Seeing the Light: Effective Strategies for Promoting Compact Fluorescent Lighting to Residential Customers

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In recent years, many utilities have undertaken a wide range of promotional programs to encourage adoption of compact fluorescent bulbs, with varying results. This paper reviews the findings of some recent market studies and evaluations to identify which strategies work and which do not. The review draws on results from two market studies and one evaluation in which the author participated on compact fluorescent bulbs for electric utilities and compares their findings with those from other recent program evaluations.

Introduction

Compact fluorescent light bulbs (CFBs) offer one of the most promising opportunities for energy efficiency improvements in the residential sector. Numerous utilities have developed a wide range of programs to promote their adoption through various delivery strategies. Several evaluations of these first generation programs have been performed, along with related market studies, to identify barriers to acceptance of the technology. These evaluations and market studies, taken together, provide a developing picture of the potential for compact fluorescent bulbs, the obstacles to achieving that potential, and the strengths and limitations of alternative strategies for overcoming these obstacles.

This paper presents key findings from three recent studies of compact fluorescent lighting and compares their findings with other studies. These studies were performed by HBRS for the respective utilities, and the author served as the principal investigator on each of them. The primary objective of this presentation is to summarize the current evidence on the strengths and weaknesses of alternative delivery strategies in promoting adoption of compact fluorescent lamps with recommendations on the circumstances where each is appropriate. The three studies are:

 Southern California Edison's Residential Lighting Study. This was a comprehensive study of residential lighting characteristics and potential for compact fluorescent bulbs in Southern California Edison's service territory. It included a detailed survey and a visual inspection of the lighting fixtures in each respondent's home to determine fixture characteristics, wattages, and feasibility of replacing incandescent bulbs with compact fluorescent bulbs. It also included metering a sample of light fixtures with time-of use light loggers to determine load patterns.

- Pacific Gas & Electric Company's Evaluation of its 1992 Residential Compact Fluorescent Lighting Program. This was an impact evaluation of PG&E's 1992 program that promoted the sale of compact fluorescent bulbs through financial incentives paid to manufacturers. The evaluation included a telephone survey of households who bought CFBs from participating manufacturers, a survey of a random sample of households, on-site inspections of compact fluorescent bulb installations, and time-of-use metering of a sample of compact fluorescent fixtures.
- Orange & Rockland Utilities' Residential Lighting Program Study. This was a market research study to assess the effectiveness of alternative delivery strategies and customers' willingness to pay for CFBs. The study surveyed ORU customers who had not participated in ORU's direct installation CFB program, and it interviewed a sample of lighting retailers in ORU's service territory.

In the following sections, we discuss the results of these studies and compare them to other evaluations and market studies on compact fluorescent bulbs.

Background

The three utilities where the studies were conducted differ significantly in the degree to which they have promoted compact fluorescent lighting. Southern California Edison had no compact fluorescent program prior to conducting its study. Two of the key objectives of its study were to estimate the potential for CFBs in SCE's service territory and to determine the baseline market conditions for later estimation of free ridership, spillover, and market transformation effects in future program evaluations.

Pacific Gas & Electric had promoted CFBs for three years at the time it evaluated its 1992 program. During 1990 and 1991, it promoted CFBs through a mail order delivery program. In 1992, it switched to a manufacturer rebate program. Under this program, PG&E negotiated agreements with three major manufacturers where they received rebates for models sold at stores in PG&E's service territory. The manufacturers promoted these models through a combination of reduced prices, customer rebate coupons, and special displays and advertising. By the end of 1992, less than 5 percent of PG&E's residential customers had purchased compact fluorescent under a past PG&E program.

Orange & Rockland had promoted CFBs aggressively through a free direct installation program prior to commissioning its study in late 1993. Participants received an average of 9 bulbs under the direct installation program. ORU staff estimated that approximately one third of all eligible customers had participated in the program through the end of 1993.

The differences among the three service areas provide an opportunity to compare how the types and intensities of CFB promotions have affected general awareness and use by all customers. Our expectation was that awareness and use would be significantly higher in the areas where CFBs had been promoted more aggressively. As discussed below, this was not borne out by the survey results.

Characteristics of Residential Lighting and Potential for Compact Fluorescent Bulbs

The SCE study provided a detailed assessment of the potential for compact fluorescent lighting in the residential sector. It included a comprehensive inventory of residential lighting characteristics and the suitability of fixtures for CFBs. The inventory was conducted through in-person inspections of a sample of 692 residential dwellings in SCE's service territory. The sample was stratified by consumption level, location, and building type. The inventory determined the number of fixtures in each dwelling, their locations and wattages, and whether a compact fluorescent bulb would fit in each of them with or without some modification.

The inventory obtained the following major findings:

- The average number of lighting fixtures per dwelling in Southern California Edison's service territory is over 21, and the average number of bulbs per fixture is 1.6.
- The average number of watts per fixture is almost 100 watts, and the average installed watts per dwelling is 2100. The installed wattage per dwelling increases significantly for higher consumption customers due to the greater number of fixtures in these dwellings.
- The lighting intensities average over 2 watts per square foot. Lighting intensities are somewhat higher for larger consumption segments. They are also greater for single-family than for multi-family units.
- The self-reported average hours of operation of lighting fixtures is 2.2 hours per day.
- The average electricity use per household for lighting is over 1,500 kWh per year, based on self-reported hours of operation and confirmed wattages. The estimate of lighting use differs significantly across consumption customer segments and building types.
- Almost 40 percent (an average of more than thirteen bulbs per dwelling) of the installed light bulbs could be replaced with compact fluorescent bulbs. Approximately 20 percent of these (or 8 percent of all bulbs) would require some minor fixture modification such as a socket extender or new lamp harp.
- The potential wattage reduction from retrofitting all of the suitable sockets with compact fluorescent bulbs averages over 550 watts per household. This potential increases significantly for higher consumption households, and it is greater in single-family than in multifamily dwellings.
- The kilowatt-hours savings potential from retrofitting all suitable sockets is over 390 kWh per year based on the self-reported hours of operation. This potential is greatest in the top consumption tercile and in single-family dwellings.

These findings about the installed wattages and potential for savings from conversions to CFBs are generally consistent with those from other studies that have examined residential lighting characteristics. The results of three such studies were reported in Proceedings from the ACEEE 1992 Summer Study. In a lighting survey of Pacific Gas & Electric residential customers, Kelsey and Richardson (1992) found the average installed lighting wattage was 1800 watts, and they estimated that the average annual electricity consumption due to lighting was 1270 kWh. They estimated that the kWh savings potential from conversions was 23 percent.

In their evaluation of PG&E's 1991 compact fluorescent lighting program, Goett, et al. (1992) found an installed wattage of over 2100 watts and estimated annual consumption over 1300 kWh. They found savings potential of 30 percent. This study was performed on a sample of 1991 program participants rather than a representative sample of all residential customers.

In a paper dealing with a direct installation program for Orange and Rockland Utilities, Robinson (1992) reported an average connected lighting load of 2500 watts per participating household. The direct installation program reduced connected loads by an average of 30 percent with an estimated average energy savings of almost 1000 kWh. Given the differences in service area characteristics between SCE and ORU, as well as differences in the samples, these findings are roughly consistent.

Lighting Load Curves

The SCE study metered a representative sample of lighting fixtures to determine operating hours and load profiles. The metering component also allowed comparisons of the respondents' self reported hours of operation of lighting fixtures with the metered use.

The meters were installed in fixtures that respondents said were used at least an average of one hour per day. The meters were installed during the winter of 1992-93 and left in place until September 1993. The meters recorded the time and date every time the light fixture was turned on or off.

The average daily summer and winter lighting load shapes are presented in Figure 1. They show a large evening peak around 7 to 8 p.m. and a small secondary peak around 6 a.m. The average hours of operation of the metered fixtures was 2.6 hours per day over the entire study period. During the on-site inspection, however, participants reported that they used the metered fixture an average of 3.8 hours per day. Respondents overestimated hours of operation an average of 1.2 hours a day.

Part of this discrepancy between self-reported and metered hours of operation can be explained by the seasonality of lighting usage and when the on-site visits were conducted. The meters were installed during the winter months when fixtures are used more intensively. The metered average daily hours of operation were 3.5 hours during January versus 2.2 hours in July.

Customer Awareness and Attitudes Toward Compact Fluorescent Bulbs

The Southern California Edison study investigated issues surrounding customer awareness and attitudes toward compact fluorescent lighting, as did the PG&E and ORU projects. Comparisons of the results from the three studies provide insight into how different types and levels of utility CFB programs had affected customers in each service territory. At the time of its study, SCE had no significant program promoting CFBs. PG&E had been promoting CFBs at a modest level of intensity for three years by the early 1993 when its study was performed. Orange and Rockland had provided free CFBs to almost a third of their residential customers through a direct installation program by the time their study was conducted in late 1993.

Our expectation was that the level of awareness and use of compact fluorescent bulbs by nonparticipants would be higher in the service areas where they had been promoted more aggressively. Surprisingly, this was not the case. The response rates to key questions are presented in Table 1. It is important to note that each of the surveys was administered to customers who said that they had not previously participated in a utility sponsored CFB promotional program.

The percentage who said that they were familiar with CFBs did not vary substantially across the studies. The percent in ORU's service area where CFBs had been promoted most aggressively did not differ significantly from those in either SCE or PG&E.

The surveys obtained qualitatively similar results for the questions asking whether the respondents were currently using CFBs or had bought them in the past. The respondents in SCE's service area where no CFB program existed actually had the highest percent of affirmative responses. Even this result is suspect, however, since follow-up inspections determined that the true installation rate of CFBs among these SCE respondents was much lower.

Willingness to Pay for CFBs

The Orange and Rockland study and the SCE study asked questions about customers' willingness to pay for compact fluorescent bulbs. This information is useful estimating participation in programs that would offer CFBs at some price, albeit discounted from the full retail rate.

The ORU study investigated this issue in greatest detail by asking different subsamples about respondents' willingness to pay different price levels. In addition, the survey



Figure 1. Average Daily Summer and Winter Lighting Load Shapes

	SCE	PG&E	ORU
Percent of respondents who said they were familiar with CFBs	58%	64 <i>%</i>	60%
	(1.9)*	(2.1)	(3.5)
Percent who had ever purchased CFBs	27%	24%	20%
	(1.7)	(1.9)	(2.8)
Percent who are currently using CFBs	18%	12%	14%
	(1.5)	(1.4%)	(2.5)
Number of respondents	700	520	200

included a follow-up question asking the respondent his willingness to pay a higher or lower price, depending on the response to the first question. The responses to these questions were used to bracket the percent of respondents who would pay a given price for a CFB. The results from the ORU survey on this question are shown in Figure 2. They show that approximately 60 percent of respondents would be willing to pay \$6 per bulb. The percent declines roughly at a rate of 9 percent for every dollar increase in price from \$6 to \$12.

The findings from the SCE study are consistent with those from the ORU one, although they are less detailed. Seventy percent of the respondents to the SCE survey said



Figure 2. Willingness to Purchase Compact Fluorescent Bulbs (Assuming Consistent Response to Untested Prices)

that they would be willing to pay \$5 for CFBs, and a third said they would pay \$10.

The Effectiveness of Retail Versus Direct Mail Mechanisms

The PG&E study provided a good basis for comparing the relative effect on purchases and installations of a promotional program that worked through normal retail channels versus one that dealt directly with the customer. The 1992 program rebated manufacturers for sales through their regular distribution channels. Previously, PG&E had offered CFBs by direct mail promotions with a mail order delivery.

The evaluation of the 1992 program found that the average purchase from participating manufacturers was 2.8 bulbs. Over 84 percent of these were installed at the time of the survey. Respondents said they planned to install an additional 9 percent and had no plans to install the remainder.

In contrast, participants in the 1991 direct sales program purchased an average of 3.9 bulbs. A survey in the spring of 1992 found that respondents had installed 56 percent of these. They said that they planned to install an additional 32 percent. However, a persistence study conducted in late 1993 found a total installation rate of 60 percent, less than 5 percent greater than 18 months before.

Retailer Attitudes and Knowledge of CFBs

The Orange and Rockland study included interviews of lighting retailers to assess their attitudes and knowledge of compact fluorescent bulbs and to gauge their willingness to participate in a utility-sponsored rebate program. Thirty retailers were interviewed, broken down roughly equally among grocery and convenience stores (7), hardware stores and home centers (10), and general merchandise stores including discount outlets (12).

The results were striking, given the intensity with which ORU had promoted CFBs in its service territory. Only 11 out of the 30 stocked CFBs. All but one of these were hardware stores or home centers. Most of the retailers who did not stock CFBs were either unaware of the technology or believed that there was no significant demand for it.

The interview also asked about the willingness of retailers to participate in either a mail-in or instant rebate program for CFBs. All but one of the retailers who currently stock CFBs said they would be willing to participate in a rebate program where customers mailed in the rebate coupon. Among the retailers who did not stock CFBs, one third said they would participate in a mail-in rebate program, a third said that they would not, and a third were unsure whether they would participate.

The retailers were less willing to participate in an instant rebate program. Less than a quarter of the respondents said they would be willing to participate in such a program. More than half said no. The resistance was strong among both those who currently stock CFBs and those who did not stock them. Most of those who were unwilling cited "too much paperwork" as the primary reason.

Implications for Program Design and Delivery Strategies

The three studies summarized here help fill out the picture of the market for compact fluorescent bulbs, the barriers to their adoption, and the effectiveness of alternative strategies for overcoming these barriers. The outline of this picture as we perceive it is summarized here.

The SCE study provides additional confirmation of the significant potential for CFBs in the residential sector. This study, along with others cited above, indicate an average installed wattage of 1800 to 2500 watts per house-hold and annual usage ranging from 1200 to 1500 kWh. Roughly one third of this could be replaced by CFBs with no significant changes in fixtures. CFB savings would have a minimal effect on critical summer peaks, but would reduce winter peak loads significantly.

The results imply that the obstacles to adoption of CFBs are not physical limitations. Rather, they appear to arise from lack of awareness and misperceptions about the performance of CFBs and the unavailability of CFBs through normal retail outlets.

The significant potential for CFB warrants very aggressive promotional strategies on the part of utilities from the standpoint of cost effectiveness. Other studies (e.g., Robinson 1992, Shirlau, et al. 1992, Granda 1992) have reported on the effectiveness of direct installation delivery strategies. Granda reports one case where the realized savings were significantly lower than estimates made in conjunction with the installations. One of the key reasons for this shortfall appears to have been the significant removal of CFBs by treated dwellings. Robinson reports the results of another direct install program where the removal rate was minimized by careful matching of the CFBs to the applications. None of these studies addresses the effects of the direct installation delivery on the development of a retail market for CFBs. The results of the Orange & Rockland study strongly indicate that the direct installation delivery strategy significantly retards it. Utilities that are considering direct installation programs should consider this effect and its implications for their long-run DSM goals.

The results of the three studies indicate that the primary obstacles to adoption of CFBs from the standpoint of customers deal with lack of awareness and perceptions about their performance. A significant percent of customers in all three studies had no knowledge of CFBs. A minority of those who were familiar with the technology had ever purchased a CFB. This implies that utilities should complement any incentive based program with information about the performance of CFBs and the applications where they are best suited.

The ORU and SCE studies confirm that customers are willing to pay some amount for CFBs. The results of the ORU study show a steady, gradual decline as the price is increased. The percentages are consistent with the responses to the SCE survey and other studies that have asked about willingness-to-pay. They do not support the contention by some that there is a threshold (e.g., \$10) where willingness-to-pay drops significantly.

Finally, the results of the PG&E program evaluation shed light on the effectiveness of direct mail versus retail rebate programs. When the 1992 program that used manufacturers rebates was compared to the previous year's direct mail promotion, the evaluation found that the retail rebate results in a much higher percent of in-service bulbs. This finding indicates that the use of retail delivery channels has significant advantages over direct mail in terms of realized savings, at least in the year following sales.

Conclusion

Compact fluorescent light bulbs are a very attractive efficiency technology for residential applications. Utilities must consider carefully how different delivery strategies will serve their strategic goals in the long run. The major obstacles to adoption appear to be awareness and perceptions about CFBs, as well as the lack of a developed retail market for the product. The results of the studies reported here suggest that strategies that bypass the retail delivery channels significantly retard the development of this market. In the short term, such strategies may be justified to secure large savings or to expose customers to the new technology. In the long term, however, strategies that work through retail channels may be more effective in securing the overall adoption of the technology.

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