, CFL installation patterns should be revisited to determine whether these study results are still valid. Second, the recent telephone and on-site samples (and likely many other residential telephone and on-site samples from similar evaluations) used to evaluate this program have tended to underrepresent multi-family dwellers and renters. This issue did not affect this study's conclusions since we did not find significant differences in key results across these segments.

Table 3-11
On-site Sample Comparison

Pop Segment	Survey Approach	Source	Home ownership	Single-family home	Avg home square footage	2 or fewer people in the home	Homes with Seniors	Used CFLs pre-energy crisis
CFL users	On-site + phone	This study's metering sample	72%	88%	1,550	50%	24%	40%
CFL users	Phone	2002 evaluation phone sample	78%	87%	1,900	45%	34%	37%
All CA HH	Phone	2002 evaluation phone sample	71%	82%	1,800	45%	32%	na
All CA HH	Mail+	2000 U.S. Census (*2002 CA RASS)	56%	64%	*1,483	52%	*25%	na

3.7.3 On-Site Sample Lighting Inventory

This section describes the study sample's lighting inventory. The purpose of this section is to provide program planners and the like with an understanding of the types of bulbs and fixtures that are in use by households that have been targeted by the program, i.e., those that have CFLs installed in their homes.

Fixture Type

Table 3-12 shows the breakdown of fixture types found in the sample. As shown, the most common fixture found was the ceiling-mounted fixture, followed by floor or table lamps. Overall, the sampled homes had an average of 24 lighting fixtures per household. By comparison, single-family homes had 27 fixtures per home while multi-family households had 14.

Table 3-12
Fixture Types

Fixture Type	Percentage of Sampled Fixtures	Number of Sampled Fixtures
Ceiling Mounted	26%	2,376
Wall Mounted	19%	1,730
Suspended from Ceiling	7%	595
Floor or Table Lamp	20%	1,802
Downlights (Can Style)	11%	1,000
Torchiere	2%	201
Recessed	5%	424
Ceiling Fan	8%	703
Other Hard-Wired Fixture	0.8%	72
Other Plug-In Type Light	0.2%	14
Other	0.9%	78
Total		8,995

Table 3-13 provides a breakdown of the predominant fixtures observed in the major room types.

Table 3-13
Dominant Fixture Types by Room

Room	Dominant Fixture Type
Living room	Floor/Table lamps
Bedroom	Floor/Table lamps
Bathroom	Wall
Kitchen/Dining room	Ceiling
Family room	Floor/Table lamps
Hallway	Ceiling
Garage	Ceiling
Other room	Ceiling
Laundry/utility room	Ceiling

Control Type

Table 3-14 shows the distribution of controls used to power the sample's fixtures. Very few fixtures (less than 2 percent) are controlled by photocells, timers, and motion sensors.

Table 3-14
Control Types

Control Type	Percentage of Sampled Fixtures	Number of Sampled Fixtures
Switch	94%	8,519
Dimmer	4%	335
Other (photocells, timers, and motion sensors)	2%	159
Total	100%	9,013

Being more difficult to adapt to CFL bulbs, the non-switch-controlled fixtures are of particular interest here. Of the fixtures with dimming controls, most are found in the dining and living/family rooms, and most are suspended fixtures. The fixtures with other control types—photo sensors, motion detectors, and timers—are most often found outside and are predominantly wall-mounted.

Lamp Category

Each household in the sample has an average of 40 sockets, with single-family dwellings having a higher number (46) and multi-family dwellings a lower number (22). Table 3-15 displays the breakdown of fixtures in the sample by lamp type, with 23 percent of fixtures containing CFLs.

Table 3-15
Lamp Categories—Fixtures

Lamp Categories	Percentage of Sampled Fixtures	Number of Sampled Fixtures
Incandescent	62%	5,554
Compact fluorescent	23%	2,068
Fluorescent tube	10%	925
Halogen	5%	413
High Intensity Discharge (HID)	0.03%	3
Total		8,963

Table 3-16 shows the breakdown of lamp types by bulbs, with 18 percent of all bulbs in the sample being CFLs.

Table 3-16
Lamp Categories—Bulbs

Lamp Categories	Percentage of Sampled Lamps	Number of Sampled Lamps
Incandescent	66%	9,805
Compact fluorescent	18%	2,717
Fluorescent tube	12%	1,784
Halogen	3%	509
High Intensity Discharge (HID)	0.02%	3
Total		14,818

We found that the majority of incandescent bulbs and CFL bulbs are in ceiling and table/floor lamps. Fluorescent light fixtures were most often seen in ceiling fixtures, and halogen lamps were found to be largely in outdoor wall fixtures and small desktop lamps.

Incandescent Lamps

Table 3-17 looks at the breakdown of incandescent bulbs in our inventory, the vast majority (74 percent) being standard incandescent, followed by small-based at 16 percent.

Table 3-17
Incandescent Lamp Type

Incandescent Lamp Type	Percentage of Sampled Incandescent Lamps	Number of Sampled Incandescent Lamps
Standard	74%	7,273
PAR	2%	211
Globe	0.8%	82
Small Base	16%	1,546
Reflector	7%	653
Decorative	0.4%	40
Total		9,805

Table 3-18 shows the range of incandescent bulbs per fixture.

Our inventory also lists 260 3-way incandescent bulbs, installed exclusively in floor and table lamps in living rooms and bedrooms.

Table 3-18
Number of Incandescent Lamps per Fixture

	Incandescent Lamps Per Fixture			Number of Sampled Fixtures with Incandescent Lamps
Fixture Type	Average	Min	Max	
Standard	1.7	1	12	4,413
PAR	1.4	1	4	167
Globe	5.9	1	14	14
Small Base	4.0	1	14	451
Reflector	1.6	1	9	496
Decorative	4.1	1	12	12
Total				5,554

Fluorescent Lamps

By far, the typical fluorescent fixture is still the 4-foot-long, T12 diameter, 34- or 40-Watt ceiling-mounted type, most often found kitchens and garages. Table 3-19 breaks down the number of standard fluorescent fixtures versus other fluorescent fixture types.

Table 3-19
Fluorescent Lamp Type

Fluorescent Lamp Type	Percentage of Sampled Fluorescent Lamps	Number of Sampled Fluorescent Lamps
Standard Tubes	94%	1,681
U-Tubes	0.7%	13
Other	5%	90
Total		1,784

Table 3-20 presents the number of bulbs per fluorescent fixture observed.

Table 3-20
Number of Fluorescent Lamps per Fixture

	Fluorescent Lamps Per Fixture			Number of Sampled Fixtures with Fluorescent Lamps
Fixture Type	Average	Min	Max	
Standard Tubes	2.0	1	12	865
U-Tubes	1.7	1	5	10
Other	1.2	1	2	50
Total				925

Table 3-21 shows that the majority of fluorescent lamps are still of T12 diameter; 87 percent of all fluorescent lamps counted were T12, while 11 percent were the narrower T8-style bulb.

Table 3-21
Fluorescent Lamp Tube Diameter

Fluorescent Lamp Tube Diameter	Percentage of Sampled Fluorescent Lamps	Number of Sampled Fluorescent Lamps
T12	87%	1,492
T8	11%	194
T5	2%	36
Total		1,772

Compact Fluorescent Lamps (CFL)

Table 3-22 lists the range of CFL fixture styles observed in our inventory. The majority were the typical spiral-shaped bulb found most readily through California retailers.

Table 3-22
CFL Type

CFL Type	Percentage of Sampled CFLs	Number of Sampled CFLs
Capsule Diffuser	12%	328
Globe Diffuser	5%	140
Reflector	3%	76
Circline	6%	176
Other (Spiral, etc.)	74%	1,997
Total		2,717

As the most readily available CFL bulbs come with directions on the packaging instructing the consumer to use them only in standard switched fixtures, we found that 98 percent of fixtures in our CFL sample were indeed operated by a normal switch.

Table 3-23 shows the range of CFL bulbs installed per fixture, across the various categories of CFL lamp styles.

Table 3-23
Number of CFLs per Fixture

	CFLs Per Fixture			Number of Sampled Fixtures with CFLs
Fixture Type	Average	Min	Max	
Capsule Diffuser	1.6	1	5	213
Globe Diffuser	1.5	1	8	107
Reflector	1.4	1	4	62
Circline	1.1	1	3	163
Other (Spiral, etc.)	1.4	1	8	1,523
Total				2,068

Refer to Section 5 for further detail on CFL installations, including CFL installation/retention rates, location of installations, wattage breakdown, incandescent replacement wattage, CFL base type and ballast type. We also discuss the potential for CFLs in Section 5.

Halogen Lamps

Table 3-24 shows the various halogen lamp types observed in the study. Seventy-seven percent of all halogen fixtures were controlled by a switch, 18 percent by dimmer, and 5 percent by motion sensor. Halogens were most often seen on outdoor wall fixtures, followed by bedroom table lamps and torchieres.

Table 3-24
Halogen Lamp Type

Halogen Lamp Type	Percentage of Sampled Halogen Lamps	Number of Sampled Halogen Lamps
"A" Type	34%	173
Tubular	23%	116
Low Voltage	6%	32
PAR	31%	158
IR	6%	30
Total		509

Table 3-25 provides a breakdown of the number of halogen bulbs we saw in each fixture across the categories of halogen fixture types used.

Table 3-25
Number of Halogen Lamps per Fixture

	Halogen Lamps Per Fixture			Number of Sampled Fixtures with Halogen Lamps
Fixture Type	Average	Min	Max	
"A" Type	1.4	1	5	140
Tubular	1.1	1	3	111
Low Voltage	1.4	1	4	23
PAR	1.9	1	12	117
IR	1.4	1	6	22
Total				413

4 CFL HOURS OF USAGE

This section describes the hours of usage results. The first subsection presents the average hours of usage results overall and by various customer, dwelling, and compact fluorescent lamp (CFL) product and installation characteristics. The second subsection presents load shapes, and the last section compares self-reported hours of usage to metered hours of usage.

4.1 CFL HOURS OF USAGE

CFL usage assumptions are key factors in lighting program savings estimates. In the past, the utilities and other energy-efficiency program implementers relied on studies of residential lighting in general (not specifically CFLs) or specific impact evaluations of CFL programs. This study's approach is unique in that it provides estimates of CFL usage across all homes in the investor-owned utilities' service territories—a segment that has been directly (via point-of-sale rebates) or indirectly (via manufacturer buydown and macro effects of the program on product price, availability, and exposure) influenced by the Upstream Residential Lighting Program.

Based on this study's metering results, the average usage of indoor CFLs is 2.3 hours per day. The estimate does not change much when we include our estimated of outdoor lighting usage, increasing from 2.28 to 2.34.[1] Table 4-1 describes CFL hours of usage per day for indoor fixtures and for all fixtures (including outdoor). Note that the number of observations refers to the number of CFLs that were monitored. The exception is for outdoor CFLs, where the number of observations is equal to the number of outdoor CFLs that were present in the homes in the study sample according to the on-site lighting inventory survey. Throughout this section we present results for indoor CFL usage only since the monitoring results do not apply to outdoor fixtures, except when we break out usage by room type.

Table 4-1
CFL Hours of Usage Per Day—Indoor Only and Including Outdoor

	Min # hours	Max # hours	Average # hours	Std. Error	±90% CI	# of obs
Outdoor included	0.0	23.3	2.34	0.1	0.4	1514
Indoor only	0.0	23.3	2.28	0.1	0.4	983

The remainder of this subsection shows CFL hours of usage per day broken out by various segments, including demographic and geographic characteristics of sample dwellings and

[1] As described in Section 3, outdoor lighting was not monitored as part of this study. However, we applied adjusted self-reported outdoor usage from the California Baseline Lighting Efficiency Technology Report (HMG 1997) to this study's inventory data.

households, characteristics of the metered CFLs, and experiences of the study participants. We analyzed differences in the variance across each of the segments to determine whether differences in the average usage were statistically significant. Where we found statistically significant differences, we have noted so either at the 90- or 95-percent confidence level.

Table 4-2 shows the mean, minimum, maximum, and standard error of CFL hours of usage by the room in which the CFL was installed. Note that CFL usage per day ranges from 0 to 23 hours. The differences shown in the average usage across room types is statistically significant at the 95-percent level.

Table 4-2
CFL Hours of Use Per Day by Room Type

Location	Min # hours	Max # hours	Average # hours	Std. Error	±90% CI	# of obs
Bedroom	0.0	9.2	1.6	0.1	0.4	199
Bathroom	0.0	5.9	1.5	0.2	0.4	181
Family room	0.0	9.2	2.5	0.3	1.3	93
Garage	0.2	23.3	2.5	1.5	6.0	27
Halls/entry	0.0	15.6	1.6	0.3	0.9	61
Kitchen	0.0	12.9	3.5	0.4	2.1	170
Living room	0.0	16.3	3.3	0.3	1.5	204
Laundry room	0.1	9.0	1.2	0.4	0.8	27
Other room	0.0	5.7	1.9	0.5	1.7	21
Outdoor	3.1	3.1	3.1	0.0	0.0	531
Overall	0	23.3	2.3	0.1	0.4	1514

Significant at the 95% level

The California Baseline Lighting Efficiency Technology Report (HMG 1997) estimated average residential lighting usage (including all lamp types) as 2.34 hours per day. If we compare this estimate to our study's estimate including outdoor fixtures, the estimates are equivalent. Figure 4-1 compares the two studies' results by room type. As shown, although the overall estimates are the same, CFLs installed in living rooms tend to be used more than lighting in general, while CFLs installed in laundry rooms, bathrooms, and hallways tend to be used less than lighting in general.

Figure 4-2 shows average hours of CFL usage per day on weekdays, weekends, and all days across room types. CFLs used in kitchens and living rooms are used the most often, while CFLs used in laundry room, bathrooms, hallways, and bedrooms are used the least often. CFLs are used more often on weekends, particularly those installed in garage, laundry room, and hallway fixtures.

Figure 4-1
Average CFL v. All Residential Lighting Use Per Day by Room Type

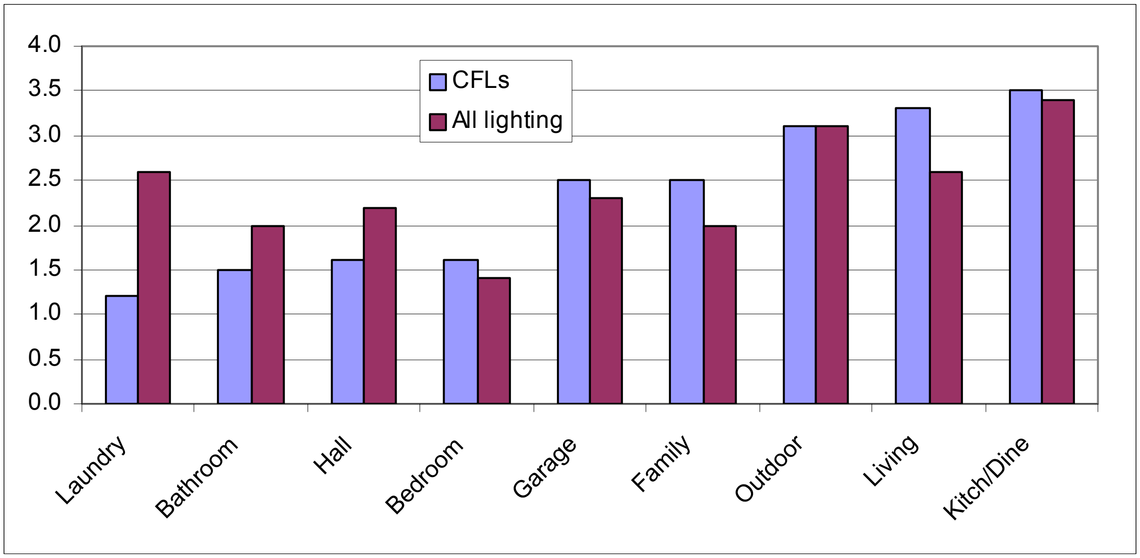


Figure 4-2
CFL Average Hours of Use Per Day by Room Type

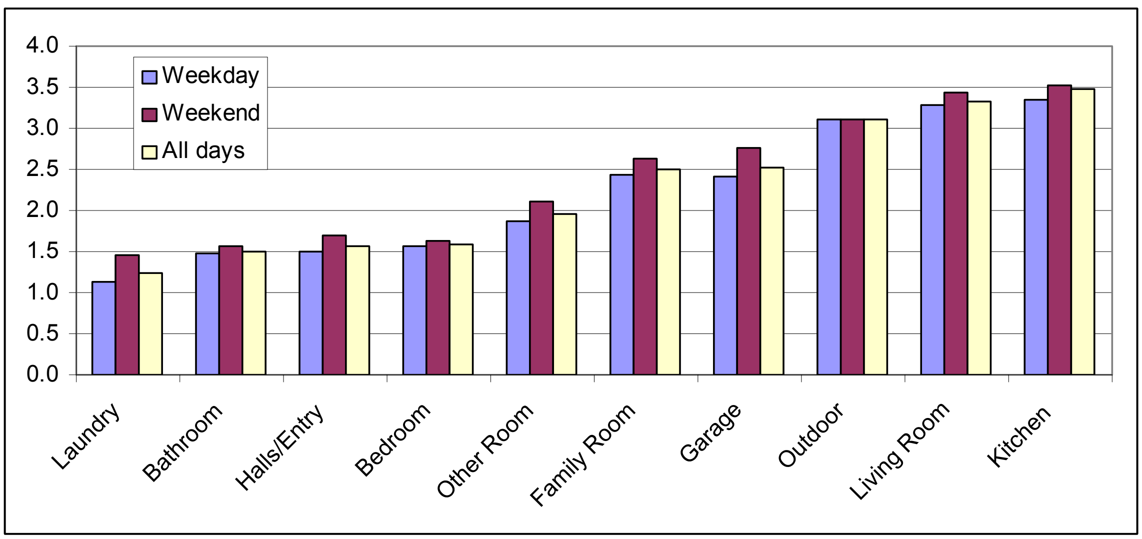


Table 4-3 shows CFL usage by household and demographic characteristics. One might expect to see differences in CFL usage across these segments due to variations in behaviors such as being home more or less often, occupying certain rooms more or less often, or installing CFLs in high- or low-use fixtures (as a result of concern for and knowledge of first-cost v. energy savings or a result of installing a high number of CFLs in the home). However, we did not find any statistically significant differences in usage by dwelling type, homeownership, or household composition. Accordingly, we did not find any differences in installation patterns by room type across these segments.

Table 4-3
Indoor CFL Hours of Use Per Day by Home and Demographic Characteristics

Characteristic	Min # hours	Max # hours	Average # hours	Std. Error	±90% CI	# of obs
Multi-family	0.0	12.9	2.3	0.2	0.8	173
Single-family	0.0	23.3	2.3	0.1	0.5	810
Households with seniors	0.0	23.3	2.2	0.2	0.8	292
Households with children	0.0	16.1	2.4	0.2	0.7	398
Homeowners	0.0	23.3	2.3	0.1	0.5	781
Renters	0.0	15.6	2.3	0.2	0.8	202

Figures 4-3 through 4-6 show average CFL usage during weekdays and weekends by the demographic and household segments. Weekend use tends to be even higher than weekday use for homeowners, multi-family dwellings, and households with no children or seniors.

Figure 4-3
Indoor CFL Average Hours of Use Per Day by Single-Family versus Multi-Family

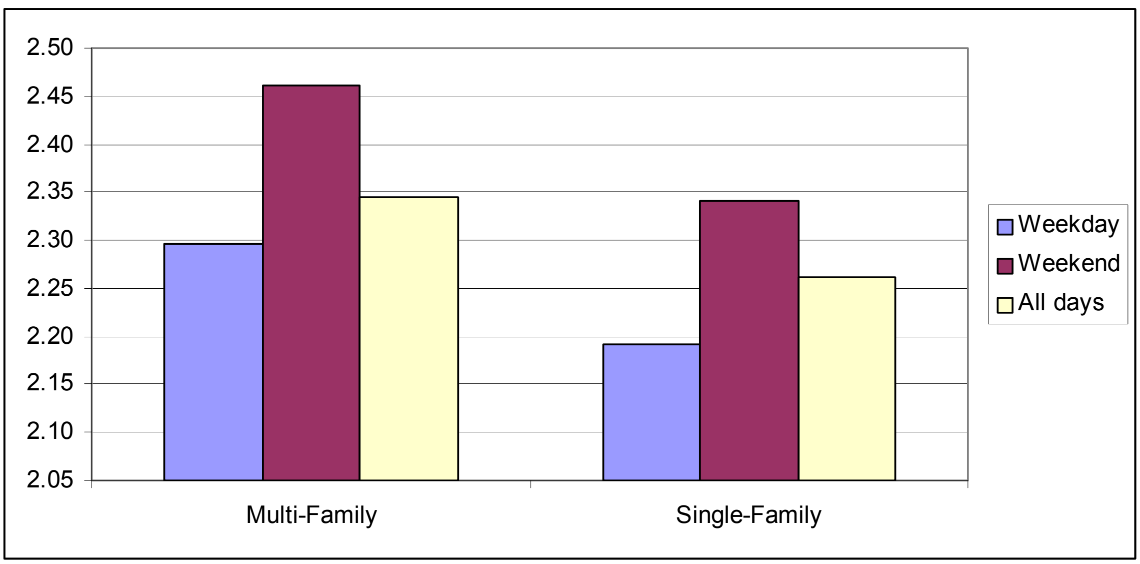


Figure 4-4
Indoor CFL Average Hours of Use Per Day by Presence of Seniors

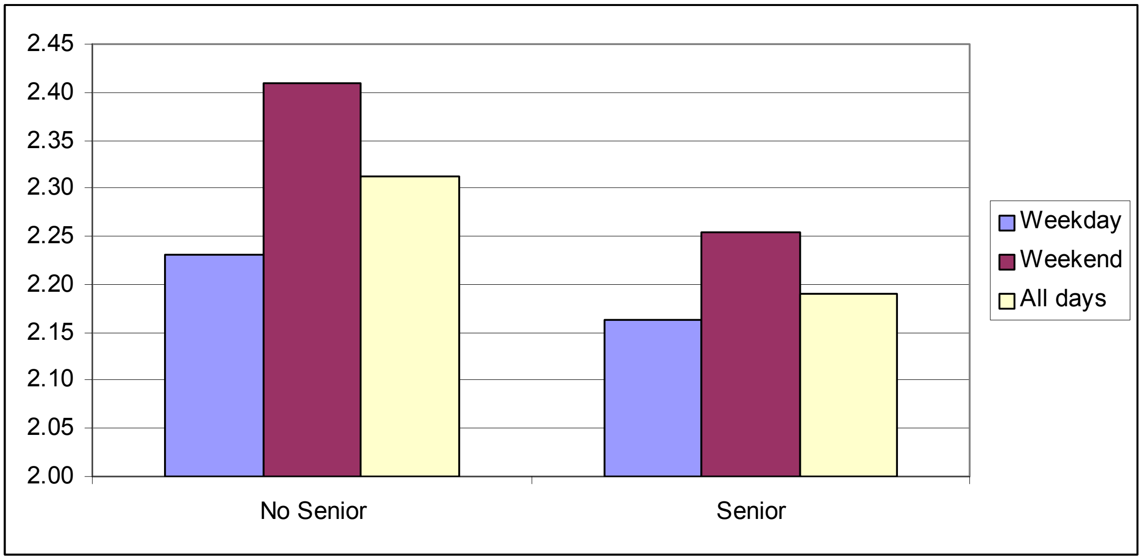


Figure 4-5
Indoor CFL Average Hours of Use Per Day by Presence of Children

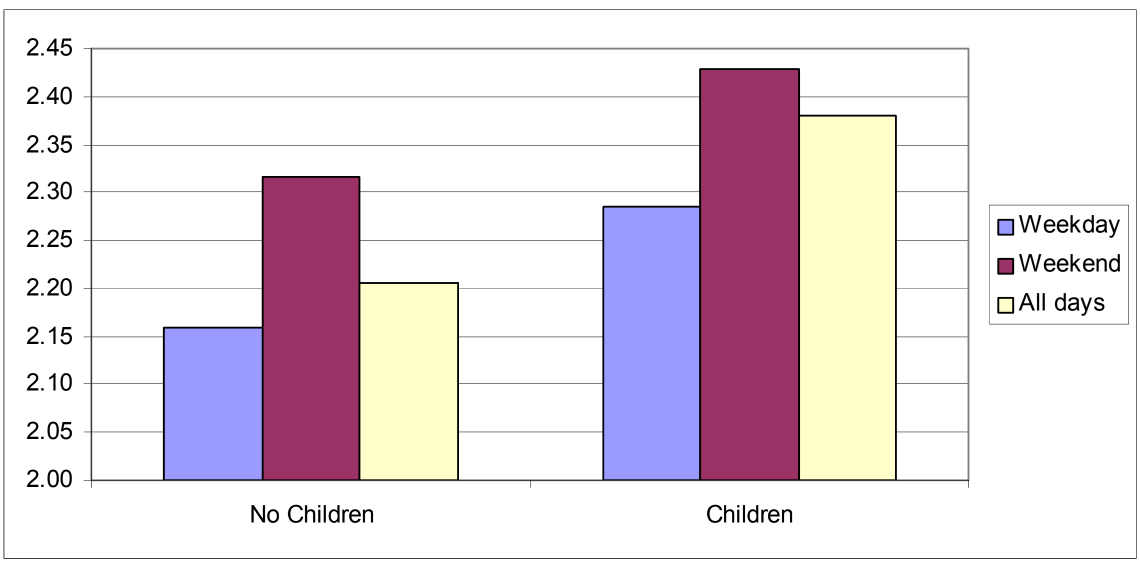


Figure 4-6
Indoor CFL Average Hours of Use Per Day by Homeownership

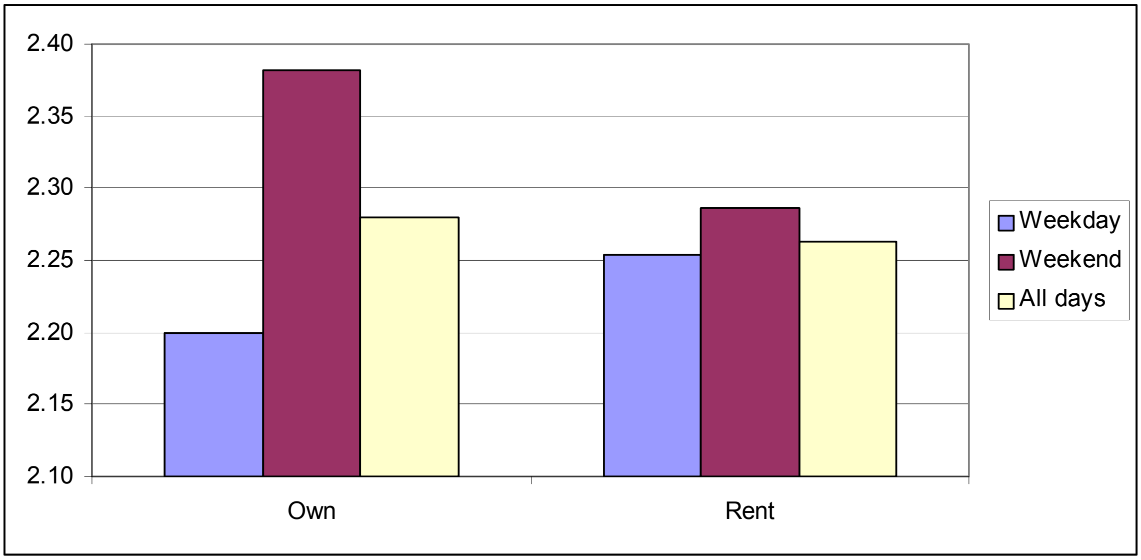


Figure 4-7 shows CFL average usage by size of the home. One might expect to see lower average CFL usage in larger homes because it is likely there are more rooms and fixtures and, as such, on average each fixture might be used less. We did not find any significant differences by home size. The small differences shown in Figure 4-7 show highest usage in the smallest and largest homes.

Figure 4-7
Indoor CFL Average Hours of Use Per Day by Square Footage

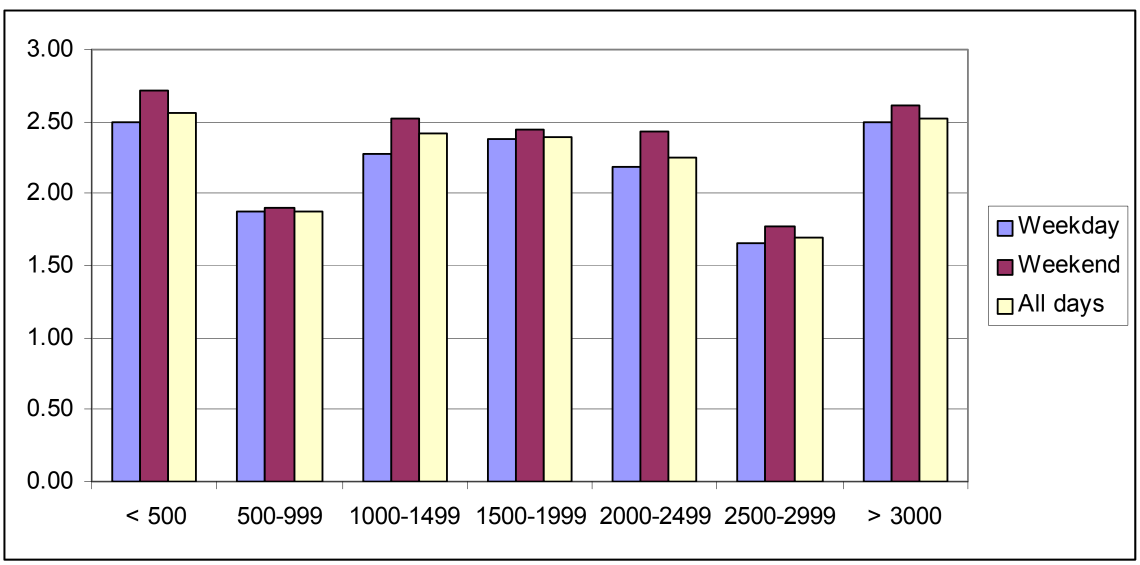


Table 4-4 breaks out CFL usage by utility service territory. While it appears that San Diego Gas & Electric (SDG&E) has higher than average usage and Southern California Edison (SCE) has lower than average usage, these differences were not found to be statistically significant.

Table 4-4
CFL Indoor Hours of Use Per Day by Electric Utility Service Territory

Electric Utility	Min # hours	Max # hours	Average # hours	Std. Error	±90% CI	# of obs
PG&E	0.0	23.3	2.3	0.2	0.6	572
SCE	0.0	16.3	2.1	0.2	0.6	281
SDG&E	0.0	14.1	2.7	0.3	1.3	130

Figure 4-8 displays the CFL usage data by utility and overall including the 90-percent confidence bounds. Since SDG&E's sample was smaller, the confidence bounds surrounding its estimate are wider.

Figure 4-8
Indoor CFL Average Hours of Use Per Day by Utility and Overall with 90% Confidence Bounds

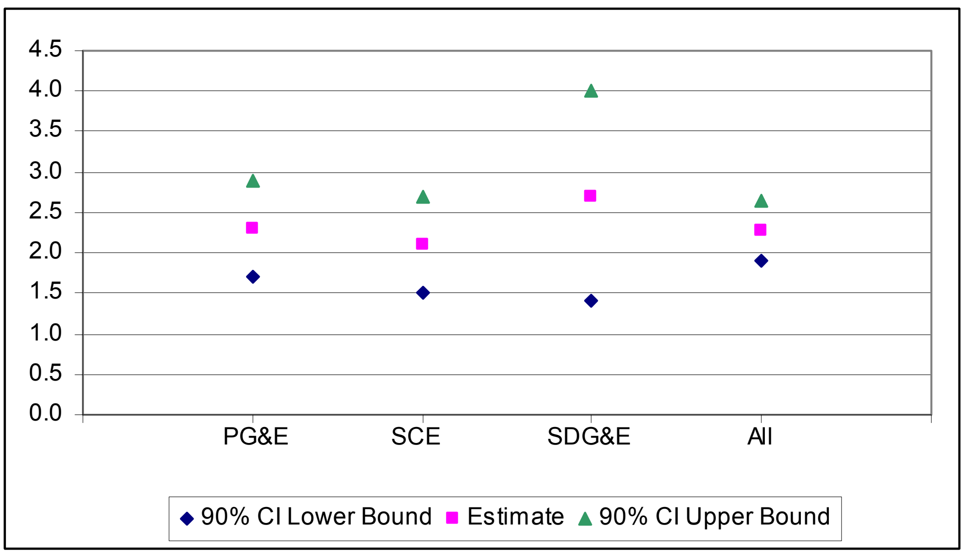


Figure 4-9 shows CFL usage by utility for weekdays and weekends compared to all days. The differential between weekend and weekday use is narrower for SDG&E and slightly wider for Pacific Gas and Electric (PG&E).

Figure 4-9
Indoor CFL Average Hours of Use Per Day by Utility Service Territory

Table 4-5 shows CFL usage by geographic location of the study dwellings. While one might expect lighting usage to be correlated to north-south geographic location (i.e., higher usage at higher latitudes), on average we did not find statistically significant differences in usage across these regions.

Table 4-5
Indoor CFL Hours of Use Per Day by Geographic Region

Geographic Location	Min # hours	Max # hours	Average # hours	Std. Error	±90% CI	# of obs
Northern California (SF Bay Area and Chico)	0.0	23.3	2.1	0.2	0.7	358
Central Valley (Fresno and Bakersfield)	0.0	15.6	2.4	0.2	0.9	272
Southern California (LA, OC, Riverside and San Diego Counties)	0.0	16.3	2.3	0.2	0.6	353

Figure 4-10 shows average CFL usage by region of the state. While estimated Northern California usage is lower than the other two regions, the differences, as mentioned above, are not statistically significant. The difference between weekday and weekend use is similar across regions.

Figure 4-10
Indoor CFL Average Hours of Use Per Day by Region

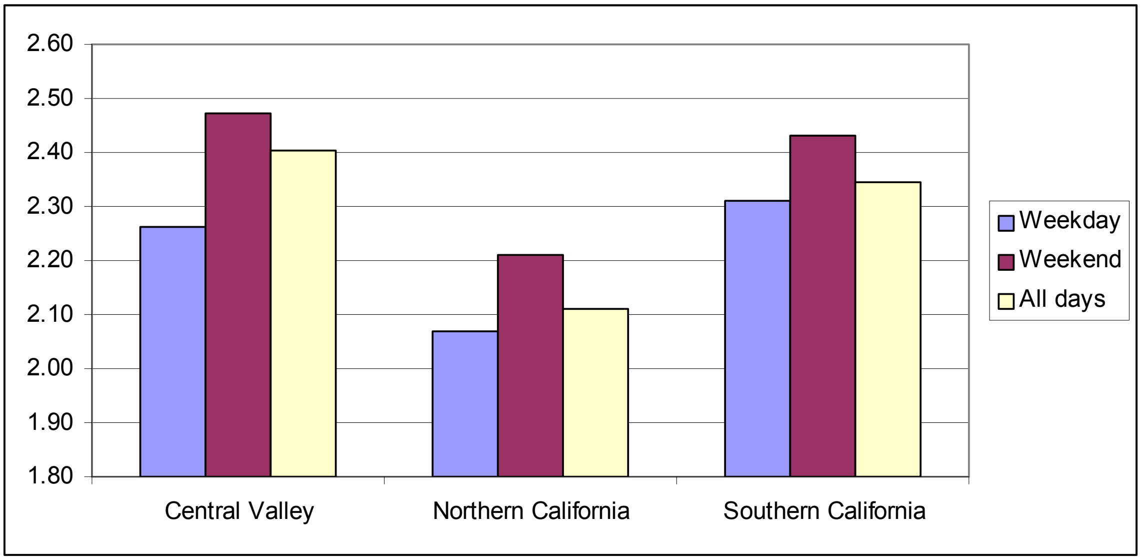


Figure 4-11 shows CFL average use by the seven clusters included in the study sample. Latitude of the clusters does not drive differences in usage since the areas associated with the highest usage (San Diego and Fresno) do not have the highest latitudes. We did not find statistically significant differences across these segments. Note that weekend v. weekday use is flatter in San Diego and Bakersfield.

Figure 4-11
Indoor CFL Average Hours of Use Per Day by Cluster

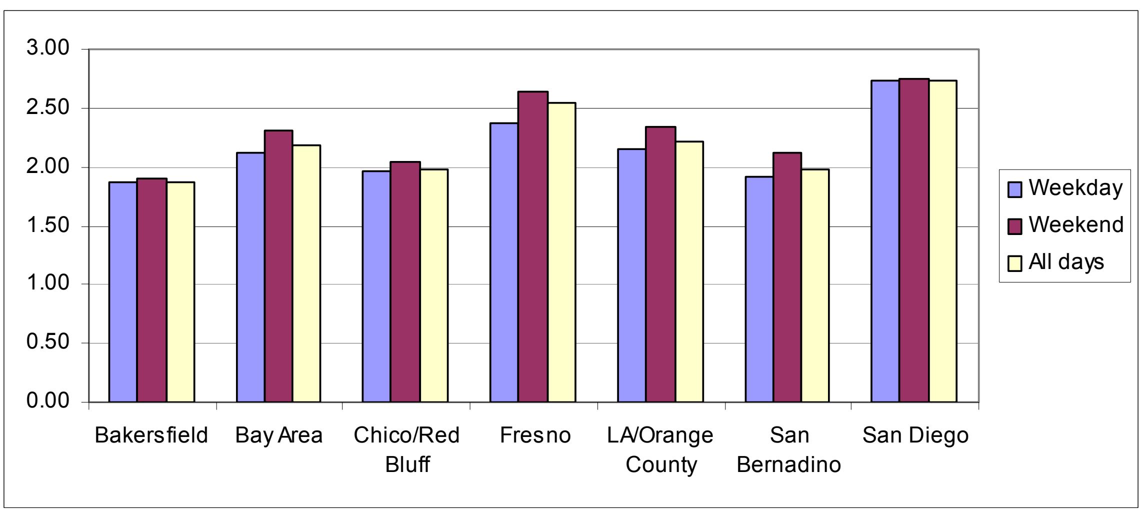


Figure 4-12 shows average hours of usage by month. The trend is intuitive, with lower usage in the summer months and higher usage in the winter months. The differential between weekend and weekday use is more pronounced during the winter when people are more likely to be home on the weekends using lights as compared to summer.

Figure 4-12
Indoor CFL Average Hours of Use Per Day by Month

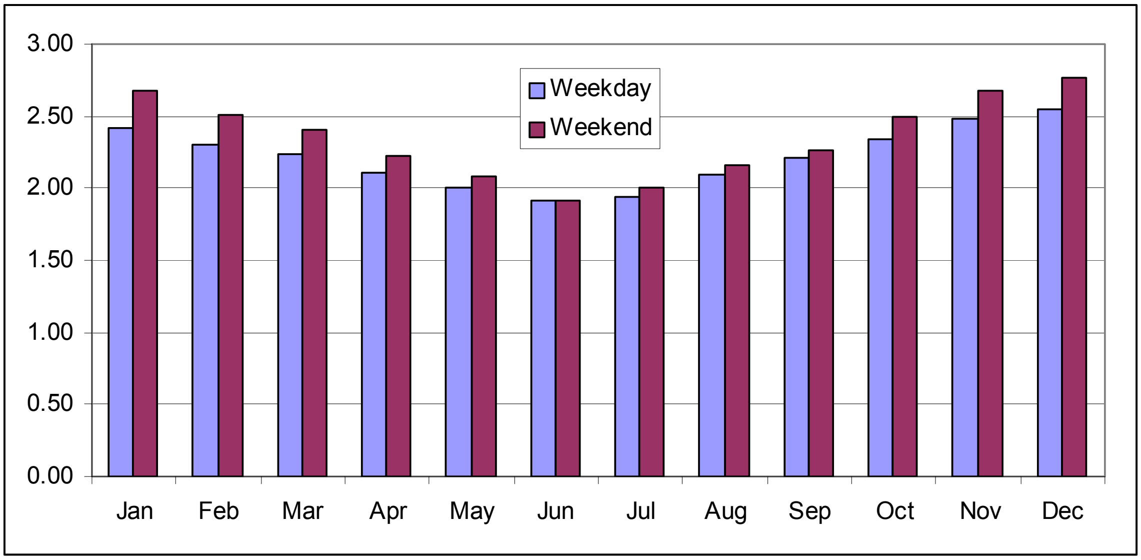


Table 4-6 shows CFL usage by various fixture and CFL characteristics. CFL usage varies significantly by fixture type, with suspended fixtures associated with the highest usage followed by torchieres and downlights. Ceiling and wall-mounted fixtures tend to be used less than the other fixture types. The correlation between fixture type and location of installation seems to be driving this result, with higher-use fixtures tending to be located in high-use rooms (kitchens and living rooms).

Even with only a small sample of non-switch-powered fixtures, we found a statistically significant difference in usage of CFLs controlled by timers or dimmers than those controlled by switches. We attempted to determine whether this result was related to the location of the non-switch controls (e.g., room type), but the sample size was so small no conclusion could be drawn.

Another CFL characteristic that we found to be statistically significant was that older CFLs (those purchased prior to 2001) are on average used less often than newer CFLs. This result is interesting because it might suggest that people are using the "newer" CFLs—those that fit into more fixtures and have better lighting quality—in their higher-use fixtures. We did not find any correlation of CFL vintage to location of installation, so differences in usage of older v. newer CFLs are not a result of the room they are in.

CFL usage does not vary significantly by CFL base type and wattage category.

Table 4-6
Indoor CFL Hours of Use Per Day by Monitored Fixture and CFL Characteristics

Segment	Category	Min # hours	Max # hours	Average # hours	Std. Error	±90% CI	# of obs
Fixture type	Ceiling mounted	0.0	15.6	1.7	0.2	0.5	221
	Ceiling Fan	0.0	11.2	2.7	0.5	2.4	86
	Downlights	0.0	12.0	2.8	0.6	2.6	69
	Floor/Table lamp	0.0	23.3	2.6	0.2	0.9	312
	Other	0.0	7.3	2.8	1.7	7.9	4
	Suspended	0.0	12.3	3.8	0.7	4.2	48
	Torchiere	0.1	9.2	2.9	0.4	1.9	48
	Wall-mounted	0.0	8.1	1.6	0.1	0.4	201
Base type	Screw-based	0.0	23.3	2.3	0.1	0.4	937
	Pin-based	0.0	8.0	1.8	0.4	1.1	38
Control type	Switch	0.0	23.3	2.2	0.1	0.4	969
	Other (timer or dimmer)	0.3	16.3	5.5	1.2	10.5	14
CFL vintage	Purchased prior to 2001	0.0	9.0	1.8	0.2	0.7	91
	Purchased 2001 or later	0.0	23.3	2.3	0.1	0.5	834
Wattage	7-12W	0.1	16.1	1.8	0.6	1.8	34
	13-17W	0.0	23.3	2.5	0.2	0.7	502
	18-22W	0.0	12.9	2.1	0.3	0.9	149
	23-26W	0.0	11.0	2.0	0.2	0.6	236
	27-30W	0.1	9.0	2.7	0.4	1.9	30
	>30W	0.0	5.7	2.2	0.4	1.3	32

Fixture type significant at the 95% level
Control type significant at the 95% level
CFL vintage significant at the 90% level

One might expect that CFL installation and usage patterns might be affected by a household's experience using CFLs. For example, households with only one or two CFLs might install those CFLs in their highest-use fixtures if they tended to use CFLs to save energy and/or were concerned with recouping their initial cost quickly. Likewise, households that received CFLs for free may be less concerned about payback period and might not install CFLs in high-use fixtures. Some households might be concerned with the appearance of CFLs and might only use them in less visible applications.

While our on-site survey was intended to focus on CFL and fixture characteristics and household demographics, we did attempt to collect information on a few indicators of customer experience with CFLs. Table 4-7 shows CFL usage by these categories. The first segment is based on when the survey respondent became aware of CFLs—either before 2001 (around the time of the energy crisis) or after 2001. This segment was intended to capture early adopters v. others. The next segment was based on date of first CFL purchase—either before 2001, after 2001, or those that have only received CFLs for free. The final segment is the number of CFLs that were monitored in the home, which was intended to capture the possible effects of declining hours of usage associated with a higher number of CFLs being installed. We did not find any statistically significant differences in CFL usage by these segments. This may mean that other factors such as location are more important than a customer's experience with CFLs. But CFL experience might drive the decision to install CFLs in certain fixture types and locations, and although we did not find differences, there might be other CFL experience segments that were beyond the scope of this study that might affect CFL usage (such as satisfaction with specific CFL attributes, importance of saving energy, concern for fixture aesthetics, etc.).

Table 4-7
Indoor CFL Hours of Use Per Day by Customer Experience with CFLs

Segment	Category	Min # hours	Max # hours	Average # hours	Std. Error	±90% CI	# of obs
Awareness of CFLs	Aware of CFLs before 2001	0	23.3	2.2	0.1	0.5	600
	Aware of CFLs after 2001	0	15.6	2.3	0.2	0.7	377
Purchases of CFLs	Purchased CFLs before 2001	0.0	11.0	1.6	0.5	1.3	51
	Purchased CFLs after 2001	0.0	23.3	2.3	0.1	0.5	767
	Never purchased CFLs-received them for free	0.0	11.2	2.2	0.3	1.0	142
	Purchased CFLs	0.0	16.3	2.3	0.1	0.4	788
# of interior monitored fixtures with CFLs	1	0.0	23.3	2.5	0.1	0.0	499
	2-3	0.0	11.9	2.1	0.2	0.0	163
	4+	0.0	12.1	2.8	0.9	0.0	90

Satisfaction significant at the 95% level

4.2 LOAD PROFILE

This subsection presents the load profiles of CFL usage over a 24-hour period. Figure 4-13 presents indoor CFL load shapes, showing the average percentage that fixtures with CFLs are used for each hour of the day, averaged across the entire year. The x axis denotes the hour of the day, where 1 = 12 Midnight to 1:00 AM and 24 = 11:00 PM to 12 Midnight. CFL usage peaks between 8:00 and 9:00 PM. The time period associated with the lowest usage of CFLs is between 3:00 and 4:00 AM. Note that CFL usage on weekends is lower in the morning, higher in the afternoon and evening, and about the same as weekday usage at night.

Figure 4-13
Indoor CFL Load Shapes by Day Type

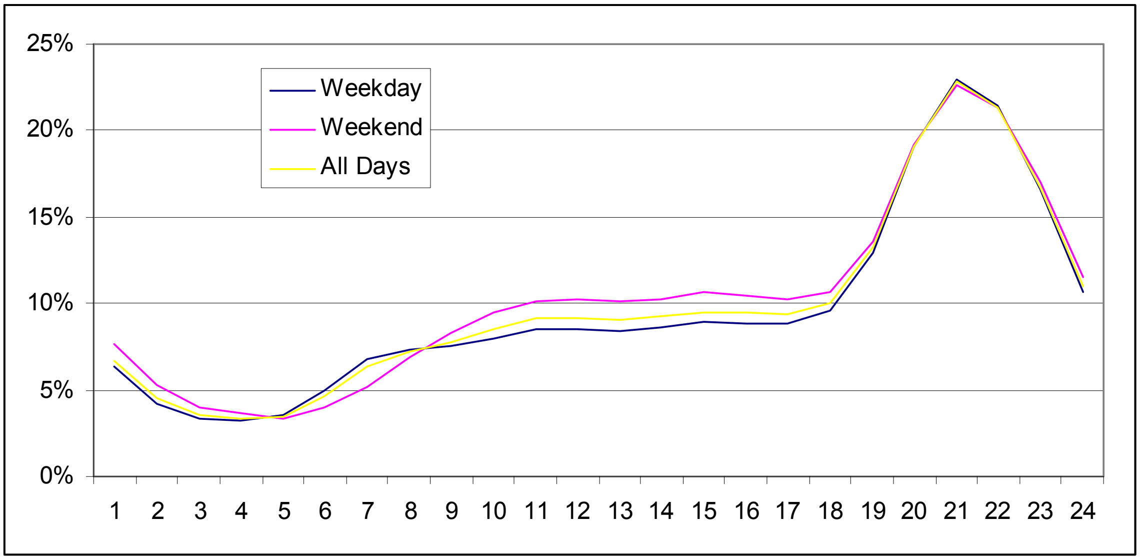


Figure 4-14 depicts indoor CFL load shapes by season and day type. For this figure, winter refers to the month with the highest usage, which is December, and summer to the lowest usage month, which is June. This figure shows that, as expected, usage is higher in the winter when daylight hours are fewer and higher on weekends (particularly during the daytime) when, in general, people are more often at home.

Figure 4-14
Indoor CFL Load Shapes by Season and Day Type

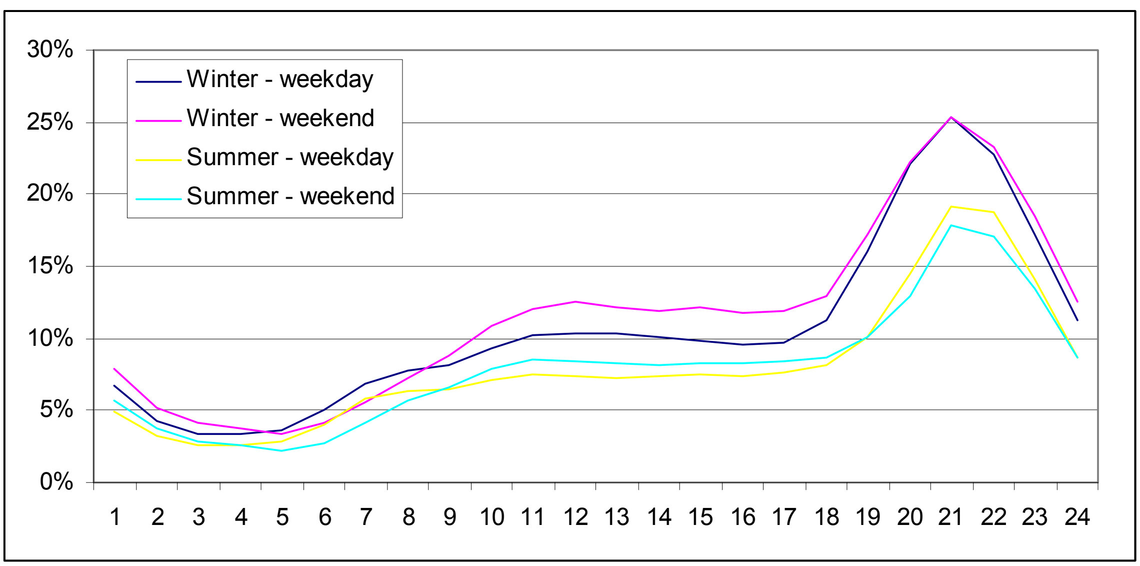
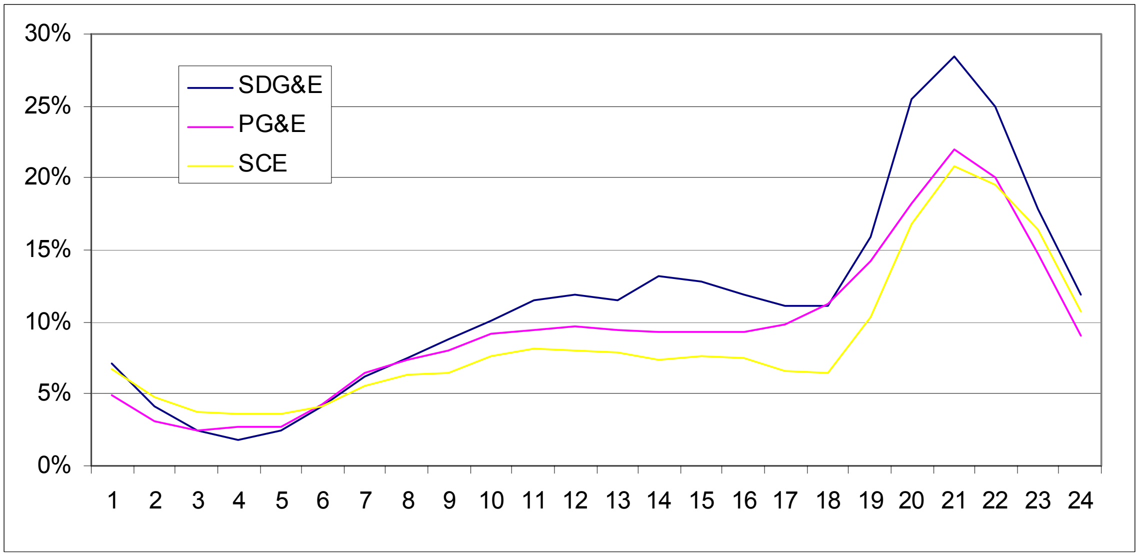


Figure 4-15 shows CFL load shapes by utility service territory. As shown, CFLs installed in SCE's service territory have higher than average usage in the early morning hours, while those in SDG&E's territory have higher than average usage the rest of the day and night.

Figure 4-15
Indoor CFL Load Shapes by Utility



4.3 SELF-REPORTED HOURS V. MONITORED HOURS

As part of the on-site survey associated with this metering study, our field auditors conducted a survey with study participants. One of the pieces of information that we collected was the participant's best guess of the average hours of usage of each of the fixtures that were to be monitored by our study. Besides using this to assist in data cleaning and validation (discussed in Section 3), we were also interested in how close these best guesses were to actual monitored data. If self-reported hours of usage were reliable and close to monitored data, collecting these types of data could be relied upon as an approach for future studies. Self-reported usage is far less costly to collect than monitoring data, and for fixtures with issues affecting the applicability of monitoring such as outdoor fixtures, self-reported data is often the only data available.

Table 4-8 compares the monitored v. self-reported average CFL usage. As shown, self-reported usage is higher than monitored usage, by about one-third.

Table 4-8
Monitored v. Self-Reported CFL Usage Per Day

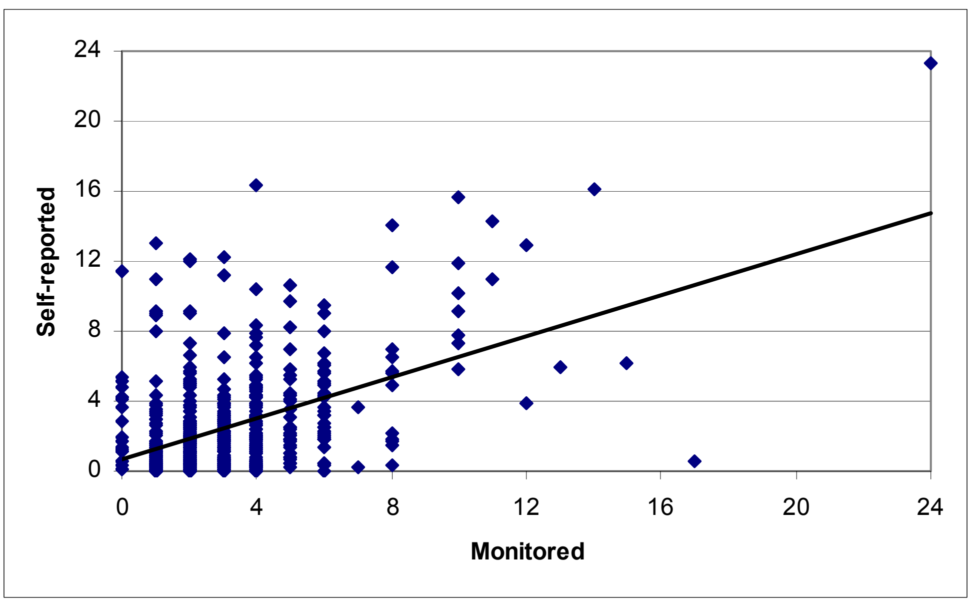
	Min # hours	Max # hours	Average # hours	Std. Error	±90% CI	# of obs
Monitored	0.0	23.3	2.28	0.1	0.4	983
Self-report	0.0	24.0	2.91	0.1	0.5	952

To determine how well self-reported estimates lined up with the monitored data fixture by fixture, we estimated the correlation coefficient, which is a measure of how well the predicted values from a forecast model fit with the real-life data. In this instance, we are interested in how well the self-reported data align with the metered data. The correlation coefficient ranges between 0 and 1. If there is no relationship between the predicted values and the actual values the correlation coefficient is 0 or very low (the predicted values are no better than random numbers). As the strength of the relationship between the predicted values and actual values increases so does the correlation coefficient. A perfect fit gives a coefficient of 1.0. The correlation coefficient between self-reported and monitored CFL usage is 0.44.

Figure 4-16 is a scatter plot of self-reported to monitored average CFL usage per day with a trend line showing the approximate relationship between the two variables. If self-reported values were equivalent to monitored values across all fixtures (a perfect fit with a correlation coefficient of 1.0), then the points in the plot below would fall along a 45-degree line, starting from the junction of the two axes. Since self-reported usage is higher than monitored usage, the points tend to be closer to the self-reported usage axis. An approximation of the relationship between these two variables is the following equation:

$$\text{monitored usage} = 0.66 + 0.59 \text{ X self-reported usage}$$

Figure 4-16
Relationship of Self-Reported to Monitored Average CFL Usage Per Day



5 CFL INSTALLATION PATTERNS

This section discusses compact fluorescent lamp (CFL) installation patterns. First, we describe CFL installation and retention of CFLs purchased from 2001 to 2004 based on self-reported on-site survey data. Next, we report on CFL installation characteristics and the potential for CFLs based on the on-site lighting inventory collected by field auditors.

5.1 CFL INSTALLATION / RETENTION RATE

The CFL installation rate is another factor in determining the savings associated with CFL programs. Since the investor-owned utilities' statewide lighting programs have focused on upstream interventions for the most part over the last several years, determining a direct installation rate of "program CFLs" is impossible. Instead, the installation rate that is most relevant for the current program is the percentage of CFLs that are installed of those that are purchased. This study attempted to determine an installation or retention rate for CFLs purchased since 2001.

We asked households how many CFLs have they purchased since 2001 and how many of them are currently installed. Of 2,739 CFLs purchased between January 2001 and June 2004, 1,794, or 65.5 percent of bulbs, are presently being used; 63 percent of recent CFL purchasers do not have all of the CFLs they recently purchased presently installed. Table 5-1 describes the various reasons for uninstalled CFLs, with almost half of respondents reporting that they are planning to use at least some of the CFLs that are not currently installed. Twenty percent said their CFLs already burned out, 12 percent said the bulbs broke, and 7 percent gave CFLs away.

A total of 370 CFLs not presently installed are likely to be installed in the future (based on respondents who said they plan to use uninstalled CFLs in the future), and when added to the 1,794 bulbs installed, now yields an upper limit of 79 percent as the usage rate.

Table 5-1
Reasons Recently Purchased CFLs are not Presently Installed

Reason	Percentage of Respondents
Planning to use	42%
Gave away	7%
Burned out	20%
Broken	12%
Don't know	2%
Number of Respondents	175

5.2 CFL INSTALLATION CHARACTERISTICS

This section documents the variety of CFL installations observed in the study sample of California households with CFLs installed. We look at the types of CFLs being used most often and in what manner.

Table 5-2 displays the breakdown of rooms with CFLs installed based on the lighting inventory data. As shown, 23 percent of CFLs are installed outside, while installations in bedrooms and living rooms are the next common location. CFLs are least likely to be installed in garages and laundry rooms. Note that households with fewer total CFL bulbs tend to install them in high-use areas. Only when a household had many CFLs installed all over the home did we find them in areas such as closets and utility rooms.

Table 5-2
Rooms With CFLs

Room	Number CFLs Bulbs	Percent CFL Bulbs
Living Room	456	17%
Family Room	209	8%
Kitchen	290	11%
Bedroom	491	18%
Bathroom	315	11%
Hallway	152	5%
Garage	46	2%
Laundry Room	71	3%
Outside	632	23%
Other Room	54	2%

Within the rooms, we saw that the majority of CFL bulbs are being installed in ceiling fixtures at 27 percent of our CFL sample. Twenty-two percent were found in floor and table lamps, while 20 percent were wall fixtures.

Table 5-3 shows the range of wattages we saw installed most frequently. Currently, the most popular wattage is in the 13–17-Watt range, at 38 percent of all CFL bulbs, followed by 23–26 at 27 percent and 18–22 at 26 percent.

Table 5-3
CFL Wattages

CFL Wattage	Number	Percent
9-12	59	2%
13-17	988	38%
18-22	665	26%
23-26	707	27%
27-30	129	5%
> 30	30	1%

Table 5-4 lists the typical incandescent bulb wattages that the CFLs are replacing. It follows that the most standard incandescent, a 60-Watt bulb, is replaced most often and by the most widely used CFL wattage range of 13–17 Watts. The majority of monitored fixtures contained CFLs that had replaced a 60–Watt standard incandescent bulb.

Table 5-4
Incandescent Bulbs Replaced by CFLs

Original Incandescent Wattage	Number of Monitored Fixtures with Replacement CFLs	Percent of Monitored Fixtures	Typical CFL Replacement Wattage
60	250	57%	13-17
75	84	19%	18-22
40	55	12%	9-12
100	53	12%	23-26

As so many of our monitored fixtures were CFL bulbs replacing standard incandescents, the vast majority of CFL bulbs in the lighting inventory were screw-in-type replacement bulbs. Ninety-one percent of CFL bulbs were screw-in type, and 9 percent were permanent pin-based CFL bulbs. Table 5-5 summarizes these findings.

Table 5-5
CFL Base Types

CFL Base Type	Number	Percent
Screw-in	2,467	91%
Pin	250	9%

Regarding the types of ballasts used on the CFL bulbs surveyed, Table 5-6 shows that 90 percent were screw-type bulbs with ballasts integrated into bulb design and inseparable from the bulb. Eight percent of them were dedicated, permanent CFL fixture bulbs. Only 2 percent of CFL bulbs had modular ballasts, allowing for replacement of the bulb and ballast separately.

Table 5-6
CFL Ballast Types

CFL Ballast Type	Number	Percent
Integrated	2,369	90%
Dedicated	219	8%
Modular	23	2%

The survey instrument recorded for all monitored CFL fixtures whether or not the bulbs were purchased before 2000. Comparing the newer and older bulbs, we observed a few trends worth noting here. Concerning wattage, we saw the percentage of bulbs in the 18–22-Watt range decrease since 2000, adding to the percentages of bulbs in the 13–17 Watt and 23–26-Watt ranges. The style of ballast used drifted toward the integrated style, rising from 84 percent previously to 97 percent after 2000. The CFL base type used before and after 2000 remained the same—predominantly the standard screw-in type.

5.3 CFL POTENTIAL

We attempted to categorize all incandescent fixtures in our sample as CFL-applicable or not to quantify the fraction of incandescent bulbs that could potentially be upgraded to CFLs. Table 5-7 shows the results of this analysis. Rapid changes in CFL technology and other market factors rendered accuracy of this measurement quite difficult. There are currently CFL bulbs available for sale on the Internet and specialty shops for nearly any incandescent fixture, if cost and product availability were not an issue. Even small, dimmable, decorative candelabra-types can be found.

Cost and availability are the prevailing limiting factors in determining whether or not an incandescent bulb may be replaced by a CFL bulb. For standard incandescents the main factors are bulb size and dimmability. CFL-style PAR lamp replacements are difficult to find and are often cost-prohibitive as well.

Table 5-7
Percentage of Incandescent Bulbs that are CFL-Applicable

Fixture Type	Percentage of Sampled Incandescent Lamps	Number of Sampled Incandescent Lamps
Standard	94%	6,864
PAR	81%	170
Globe	100%	82
Small base	49%	765
Reflector	86%	560
Decorative	100%	40
Total	86%	8,481

6 CFL MARKET UPDATE

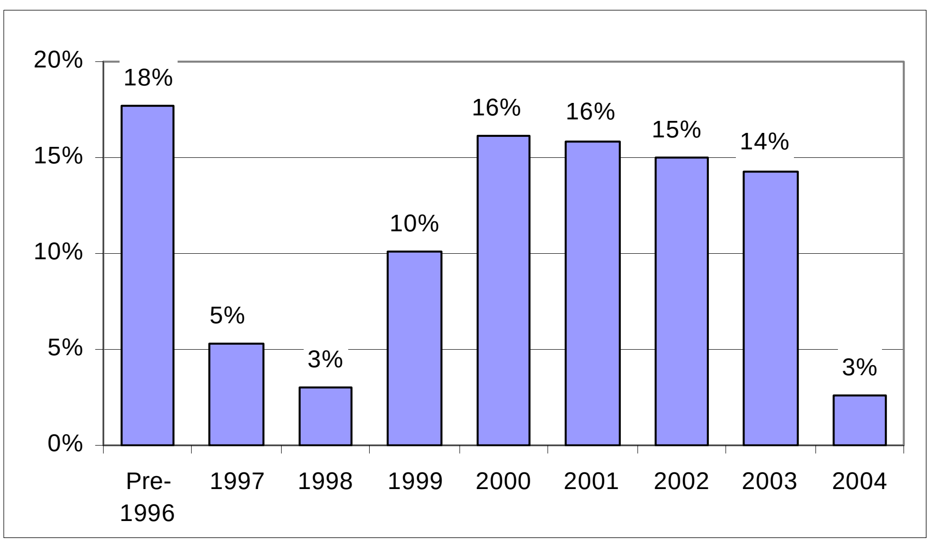
This section provides an update of the market for compact fluorescent lamps (CFLs) from the perspective of the consumer. The data used to populate this market update are from the on-site survey administered to metering study participants. As mentioned previously, two waves of surveys were conducted: phase 1 in June/July 2003, with 100 customers, and phase 2 in March/April 2004, with 275 customers. Both the 2002 evaluation of this program and the four-phased market effects evaluation of the California Residential Lighting and Appliance Program provide time series data covering the period of 1998–2003 to which these results may be compared.

Since the phase 1 metering sample was drawn from the larger 2002 consumer survey sample, we rely for the most part on phase 2 surveys to update consumer market results. However, in cases where the prior evaluation work does not provide comparable data, we compare the phase 1 and phase 2 metering study samples to show changes from 2003 to 2004.

6.1 CFL AWARENESS AND PURCHASING PATTERNS

Among California residents with CFLs installed in their homes, the majority became aware of CFLs since 2000 as indicated in Figure 6-1. Nearly 20 percent were aware of CFLs before 1996.

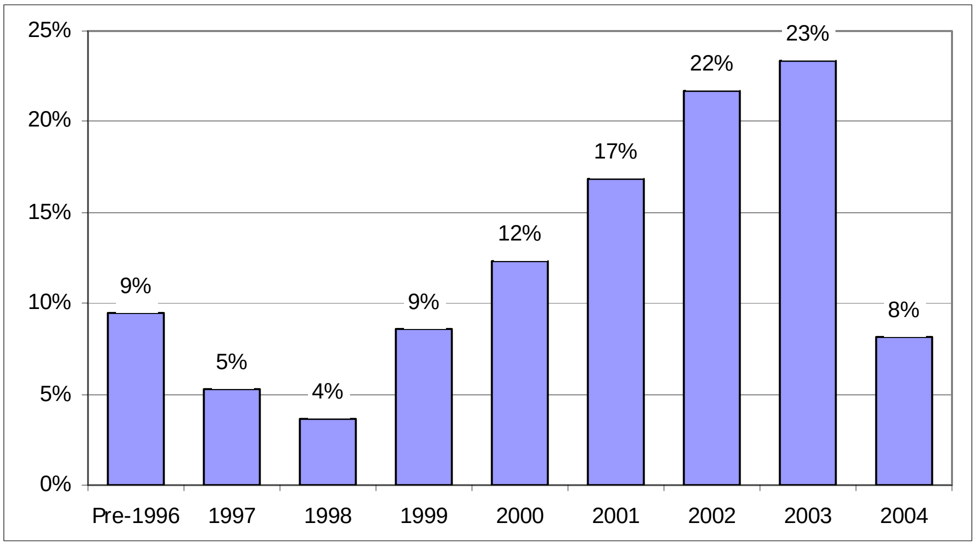
Figure 6-1
First Awareness of CFLs, Of CFL Users
Phase 2 (2004)



N = 266.

Figure 6-2 shows that among this same group of consumers, the majority first used CFLs in their homes in 2001 or later—during or since the state's energy crisis.

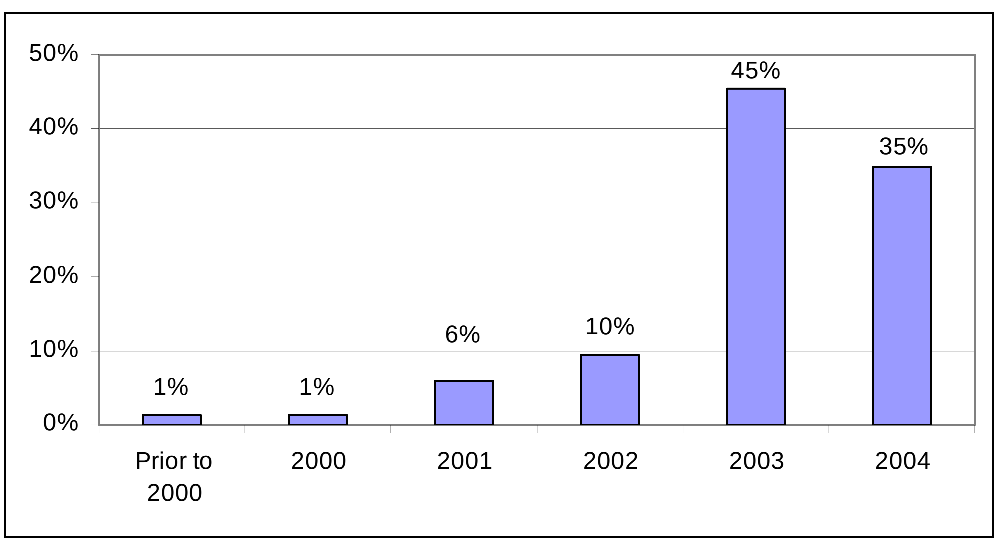
Figure 6-2
First Use of CFLs, Of CFL Users
Phase 2 (2004)



N = 220.

Figure 6-3 indicates that while half of consumers with CFLs installed in their homes first used CFLs before the energy crisis, only a small percentage purchased a CFL before the energy crisis. So many of these consumers' early experiences with CFLs were likely through giveaway programs.

Figure 6-3
Year of First CFL Purchase, Of CFL Purchasers
Phase 2 (2004)



N = 220.

Ninety-six percent of phase 2 CFL users reported that they purchased a CFL between 2001 and 2004. As shown in Table 6-1, an average of 10.6 bulbs per household were purchased over this 3½-year period, so a rough annual purchase rate of 3.5 bulbs per household. Prior evaluation results from 2003 and 2001 indicate that the average annual number of bulbs purchased per household was nearly five and six bulbs, respectively. These results might indicate that the number of bulbs purchased per household is declining or reached its peak during the energy crisis when manufacturers and retailers were more likely to promote bulk sales of CFLs (particularly Costco).

Table 6-1
Number of CFLs Purchased from January 2001–June 2004, of CFL Purchasers
Phase 2 (2004)

Number of CFLs	Percentage of Respondents	Cumulative Percentage
1	4%	4%
2	9%	13%
3	7%	20%
4	9%	29%
5	8%	37%
6	7%	44%
7	3%	47%
8	8%	56%
9	1%	57%
10	8%	64%
11	1%	65%
12	7%	73%
More than 12	27%	100%
Mean	10.6	
Number of Respondents	**205**	

Of phase 2 CFL purchasers, nearly half (47 percent) who purchased their most recent CFLs after 2000 purchased at least one of their bulbs at a home improvement store. Thirty percent purchased CFLs at Costco, 26 percent at big box retail stores, 12 percent at drug stores, and 10 percent at grocery stores.[1] Compared to 2002 evaluation results, 2004 purchasers are more likely to buy CFLs at grocery and drug stores and Costco and less likely to buy them at big box stores. This is likely a reflection of the program's focus on grocery and drug stores and the continued involvement of Costco.

[1] Does not total 100% as this question allowed multiple responses.

6.2 CFL PRODUCT MARKET KNOWLEDGE

Respondents who are aware of CFLs cited having seen CFLs in home improvement stores more than any other store type (71 percent overall; see Table 6-2). When compared with phase 1 respondents, a smaller proportion of phase 2 respondents reported seeing CFLs in every store type, with the exception of grocery stores and "other" stores.

Table 6-2
Where Consumers Have Seen CFLs for Sale, of Those Who Are Aware of CFLs
Phase 1 (2003) and Phase 2 (2004)

Type of Store	Percentage of Respondents [1]		
	Phase 1 (2003)	Phase 2 (2004)	Overall
Home Improvement Store	93%	62%	71%
Big Box Store	67%	53%	57%
Costco	49%	30%	35%
Grocery Store	28%	33%	32%
Drug Store	33%	18%	22%
IKEA	22%	4%	9%
Other Store	5%	10%	8%
Number of Respondents	**100**	**269**	**369**

[1]Multiple mentions accepted

More than four out of five respondents from phase 1 and 2 believe that CFLs are more commonly available in stores now than they were 3 years ago. Seven percent indicated their belief that availability had not changed, 1 percent that CFLs had become less available, and 12 percent were not sure.

Among respondents who purchased CFLs during or after 2001, nearly half perceive that CFLs cost between $3 and $5 per bulb (45 percent). Thirty-two percent indicated that CFLs cost less than $2 each, 16 percent that they cost between $6 and $10 each, and 7 percent did not know (Table 6-3). When compared with the prior 2002 evaluation results from 2003, CFL purchasers' price estimates have dropped along with the retail price of CFLs over time.

Table 6-3
Perception of Current Retail Price of CFL Without Discounts or Rebates,
of Those Who Have Purchased CFLs Between 2001 and 2004
Phase 2 (2004)

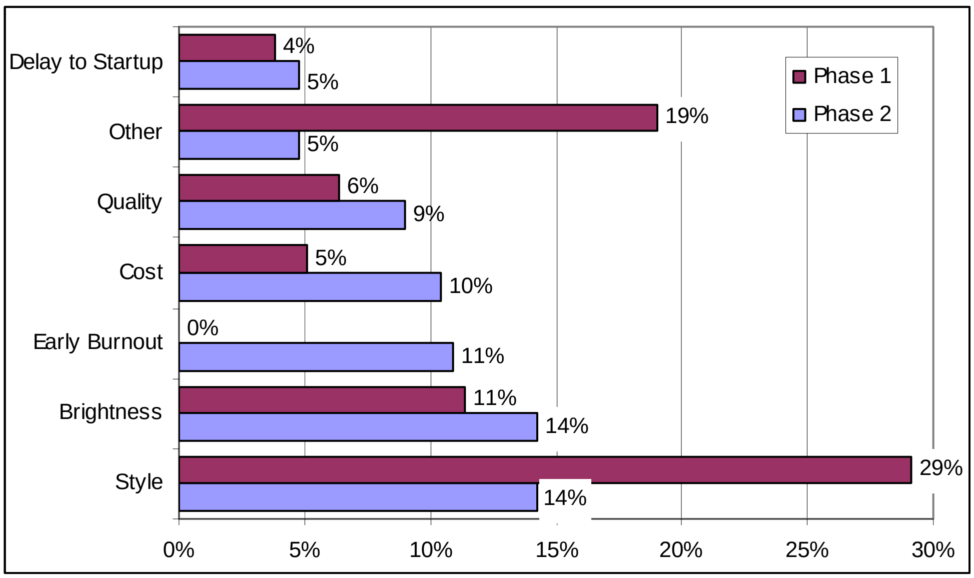
Cost per CFL	Percentage of Respondents
Less Than $2 Each	32%
$3-$5 Each	45%
$6-$10 Each	16%
Don't Know	7%
Number of Respondents	**88**

6.3 CFL Product Satisfaction

Of respondents who reported purchasing CFLs during or after 2001, 28 percent indicated that they are more satisfied with the newer CFLs than with the ones they first used. Thirty-one percent indicated that they are neither more nor less satisfied, and 5 percent report that they are less satisfied. An additional 26 percent didn't know whether they were more or less satisfied with newer CFLs.

Satisfied CFL purchasers cite bulb style, shape, and size as among the top reasons for their satisfaction (18 percent overall: 29 percent of phase 1 respondents, 14 percent of phase 2; see Figure 6-4). Nineteen percent of phase 1 respondents cited "Other" reasons for their satisfaction, primarily related to perceived increases in bulb life.

Figure 6-4
Reasons for Increased Satisfaction in CFLs Among CFL Purchasers
Phase 1 (2003) and Phase 2 (2004)[2]



2003 N = 79; 2004 N = 211.

Phase 2 respondents who indicated that they were less satisfied with their current CFLs than they were with previous bulbs cited dissatisfaction with early burnout as the primary reason (3 percent), along with cost (1 percent) and style (1 percent).

6.4 Influence of Advertising and Rebates

More than one-fourth of phase 2 CFL purchasers noticed retailer advertising, information, or materials related to CFLs displayed in the store (28 percent). This is a decrease from 2003, during which 36 percent of purchasers reportedly noticed retailer advertising, and from 2001, during which almost half (46 percent) of purchasers noticed in-store advertising.

[2] Phase 2 (2004) results include respondents who purchased CFLs during or after 2001.

As shown in Table 6-4, nearly three out of five purchasers from the phase 2 survey who noticed the in-store displays would have been very unlikely or not very likely to purchase CFLs in the absence of these displays (59 percent). When compared to the 2002 evaluation results, it appears that the influence of in-store displays has increased over time. The 2002 evaluation noted a decrease in the effectiveness of in-store advertising in 2003 from previous years when the program focused more resources on this activity. It may be that the utility program managers worked more closely with retailers on their displays in response to the evaluation results, and consumers were more likely to be influenced. The 2004–2005 program will be evaluated comprehensively and will likely be able to shed light on the current status of in-store display effectiveness.

Table 6-4
Likelihood of Purchased CFLs in Absence of Seeing In-Store Displays Among CFL Purchasers
2002 Evaluation (2003) v. Phase 2 (2004)

Response	Percentage of Respondents	
	2003	2004
Very Likely (8-10)	42%	29%
Somewhat Likely (6-7)	33%	9%
Not Very Likely (4-5)	13%	26%
Very Unlikely (1-3)	11%	33%
Don’t Know	1%	3%
Number of Respondents	**145**	**58**

Across phases 1 and 2, the majority of CFL purchasers indicated that they received no discounts on their purchases (57 percent; see Table 6-5). The proportion of customers who recalled receiving discounts during phase 2 (53 percent) was less than during phase 1 (70 percent). During the 2002/2003 survey, approximately one-fifth of CFL purchasers recalled receiving a discount or rebate when they bought their bulbs (19 percent).

Table 6-5
Recall of In-Store Discount Among CFL Purchasers
Phase 1 (2003) and Phase 2 (2004)

Response	Percentage of Respondents		
	Phase 1 (2003)	Phase 2 (2004)	Overall
Do Not Recall Any Discount; Paid Full Price	70%	53%	57%
Recall Discount Marked on Product	3%	30%	23%
Recall Discount Taken off at Register	13%	8%	9%
Recall Discount, Not Sure How Applied	6%	5%	5%
Don't Know	8%	4%	5%
Number Of Respondents	**71**	**205**	**276**

As shown in Table 6-6, approximately 76 percent of phase 2 purchasers who recalled receiving a discount were influenced to some degree by the discount (they would have been only somewhat likely, not very likely, or very unlikely to have purchased the CFLs without the discount). Similar to the in-store advertising results above, utility or other discounts were more effective in 2004 than 2003. This may reflect more strategic utility discount strategies (such as the use of a tiered rebate) or a change in consumer receptiveness to outside influences on their purchase decisions. While in years past, the energy crisis and associated media coverage may have spurred CFL purchases with the statewide program laying the supplier groundwork to capitalize on the increased demand, consumers in the current climate may be more responsive to utility and retailer promotions.

Table 6-6
Likelihood of Purchasing CFLs in Absence of the Discount
Among Purchasers Who Recalled Receiving a Discount
2002 Evaluation (2003) v. Phase 2 (2004)

Response	Percentage of Respondents	
	2003	2004
Very likely	52%	26%
Somewhat likely	20%	16%
Not very likely	17%	21%
Very unlikely	8%	37%
Number of respondents	101	87

7 CONCLUSIONS AND RECOMMENDATIONS

This section discusses the study conclusions and provides some recommendations for the utility program planners and other stakeholders interested in residential lighting products and markets.

7.1 CONCLUSIONS

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. Compact fluorescent lamp (CFL) hours of usage
2. CFL peak diversity factors
3. CFL installation/retention rates
4. Pre-CFL wattage assumptions.

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 the California Residential Lighting and Appliance Program 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.

Below, we present the study's conclusions organized by CFL hours of usage, installation patterns, and updated market information.

7.1.1 CFL Hours of Usage

CFL usage assumptions are key factors in lighting program savings estimates. In the past, the utilities and other energy-efficiency program implementers relied on studies of residential lighting in general (not specifically CFLs) or specific impact evaluations of CFL programs. This study's approach is unique in that it provides estimates of CFL usage across all homes in the investor-owned utilities' service territories—a segment that has been directly (via point-of-sale rebates) or indirectly (via manufacturer buydown and macro effects of the program on product price, availability, and exposure) influenced by the Upstream Residential Lighting Program.

Based on this study's metering results, the average usage of indoor CFLs is 2.3 hours per day. The estimate does not change much when we include our estimate of outdoor lighting usage, increasing from 2.28 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 addition to using the CFL monitoring data to generate estimates of CFL usage and lifetime, we also were interested in how close respondent self-reported hours of usage were to actual monitored data. If self-reported hours of usage were reliable and close to monitored data, collecting these types of data could be relied upon as an approach for future studies. 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.

7.1.2 CFL Installation Patterns

The CFL installation rate is another factor in determining the savings associated with CFL programs. This study attempted to determine an installation or retention rate for CFLs purchased since 2001. Of 2,739 CFLs purchased between January 2001 and June 2004, 1,794, or 65.5 percent of bulbs, are presently being used.

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.

The pre-installation wattage is another important factor that is considered when determining energy savings associated with CFLs. The most common CFL wattage is in the 13–17-Watt range, which is most often used to replace a 60-Watt incandescent bulb. We found that over half of installed CFLs replaced 60-Watt incandescent bulbs, 19 percent 75-Watt bulbs, and 12 percent 40- and 100-Watt bulbs.

As part of this study, we also conducted a lighting inventory in order to explore CFL installation patterns. Some of the highlights from these data are as follows:

- 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 13–26-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-Watt or 23–26 range and are more likely to have an integrated ballast v. those that were purchased in 2000 or earlier.

7.1.3 CFL Market Update

As mentioned above, a secondary objective of this evaluation was to provide an update of the market for CFLs from the perspective of the consumer. The data used to populate this market update were from the on-site survey administered to metering study participants.

The major findings from the market update are as follows:

- 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 as 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.

7.2 Recommendations

Below we discuss four recommendations that we developed in response to the study's conclusions.

7.2.1 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.

Our analysis shows that the study's sample is demographically similar to the population in general and thus similar to the program's target market. Likewise, the program continues to promote CFL products that are well represented in this study. As the program changes over time and begins to focus on different products (e.g., CFL fixtures and/or specific types of CFLs) and/or different customer segments, the utilities should consider whether these study results are comparable, i.e., whether the customer and CFL product mix addressed by this study align with those targeted by the program.

7.2.2 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.

7.2.3 Consumer and Supplier Market Data

This study provided some interesting updated consumer market information, but these results were narrow due to the limitations of the on-site survey. 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 of those using CFLs what barriers exist to expanding their usage of them.

Prior evaluations of this program have included upstream research including manufacturer, retailer, and stakeholder interviews to help guide the program in terms of product offerings, incentive levels, and retailer and manufacturer support and interest in the program. We recommend that the 2004–2005 evaluation include this type of research in order to probe current issues with regard to the supply and sale of CFLs. This information would complement a consumer study and would provide valuable feedback to program planners as they continue to adjust the program to adapt to current market conditions and as they attempt to expand the energy savings accomplishments of the program in response to the energy needs of the state.

A SURVEY INSTRUMENTS AND GUIDELINES

This appendix presents the telephone recruitment screener, the on-site survey instrument and field auditor instructions for conducting the on-site surveys.

A.1 TELEPHONE RECRUITMENT SCREENER

Screener for Residential Lighting Onsite Surveys

Hello, I'm calling from Gilmore Research on behalf of your local electric utility. We're conducting a short survey on household lighting. Do you have a few minutes to see if you qualify for our study?

[IF NOT ARRANGE CALL BACK]

1. What type of home do you live in? Is it … [Track multi-family (c and d) for quotas]

   a. A single family detached home
   b. A single family attached home
   c. An apartment [How many units in the building? _______]
   d. A mobile home
   e. [DO NOT READ] Other [SPECIFY_______]
   f. [DO NOT READ] DK [SKIP TO END]

2. Are you aware of compact fluorescent light bulbs?

   a. Yes [SKIP TO 3]
   b. No
   c. DK

3. Compact fluorescent bulbs are small screw-in fluorescent bulbs that fit in regular light bulb sockets. They look different than standard incandescent bulbs and typically cost a lot more. They are often made out of thin tubes of glass bent into loops. Now do you think you've heard of compact fluorescent light bulbs?

   a. Yes
   b. No [THANK AND TERMINATE]
   c. DK [THANK AND TERMINATE]

4. Are you currently using any compact fluorescent light bulbs in any ***interior*** lighting fixtures in your home?

a. Yes
b. No [THANK AND TERMINATE]
c. DK [THANK AND TERMINATE]

5. Approximately how many fixtures in your home currently are using compact fluorescent light bulbs?

___ Number of fixtures using CFLs [DK=99]

6. Do you own your home or rent?

a. Own [SKIP TO 7]
b. Rent
c. DK

7. Do you pay a utility company directly for your electricity, or is it included in your rent?
a. Pay electric bill directly
b. Included in rent
c. Other [SPECIFY]
d. DK

8. What is the name of your electric utility company?

a. PG&E
b. SDG&E
c. SCE
d. Other [THANK AND TERMINATE]
e. DK [THANK AND TERMINATE]

9. How large in square feet is your home. Is it…

a. Less than 1,000 square feet
b. Between 1,000 and 2,500
c. More than 2,500
d. DK

10. Great! Your home qualifies for our survey. In the next week or so, someone will be contacting you to offer you $50 for your participation in a research study being sponsored by the California Public Utilities Commission and your local electric utility. The purpose of this study is to help better understand the amount of energy used by compact fluorescent light bulbs as compared to other lighting technologies. We are not selling you anything, we are part of a research project and you will not be contacted by anyone else interested in selling you anything.

Would you be interested in receiving $50 for participation in this study?

a. Yes
b. No
c. DK

Great! Let me verify your contact information:

Name: ________________
Phone Number: ________________
Address: ________________
____
City: ________________
Zip: ________________

Someone will contact you if your home can be included in this study. Thanks again for your interest and time!

[GIVE UTILITY CONTACT INFO IF NEEDED TO VERIFY PURPOSE OF STUDY OR REASON FOR NEEDING ADDRESS INFORMATION]

A.2 On-Site Survey Instrument

2004 Residential Lighting Onsite Survey Form

KEMA-XENERGY

Contact Information

Contact Name:			
Phone Number:	( )		
Street Address:			
City:		Zip Code:	
Mailing			
City:		Zip Code:	
County:		Region:	

Survey Tracking Information

	Date Completed	Performed by (Initials)
Field Survey Performed:	__ / __ /__	__ __ __
Quality Control Check:	__ / __ /__	__ __ __
Data Entry Complete:	__ / __ /__	__ __ __
Copy Filed:	__ / __ /__	__ __ __

Energy Utility Meters & Accounts

1.1 Does the occupant own or rent this residence?

- Own
- Rent → 1.2Does the household pay energy utility bills directly to the utility, or are the energy utilities included in the rent payment?
  - Paid directly

- Included in rent

1.3 Which utility provides electric service to your house?

- ❑ PG&E
- ❑ SCE
- ❑ SDG&E

1.4 What is your electric utility account number?

Item #	Service Type *	Electric Utility Service Provider	Account Number
1	E G O	SDG&E SCE SCG PG&E SMUD OTHER ____________	
2	E G O	SDG&E SCE SCG PG&E SMUD OTHER ____________	
3	E G O	SDG&E SCE SCG PG&E SMUD OTHER ____________	

* Description for Other (O) Service Type: ______________________

Comments:

____

____

____

____

____

General Site Information

2.1 Type of residence: (CHECK ONLY ONE)

- ❑ Detached, single family home
- ❑ Attached, single family home
- ❑ Mobile home
- ❑ Manufactured home
- ❑ Multi-unit building [SPECIFY NUMBER OF UNITS: _____]
- ❑ Other [COMMENT: ______________________________]

2.2 How many bedrooms/bathrooms does the residence have?

____ # of bedrooms

____ # of bathrooms

2.3 What is the total conditioned floor area of the residence other than garage, basement, and porch?

__________ Total conditioned square footage of home

2.4 Are any of the following areas used as conditioned living space? (Enter floor area for all that apply)

__________ Garage (ft^2) __________ Porch (ft^2)

__________ Basement (ft^2)

2.5 How many people living in this house at least 9 months of the year are in the following age groups:

Under 2 years	__________
2-5	__________
6-21	__________
22-39	__________

40-64 __________

65 and up __________

2.6 Respondent gender

- ❑ Female
- ❑ Male

CFL Section

In this part of the survey I would like to ask you some questions about the compact fluorescent light bulbs or CFLs you use in your home. When we called to see if you were interested in participating in this study, you mentioned that you are currently using one or more CFLs in your home.

3.1 When did you first become aware of CFLs?

_____ YEAR Or “Other” ________________________________

3.2 When did you use your first CFL?

_____ YEAR Or “Other” ________________________________

3.3 Did you purchase it/them or were you given it/them as part of a free program?

- ❑ Purchased
- ❑ Given for free
- ❑ Both
- ❑ Other [SPECIFY]

3.4 When did you purchase your most recent CFL?

- ❑ Prior to 2000
- ❑ 2000
- ❑ 2001
- ❑ 2002
- ❑ 2003
- ❑ 2004
- ❑ DK

3.5 Are you more, less or about as satisfied with the CFLs you recently purchased as compared to those you first used?

- ❑ More satisfied
- ❑ Less satisfied
- ❑ Same
- ❑ DK

3.6 [IF MORE/LESS] Why do you say that? *[If needed, probe for changes in product performance, price, size, shape, etc.]*

3.7 Where (i.e., what types of stores) have you seen CFLs for sale recently? [SELECT ALL THAT APPLY]

- ❑ Grocery store
- ❑ Drug store
- ❑ Home improvement store (e.g., Home Depot, Lowe’s, hardware store, etc.)
- ❑ Big-box retailer (e.g., Sears, Target, K-mart, Walmart)
- ❑ Costco
- ❑ IKEA
- ❑ Other
- ❑ Haven’t seen them in any stores recently
- ❑ DK

3.8 Do you think CFLs are more, less or about as commonly available to consumers in stores today as they were three years ago?

- ❑ More commonly available
- ❑ Less commonly available
- ❑ Same
- ❑ DK

[ASK NEXT QUESTIONS IF MOST RECENT CFL PURCHASE WAS IN 2001, 2002, 2003 OR 2004. OTHERWISE SKIP TO LIGHTING INVENTORY SECTION]

3.9 You mentioned you had purchased a CFL in the last year or two. How many did you purchase?

________ Number purchased > 2000

3.10 How many of these are you currently using in fixtures in your home?

________ Number currently installed

3.11 [ASK IF # INSTALLED < # PURCHASED] What happened to the others? [CHECK ALL THAT APPLY]?

- ❑ Still have them, planning to use
- ❑ Gave them away
- ❑ Burned out, broke [How many? ____________]
- ❑ DK

3.12 Where did you purchase it/them? [RECORD SPECIFIC STORE NAME/S]

3.13 When you were shopping, did you notice any special CFL advertising or information materials on display in the store near the lighting section?

- ❑ Yes
- ❑ No [SKIP TO 3.15]
- ❑ DK [SKIP TO 3.15]

3.14 How likely would you have been to purchase the CFLs if you had not noticed the special display information?

- ❑ Very likely
- ❑ Somewhat likely
- ❑ Not very likely
- ❑ Very unlikely
- ❑ DK

3.15 Do you recall if you received a special discount or a rebate when you purchased these CFLs? The discount might already have been marked on the product, or it may have been taken off at the cash register.

- ❑ Recall discount marked on product
- ❑ Recall discount taken off at register
- ❑ Recall discount, not sure how applied
- ❑ Do not recall any discount, paid full-price [SKIP TO LIGHTING INVENTORY]
- ❑ DK [SKIP TO LIGHTING INVENTORY]

3.16 How likely would you have been to purchase the CFLs if you had not received a discount?

- ❑ Very likely
- ❑ Somewhat likely
- ❑ Not very likely
- ❑ Very unlikely
- ❑ DK

3.17 If you were going to buy a CFL today, how much do you think *each* bulb would cost, not including any discounts or rebates?

- ❑ Less than $2 each
- ❑ $3-5 each
- ❑ $6-10 each
- ❑ More than $10 each
- ❑ DK

Lighting Inventory & Logger Tracking Information

Complete as many "Lighting Inventory Data Entry" sheets as necessary to get a full inventory of all light bulbs and lighting fixtures – including interior and exterior fixtures. Use the lighting inventory code sheet for entering data on these sheets. Keep track of how many total sheets are included.

Complete the "Logger Tracking Information" sheet. Record Fixture # from "Lighting Inventory Data Entry" sheets.

Track any and all comments by Fixture # on the "Comments" sheet.

LIGHTING INVENTORY CODE SHEET

Location Codes

X=OutsideLtg **G**=Garage **LN**=Laundry Rm **L**=LivingRm
D=DiningRm **F**=FamilyRm **U**=UtilityRm **CL**=Closet
BT=Bathroom **MB**=MstrBdRm **OB**=OthrBedRm **H**=Halls/Entry
KG=Kitchen general/area **KD=**Kitchen decorative/other **KN**=BrkfstNook **OR**=Other room (describe)

Control Type Codes

S=Switch (on/off) **M**=Motion sensor **D**=Dimmer **P**=Photocell
T=Timer **H**=Home Automation System **OC**=Other (describe)

Fixture Type Codes

C=Ceiling, surface-mounted **L**=Floor/table lamp **D**=Downlights (cans) **T**=Torchiere
W=Wall –mounted **H**=Other hard-wired **R**=Recessed **P**=Other plug-in
S=Suspended **F**=Ceiling fan **OF**=Other (describe)

Incandescent Lamp Type Codes

I=Incandescent Standard, medium base **IS**=Incandescent Standard, small base
IG=Incandescent Globe **ID**=Incandescent Decorative
IP=Incandescent PAR **IR**=Incandescent Reflector

Fluorescent Lamp Type Codes

F=Fluorescent Tube **UT**=Fluorescent U-tube **OF**=Other Fluorescent Tube

Compact Fluorescent Lamp Type Codes

CFG=CF w/Globe-Shaped diffuser **CFC**=CF, w/Capsule-Shaped diffuser
CFR=CF w/reflector **CFO**=Compact Fluorescent, Other (describe)
CIR=Circline

Compact Fluorescent Base Type Codes

S=Screw-based P=Pin based

Compact Fluorescent Ballast Type Codes

I=Integrated M=Modular D=Dedicated

Halogen Lamp Type Codes

HA=Halogen "A" HT=Halogen Tubular HL=Halogen low voltage
HP=Halogen reflector w/PAR HI=Halogen IR

High Intensity Discharge (HID) Lamp Type Codes

MV=Mercury Vapor MH=Metal Halide
HPS=HighPressure Sodium Vapor LPS=LowPressure Sodium Vapor

LIGHTING INVENTORY DATA ENTRY SHEET 1 of ___

Fixture #	1	2	3	4	5	6
Fixture Details						
Location Code						
Control Type Code						
Fixture Type Code						
For Ceiling Fan Fixtures: **Is the ceiling fan fixture the only light source in the room?**	Y N	Y N	Y N	Y N	Y N	Y N
Total Number of Fixtures						
Number of Lamps per Fixture						
Watts per Lamp *(enter 2 or 3-way as 50/100/150)*						
Lamp Type & Lamp-Specific Details						
Incandescent Lamp Type Code	I IS IP IR	I IS IP IR	I IS IP IR	I IS IP IR	I IS IP IR	I IS IP IR
Is Incandescent Fixture CFL Applicable? *(If no, give reason in comments box)*	Y N	Y N	Y N	Y N	Y N	Y N
Fluorescent Tube Lamp Type Code	F UT OF	F UT OF	F UT OF	F UT OF	F UT OF	F UT OF
Fluorescent Tube Length in Feet *(e.g., 2, 4, 6, 8)*						
Fluorescent Tube Diameter *(e.g. T8, T10, T12)*						
Compact Fluorescent Lamp Type Code						
Base Type Code *(S=Screw-based P=Pin-based)*	S P	S P	S P	S P	S P	S P
Ballast Type Code *(I=Integrated M=Modular D=Dedicated)*	I M D	I M D	I M D	I M D	I M D	I M D
Wattage of Lamp Replaced by CFL?						
Is Lighting Logger Installed? *(if no, give reason in comments box)*	Y N	Y N	Y N	Y N	Y N	Y N
Halogen Lamp Type Code	HA HT HL HP HI	HA HT HL HP HI	HA HT HL HP HI	HA HT HL HP HI	HA HT HL HP HI	HA HT HL HP HI
HID Lamp Type Code	MV MH HPS LPS	MV MH HPS LPS	MV MH HPS LPS	MV MH HPS LPS	MV MH HPS LPS	MV MH HPS LPS

LIGHTING INVENTORY DATA ENTRY

Fixture #	7	8	9	10	11	12
Fixture Details						
Location Code						
Control Type Code						
Fixture Type Code						
For Ceiling Fan Fixtures: **Is the ceiling fan fixture the only light source in the room?**	Y N	Y N	Y N	Y N	Y N	Y N
Total Number of Fixtures						
Number of Lamps per Fixture						
Watts per Lamp *(enter 2 or 3-way as 50/100/150)*						
Lamp Type & Lamp-Specific Details						
Incandescent Lamp Type Code	I IS IP IR	I IS IP IR	I IS IP IR	I IS IP IR	I IS IP IR	I IS IP IR
Is Incandescent Fixture CFL Applicable? *(If no, give reason in comments box)*	Y N	Y N	Y N	Y N	Y N	Y N
Fluorescent Tube Lamp Type Code	F UT OF	F UT OF	F UT OF	F UT OF	F UT OF	F UT OF
Fluorescent Tube Length in Feet *(e.g., 2, 4, 6, 8)*						
Fluorescent Tube Diameter *(e.g. T8, T10, T12)*						
Compact Fluorescent Lamp Type Code						
Base Type Code *(S=Screw-based P=Pin-based)*	S P	S P	S P	S P	S P	S P
Ballast Type Code *(I=Integrated M=Modular D=Dedicated)*	I M D	I M D	I M D	I M D	I M D	I M D
Wattage of Lamp Replaced by CFL?						
Is Lighting Logger Installed? *(if no, give reason in comments box)*	Y N	Y N	Y N	Y N	Y N	Y N
Halogen Lamp Type Code	HA HT HL HP HI	HA HT HL HP HI	HA HT HL HP HI	HA HT HL HP HI	HA HT HL HP HI	HA HT HL HP HI
HID Lamp Type Code	MV MH HPS LPS	MV MH HPS LPS	MV MH HPS LPS	MV MH HPS LPS	MV MH HPS LPS	MV MH HPS LPS

LIGHTING INVENTORY DATA ENTRY

Fixture #	13	14	15	16	17	18
Fixture Details						
Location Code						
Control Type Code						
Fixture Type Code						
For Ceiling Fan Fixtures: **Is the ceiling fan fixture the only light source in the room?**	Y N	Y N	Y N	Y N	Y N	Y N
Total Number of Fixtures						
Number of Lamps per Fixture						
Watts per Lamp *(enter 2 or 3-way as 50/100/150)*						
Lamp Type & Lamp-Specific Details						
Incandescent Lamp Type Code	I IS IP IR	I IS IP IR	I IS IP IR	I IS IP IR	I IS IP IR	I IS IP IR
Is Incandescent Fixture CFL Applicable? *(If no, give reason in comments box)*	Y N	Y N	Y N	Y N	Y N	Y N
Fluorescent Tube Lamp Type Code	F UT OF	F UT OF	F UT OF	F UT OF	F UT OF	F UT OF
Fluorescent Tube Length in Feet *(e.g., 2, 4, 6, 8)*						
Fluorescent Tube Diameter *(e.g. T8, T10, T12)*						
Compact Fluorescent Lamp Type Code						
Base Type Code *(S=Screw-based P=Pin-based)*	S P	S P	S P	S P	S P	S P
Ballast Type Code *(I=Integrated M=Modular D=Dedicated)*	I M D	I M D	I M D	I M D	I M D	I M D
Wattage of Lamp Replaced by CFL?						
Is Lighting Logger Installed? *(if no, give reason in comments box)*	Y N	Y N	Y N	Y N	Y N	Y N
Halogen Lamp Type Code	HA HT HL HP HI	HA HT HL HP HI	HA HT HL HP HI	HA HT HL HP HI	HA HT HL HP HI	HA HT HL HP HI
HID Lamp Type Code	MV MH HPS LPS	MV MH HPS LPS	MV MH HPS LPS	MV MH HPS LPS	MV MH HPS LPS	MV MH HPS LPS

LIGHTING INVENTORY DATA ENTRY

Fixture #	__	__	__	__	__	__
Fixture Details						
Location Code						
Control Type Code						
Fixture Type Code						
For Ceiling Fan Fixtures: **Is the ceiling fan fixture the only light source in the room?**	Y N	Y N	Y N	Y N	Y N	Y N
Total Number of Fixtures						
Number of Lamps per Fixture						
Watts per Lamp *(enter 2 or 3-way as 50/100/150)*						
Lamp Type & Lamp-Specific Details						
Incandescent Lamp Type Code	I IS IP IR	I IS IP IR	I IS IP IR	I IS IP IR	I IS IP IR	I IS IP IR
Is Incandescent Fixture CFL Applicable? *(If no, give reason in comments box)*	Y N	Y N	Y N	Y N	Y N	Y N
Fluorescent Tube Lamp Type Code	F UT OF	F UT OF	F UT OF	F UT OF	F UT OF	F UT OF
Fluorescent Tube Length in Feet *(e.g., 2, 4, 6, 8)*						
Fluorescent Tube Diameter *(e.g. T8, T10, T12)*						
Compact Fluorescent Lamp Type Code						
Base Type Code *(S=Screw-based P=Pin-based)*	S P	S P	S P	S P	S P	S P
Ballast Type Code *(I=Integrated M=Modular D=Dedicated)*	I M D	I M D	I M D	I M D	I M D	I M D
Wattage of Lamp Replaced by CFL?						
Is Lighting Logger Installed? *(if no, give reason in comments box)*	Y N	Y N	Y N	Y N	Y N	Y N
Halogen Lamp Type Code	HA HT HL HP HI	HA HT HL HP HI	HA HT HL HP HI	HA HT HL HP HI	HA HT HL HP HI	HA HT HL HP HI
HID Lamp Type Code	MV MH HPS LPS	MV MH HPS LPS	MV MH HPS LPS	MV MH HPS LPS	MV MH HPS LPS	MV MH HPS LPS

LOGGER TRACKING INFORMATION

SHEET 1 of ___

Fixture #	____	____	____	____
Logger Serial Number				
Type of Logger Installed	Dent / HOBO	Dent / HOBO	Dent / HOBO	Dent / HOBO
Was Fiber Optic Eye Installed	Y N	Y N	Y N	Y N
Time of Day Installed	_______ AM / PM	_______ AM / PM	_______ AM / PM	_______ AM / PM
Logger Installation Location				
Likelihood of Registering External Light Sources	High Average Minimal None	High Average Minimal None	High Average Minimal None	High Average Minimal None
Was CFL purchased >2000?	Y N DK	Y N DK	Y N DK	Y N DK
Was CFL discounted when purchased?	Y N DK	Y N DK	Y N DK	Y N DK
Approximate Total Hours of Use/Day				
Used During Peak Hours?	Y N DK	Y N DK	Y N DK	Y N DK

LOGGER TRACKING INFORMATION SHEET 2 of 2

Fixture #	____	____	____	____
Logger Serial Number				
Type of Logger Installed	Dent / HOBO	Dent / HOBO	Dent / HOBO	Dent / HOBO
Was Fiber Optic Eye Installed	Y N	Y N	Y N	Y N
Time of Day Installed	_______ AM / PM	_______ AM / PM	_______ AM / PM	_______ AM / PM
Logger Installation Location				
Likelihood of Registering External Light Sources	High Average Minimal None	High Average Minimal None	High Average Minimal None	High Average Minimal None
Was CFL purchased >2000?	Y N DK	Y N DK	Y N DK	Y N DK
Was CFL discounted when purchased?	Y N DK	Y N DK	Y N DK	Y N DK
Approximate Total Hours of Use/Day				
Used During Peak Hours?	Y N DK	Y N DK	Y N DK	Y N DK

Comments & Observations

Track any and all comments and observations below by Question # or Fixture #.

B

SURVEY DISPOSITION TABLES

This appendix presents a series of detailed disposition tables for the monitoring study. Table B-1 shows the number of fixtures monitored per month and year by wattage categories. Tables B-2 and B-3 show the same information but instead of by wattage categories, by location and base type.

Table B-1

Fixture Disposition by Wattage Categories and Month

Year	Month	Wattage categories						Total
		13-17	18-22	23-26	27-30	7-12W	>30W	
2003	July	70	24	13	7	4	9	127
2003	August	118	32	43	9	13	14	229
2003	September	124	28	43	9	13	15	232
2003	October	120	27	44	9	13	13	226
2003	November	119	26	42	9	13	13	222
2003	December	115	26	42	9	13	13	218
2004	January	115	25	42	8	13	13	216
2004	February	88	21	39	8	13	13	182
2004	March	160	54	69	16	17	17	333
2004	April	274	106	140	22	13	22	577
2004	May	308	122	152	23	14	21	640
2004	June	299	120	150	23	13	19	624
2004	July	299	118	150	22	13	15	617
2004	August	290	118	150	22	13	15	608
2004	September	285	117	146	22	13	15	598

Table B-2
Fixture Disposition by Location and Month

Year	Month	Bedroom	Bathroom	Family Room	Garage	Halls/ Entry	Kitchen	Living Room	Laundry	Other Room	Total
2003	July	28	13	16	0	9	18	36	6	1	127
2003	August	45	30	29	3	16	45	54	6	1	229
2003	September	48	29	29	3	17	47	52	6	1	232
2003	October	45	29	30	1	16	47	51	6	1	226
2003	November	44	29	30	1	16	47	48	6	1	222
2003	December	43	29	29	1	16	46	47	6	1	218
2004	January	42	29	29	1	16	46	46	6	1	216
2004	February	36	24	24	1	15	40	37	4	1	182
2004	March	77	44	31	21	19	65	64	7	5	333
2004	April	131	70	62	23	39	98	120	22	12	577
2004	May	137	75	63	25	46	105	152	23	14	640
2004	June	133	80	63	25	44	95	148	22	14	624
2004	July	131	79	60	25	42	97	147	22	14	617
2004	August	129	78	57	25	42	95	147	21	14	608
2004	September	128	78	55	25	41	93	143	21	14	598

Table B-3
Fixture Disposition by Base Type and Month

Year	Month	Pin-based	Screw-based	Total
2003	July	9	113	122
2003	August	10	212	222
2003	September	10	215	225
2003	October	10	211	221
2003	November	10	207	217
2003	December	10	203	213
2004	January	10	201	211
2004	February	10	168	178
2004	March	14	314	328
2004	April	31	540	571
2004	May	28	606	634
2004	June	29	590	619
2004	July	27	585	612
2004	August	26	577	603
2004	September	26	567	593