Mass Deliveries of Compact Fluorescent Lamps (CFLs) As a Response to the Energy Crisis: Evaluation of California's 2001 CFL Programs

Tami Rasmussen and Kathleen McElroy, XENERGY, Inc.
Rob Rubin, San Diego Gas & Electric Company

ABSTRACT

In 2001, an unprecedented effort was undertaken in California to deliver energy-saving measures to residents. Utilities and other organizations developed large-scale CFL programs in response to the energy crisis (1) to reduce energy consumption and (2) to help mitigate the effects of higher utility bills for low-income households. The extent of the effort and the diverse strategies employed by program sponsors created a unique opportunity to examine the advantages and disadvantages of CFL program delivery mechanisms.

As part of the California Statewide Residential Lighting and Appliance Program Evaluation, a survey of CFL recipients was conducted to evaluate CFL programs that targeted California residents in 2001. The subsequent analyses suggest the following results: (1) on a per unit basis, it is most costly to target specific groups for giveaway programs, and least costly to administer large-scale reduced price programs; (2) installation rates and hours of usage decline as the number of CFLs given away increases; (3) declines are much more gradual for reduced price programs where the consumer must share the price of the CFL; and (4) a small but significant number of program-provided CFLs are replacing existing CFLs, i.e., not incandescents as is usually assumed.

These and other lessons learned will aid program planners and policymakers in the future.

Introduction

Over the summer of 2001, numerous utility and non-utility organizations engaged in an unprecedented delivery of over ten million compact fluorescent lamps (CFLs) to residents of California. The CFLs were delivered either at no charge or at a reduced rate in an attempt to help residents conserve energy. This paper discusses major CFL programs offered to California residents in 2001, comparing the effectiveness of the mechanism by which each program delivered CFLs. The data underlying this paper and its conclusions were collected as part of a comprehensive evaluation of the California investor owned utilities' (IOU) 2001 Statewide Residential Lighting and Appliance Program.

Program Descriptions

The major CFL programs offered in California in 2001 employed four distinct methods for delivering CFLs. Each "delivery mechanism" was selected so that the program could meet a specific set of objectives, such as reaching a specific target audience or achieving maximum energy savings.

For the purposes of this paper, the major CFL programs offered in California in 2001 have been categorized into the following four delivery mechanisms:

- Targeted Event Giveaway,
- Door-to-Door Giveaway,
- Leveraging Existing Energy Efficiency Programs, and
- Reduced Price Programs.

Targeted Event Giveaway Programs

Targeted Event Giveaway Programs seek to reach a specific group of residents, often by leveraging an existing event or gathering place to reach the target audience. Each of the State's electric IOUs offered at least one CFL giveaway event in 2001.

Each utility employed a slightly different strategy for targeting various groups. San Diego Gas & Electric Company (SDG&E) held more than 60 events at senior citizen centers, giving away almost 20,000 CFLs to seniors. Southern California Edison (SCE) sponsored sixteen CFL giveaway events targeted at "under-served" residents, i.e., non-English speakers, low-income households, and those living in rural communities. Through SCE's initiatives, more than 25,000 CFLs were handed out at promotional exhibits held at county fairs, ethnic-based festivals, and senior citizen events. Pacific Gas & Electric Company (PG&E) held one significant giveaway event in 2001, targeting Asian residents of San Francisco through an event held at City Hall. About 1,500 CFLs were given away at that event.

Door-to-Door Giveaway

The Door-to-Door Giveaway delivery strategy seeks to deliver a high volume of CFLs to a targeted group of residents who are located in close geographic proximity. The major Door-to-Door Giveaway program that was implemented in California in 2001 was the State's Powerwalk program, which targeted households located in low-income neighborhoods. Through the Powerwalk program, the California Conservation Corps distributed 1.9 million CFLs to approximately 475,000 households statewide.

Leveraging Existing Programs

Leveraging Existing Programs, or "piggybacking", maximizes the energy savings of existing energy efficiency programs with minor incremental cost. In 2001, SCE leveraged an existing energy efficiency program, the Refrigerator Recycling Program, and increased its energy savings potential by introducing a CFL incentive. SCE offered participating customers the choice of $35 in cash, or a 5-pack of CFLs. A total of 5,500 people opted for the CFLs, representing ten percent of those presented with the option.

Reduced Price Programs

Usually the major goal of Reduced Price Programs is to increase the number of CFLs purchased in the marketplace. By reducing the purchase price, either through a manufacturer buydown or a Point-of-Purchase (POP) rebate, consumers would be more willing to purchase CFLs over other less efficient (and less costly) light bulbs. A secondary goal may be to affect the upstream market for CFLs, such that the increase in CFL market share may be sustained.

Each of the State's electric IOUs offered such programs in 2001 to their customers, resulting in the purchase of several million reduced price CFLs. SDG&E and SCE provided manufacturers with a $3 rebate on CFLs, while PG&E worked directly with retailers to offer a POP rebate of $3 per CFL. SDG&E rebated over 18,000 CFLs, SCE over 350,000 CFLs, and PG&E seven million CFLs.

CFL Program Costs

Table 1 presents a comparison across delivery mechanisms of the average cost per CFL delivered. These data allow for in initial assessment of the relative cost-effectiveness of program delivery strategies. Subsequent sections discuss installation rates and bulb usage by program, allowing for a comparison of cost per CFL installed and cost per annual kWh saved.

Table 1. CFL Volume and Delivery Cost by Delivery Mechanism

Delivery Mechanisms	CFL Volume	CFL Subsidy	Cost per CFL Delivered[1]
Targeted Event giveaway	Low	1 free	$15-$20[2]
Door-to-door giveaway	High	4 free	$8-$10[2]
Leveraging Other Programs	Low	5 free instead of $35 cash incentive	$5-$6[2]
Reduced Price Programs- Manufacturer Buy-Down	Medium	$3 manufacturer buy-down	$6-$7
Reduced Price Programs- POP Rebate	High	$3 POP rebate	$3-$5

[1]The cost figures were calculated based on program sponsor-provided administration, implementation, and CFL per unit cost data.
[2]The average cost of CFLs provided by the Targeted Event giveaways, the door-to-door giveaway, and the Leveraging program was between $5 and $6.

Although the cost per CFL delivered is an important factor to consider when assessing program effectiveness, many of the programs offered in California last year were designed with the intent to meet non-energy savings objectives, such as targeting seniors or historically hard-to-reach customer segments. Thus, when assessing one program's effectiveness over another, it is important to consider the specific objectives each program was designed to address.

For example, delivery strategies that are designed to target specific sectors, such as Targeted Event Giveaways, are the most expensive programs on a "per unit" basis. But often programs of this nature leverage existing events and capitalize on gathering places such as senior or civic centers, which helps control the cost of reaching the intended target. The high per unit cost is more likely a reflection of the fact that such programs are usually delivered on a much smaller scale.

Door-to-door programs are often designed to reach targeted geographic (or demographic) segments at much higher volumes than can be achieved via the Targeted Event giveaway approach. The cost per unit delivered reflects this higher participation volume. However, to be successful from a cost-effectiveness perspective, door-to-door programs

require a well-trained, established network of program canvassers and the ability to exercise purchase power in procuring a large volume of CFLs.

The Leveraging Other Programs delivery strategy is one of the cheapest mechanisms of delivering CFLs. However, by nature this delivery method provides CFLs only to those who are already participating in other energy efficiency programs. It also operates outside the market for CFLs, and similarly to targeted approaches, may not create significant lasting effects on the marketplace for efficient lighting.

Reduced Price Programs are also a relatively cheap delivery mechanism, especially when the program is large-scale, as was the case with the POP program. Administration costs are similar to those incurred by the other program delivery strategies discussed here, but because the CFL is discounted instead of fully subsidized program costs on a per unit basis are relatively lower.

The effects on the market for CFLs caused by Reduced Price Programs may be sustainable at least in the short run. That is, the increase in the product availability and exposure at retail stores will likely continue beyond the program end date. These programs, when implemented on a medium to large scale, are also effective at reaching a broader segment of the population than traditional energy efficiency programs that tend to attract a select group of individuals.[1] However, this delivery strategy is not effective at targeting specific groups, such as the hard-to-reach.

CFL Program Energy Savings

The energy savings achieved by California's 2001 CFL programs on a per unit basis depends on the rate of installation, the extent to which the bulbs are used, and the reduction in wattage realized by the installation of the CFL. Through the implementation of a telephone survey of program participants[2], it was determined that installation rates and bulb usage vary only by the number of CFLs given away by the program. As expected, the higher the number of CFLs provided per household the lower the overall installation rates and average hours of usage. This effect arises because (1) participants who received CFLs for free have less incentive to install all the bulbs and will likely remove them if they aren't completely satisfied with their performance, and (2) there are only so many high use fixtures in a home, and one or more CFLs may be installed in relatively low-use fixtures. The Reduced Price Programs, which provided discounts for as many CFLs as the customer desired to purchase, were not as adversely affected by declining installation rates and hours of usage per CFL since customers shared the cost and selected the style and size of CFLs and thus may have been more likely to install them and put them in higher use fixtures.

Bulb wattage reduction was not examined directly through the consumer survey, but the type of bulb that the program CFL replaced was assessed. It is usually assumed that a program CFL will replace an incandescent or halogen bulb. The survey results provide evidence that a small but significant group of program participants are replacing existing CFLs with new CFLs.

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[1] For example, energy efficiency rebate programs generally attract homeowners with access to sufficient capital. Audit programs also tend to appeal more to homeowners than to renters, and to those who are relatively less time-constrained, such as senior citizens.

[2] We surveyed a random sample of 201 California residents for each CFL program delivery mechanism, 67 in each electric IOU service territory, for a total of just over 800 surveys.

Installation Rates

Table 2 presents installation rates by program delivery mechanism, as determined using self-reported survey data.[3] The Targeted Event Giveaway delivery mechanism programs achieved the highest installation rate (93%), most likely because only one CFL was given away. The Reduced Price Program approach achieved a relatively high installation rate (90%), considering that on average six discounted CFLs were purchased per participant. Programs that gave away more than one CFL per resident, the Leveraging Other Programs and Door-to-Door Giveaway delivery mechanisms, achieved a much lower overall installation rate (77%).

Table 2. Installation Rates by Delivery Mechanism

Delivery Mechanism	# CFLs Provided	Installation Rate
Targeted Event Giveaway	1	93%
Door-to-Door Giveaway	4	77%
Leveraging Other Programs	5	77%
Reduced Price Programs	6[1]	90%

[1]Average number of discounted CFLs purchased over all utility reduced price CFL programs

Figures 1 and 2 illustrate that the decline in installation rates as the number of subsidized CFLs increases is much more gradual when the participant shares in the cost and may choose the style and size of the CFL. Figure 1 shows installation rates for the Door-to-Door Giveaway program, where four CFLs were given away per participant, and the Leveraging program, where five CFLs were given away per participant. The first bar shows the percentage of participants who installed at least one CFL, the second bar the percentage who installed at least two CFLs, while the last bar shows the percentage who installed ***all*** CFLs. For both programs, 62 percent of participants installed all of the free CFLs they received through participating in the program.

Figure 2 shows installation rates on a per bulb basis for the Reduced Price Program delivery mechanism. The first four bars show the percentage of participants who installed one or more, two or more, three or more, and four or more of the reduced CFLs that they purchased.[4] The final bar in the figure illustrates the percentage that installed ***all*** of the CFLs that they purchased. Recall that six reduced price CFLs were purchased on average. Overall, 81 percent of Reduced Price Program participants installed all of the CFLs that they purchased.

[3] It is likely that, for a number of reasons, survey respondents over-reported installation rates. However, for the purposes of this discussion we are only concerned with the relative hours of usage across program delivery strategies. Thus, if we can assume that the extent of over-reporting does not differ across delivery mechanisms, over-reporting does not affect the findings.

[4] Note that for the "2 or more", "3 or more", and "4 or more" bars, the denominator includes only those participants who bought at least two, three, and four CFLs, respectively. However, the final bar, "all CFLs purchased", includes all participants.

Figure 1. Percentage of Door-to-Door Giveaway and Leveraging Program Participants who Installed 1 or more, 2 or more, … and All of the CFLs That They *Were Given*

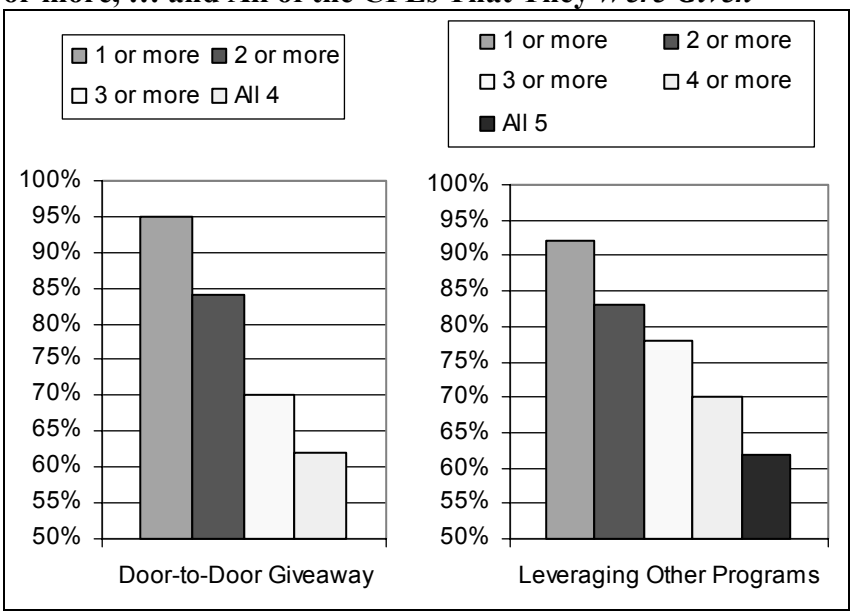
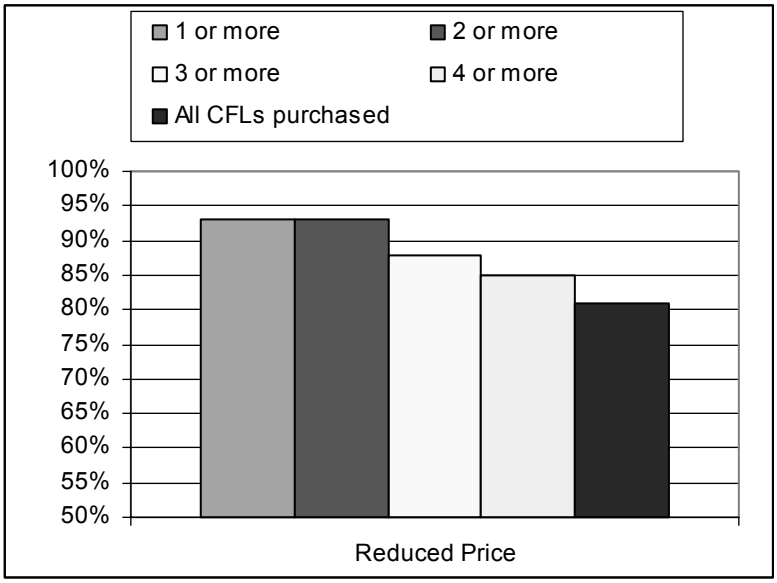


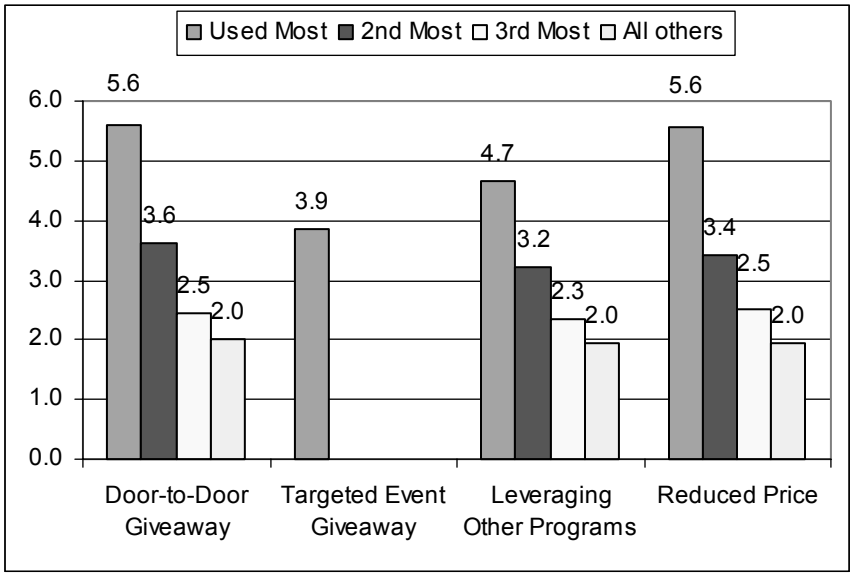
Figure 2. Percentage of Reduced Price Program Participants who Installed 1 or more, 2 or more, … and All of the CFLs That *They Purchased*



Hours of Usage

Of all program CFLs installed, participants use the bulbs on average between three and four hours per day, according to self-reported survey results.[5] Figure 3 illustrates the decline in the average usage of CFLs as the number of program CFLs installed in the home increases. This decline in hours of usage per bulb illustrates the effect of installing the first CFL in the most-used fixture, the second CFL in the next most-used fixture, and so on.

Figure 3. Average Hours of Usage Per Day By Bulb



Type of Bulb Program Bulbs Replaced

Program planners generally assume that when a free or partially subsidized CFL is provided through a program, that the participant replaces an older, less-efficient bulb (usually an incandescent bulb). It was found that a significant portion of 2001 CFL program participants (17%) replaced at least one CFL upon installing new program CFLs. On average, about ten percent of program CFLs replaced existing CFLs. Existing CFLs were replaced more frequently (15% of the time) when participants received CFLs for free, and less frequently (8% of the time) when participants shared in the cost of the CFL. This result may reflect the probability that residents who participated in the giveaway programs were "self-selectors" who were more likely to have participated in a CFL program in the past. Furthermore, the giveaway programs targeted segments that have been targeted in the past with CFLs, such as senior citizens and low-income households. The Reduced Price Programs were not perceived as an actual "program" by participants and did not require any extra effort on the consumer's part, and as such attracted a broader segment of the

[5] It is likely that, for a number of reasons, survey respondents over-reported hours of usage. However, for the purposes of this discussion we are only concerned with the relative hours of usage across program delivery strategies. Thus, if we can assume that the extent of over-reporting does not differ across delivery mechanisms, over-reporting does not affect the findings.

population, which may have been less likely to have participated in CFL programs in the past.

Conclusions

In 2001, an unprecedented effort was undertaken in California to deliver energy-saving measures to residents. Utilities and other organizations developed large-scale CFL programs in response to the energy crisis (1) to reduce energy consumption and (2) to help mitigate the effects of higher utility bills for low-income households. The extent of the effort and the diverse strategies employed by program sponsors created a unique opportunity to examine the advantages and disadvantages of CFL program delivery mechanisms. Lessons learned will aid program planners and policymakers in the future.

The findings discussed in this paper address the following CFL program planning issues:

- Selecting the Most Effective Program Delivery Mechanism;
- Determining the Number of CFLs to Offer and the Subsidy Type; and
- Estimating Program Impacts.

Selecting the Most Effective Program Delivery Mechanism

The most effective strategy for delivering CFLs largely depends on a program's objectives. Table 5 presents a matrix of delivery mechanisms and their likely success at meeting a variety of potential program objectives. Note that one program alone is not effective in meeting all the possible program objectives. Selecting a delivery mechanism involves making trade-offs of potential objectives. Where possible, selecting a suite of programs utilizing more than one delivery strategy may be optimal for meeting several programmatic objectives at a reasonable cost.

Table 5. Comparison of Delivery Mechanisms and Potential Program Objectives

Delivery Mechanism	Target Market	Market Sustainability	Volume/Total Impacts	Cost Per CFL
Targeted Event Giveaway	very good	poor	low	high
Door-to-door giveaway	good	poor	high	moderate
Leveraging Existing Programs	poor	poor	low to medium	low
Reduced Price Programs	poor	good	high	low

For utilities and other energy efficiency program administrators that already offer energy efficiency programs for other measures besides CFLs, piggybacking on the existing program and adding a CFL incentive is a very cost-effective method for increasing the energy savings potential of existing programs. However, it is likely that such an approach would not reach a broad spectrum of residents.

A large-scale Reduced Price Program is a more effective strategy for reaching a broad segment of the target population. This delivery strategy also may lead to sustained market effects, such as an increase in the stock of CFLs by retailers and more prominent placement and promotion. However, this type of program is more suitable when undertaken on a relatively large-scale.

While a Reduced Price Program would likely attract participation among a broad segment of the population, often a program administrator seeks to target a specific group, such as low-income individuals. In this case, neither the piggyback nor Reduced Price Program approach would be effective. A targeted approach is more appropriate, which because of its nature often costs more per CFL delivered. However, the objective of serving a specific community may outweigh the higher costs associated with this type of approach.

The programs offered in California in 2001 that targeted specific groups were innovative in their outreach strategies. The large-scale giveaway effort, the State's Powerwalk program, capitalized on two factors to be able to reach almost a half a million low-income households with only moderate per unit costs. First, an agency and infrastructure already existed (the California Conservation Corps) that had the capability and expertise to cost-effectively reach a large volume of households widespread throughout the State. Second, low-income households (the target population) tend to be geographically condensed or clustered around certain neighborhoods that can be effectively targeted via canvassing efforts. This delivery strategy is an effective method for delivering a large volume of CFLs to low-income (or other such geographically clustered) households.

Smaller-scale targeted giveaway programs offered by the State's electric IOUs were equally innovative at capitalizing on existing infrastructure to locate the desired target audience, leveraging existing local ethnic, rural, and senior events.

In summary, program planners should consider the following recommendations when selecting CFL Program delivery mechanism(s):

- Implement a suite of CFL Programs in order to contain costs and meet a wider array of program objectives beyond achieving maximum energy savings.
- Piggyback on existing programs by offering a CFL incentive to expand their energy saving potential.
- When considering the feasibility of implementing a large-scale door-to-door giveaway program, examine the program area's existing infrastructure and how the target population is dispersed.
- If sufficient infrastructure is not in place and/or the targeted area is not geographically clustered, leverage existing events and gathering places to cost-effectively target distinct communities.

Determining the Number of CFLs to Offer and the Subsidy Type

Once the program delivery strategy has been selected, an important program design component to consider is the extent of the program offering. The programs discussed in this paper ranged from providing one free CFL per household to discounting an unlimited number of bulbs. As reported in the previous section, installation rates and usage tend to decline as the number of CFLs provided through the program increases. The tradeoff to

consider is the cost of reaching another household versus providing multiple CFLs to the household that has already been reached.

Table 6 provides a simplified analysis of the cost implications of delivering a varying number of CFLs per household for the major giveaway program that delivered multiple CFLs per household in California last year, the Powerwalk program. The analysis is simplified because it is assumed that administration and implementation costs are the same (while CFL costs vary) whether one or four CFLs are delivered per household, since in all four scenarios a total of 475,000 homes are being served. This is a reasonable assumption for the purposes of this discussion, given that the cost of reaching households was the most significant non-CFL cost of the Powerwalk program.

Table 6. Costs for Varying # CFLs Delivered for the Powerwalk Program

	Program Costs			Impacts	
# CFLs Delivered Per Household	**Cost Per CFL Delivered**	**Cost Per CFL Installed**	**Cost Per Annual KWh[1] Saved**	**Avg. Hrs. of Use/Day/ CFL**	**Installation Rate**
1	$ 16	$ 17	$ 0.18	5.6	95%
2	$ 11	$ 13	$ 0.18	4.3	84%
3	$ 10	$ 14	$ 0.24	3.5	70%
4	$ 9	$ 14	$ 0.29	2.9	62%

[1]Assumes that 45 watts are saved per CFL installed.

In the table, the cost per CFL *delivered* is calculated as the total program costs divided by the total number of CFLs distributed by the program. As mentioned above, program costs are assumed to vary only by the total cost of CFLs that are given away. The cost per CFL *installed* equals the cost per CFL delivered divided by the overall installation rate. The installation rate for each scenario is equal to the self-reported installation rates on a per bulb basis illustrated by Figure 1, Door-to-Door Giveaway. The cost per *annual kWh saved* is equal to the installation costs divided by the annual kWh savings, which is equal to the bulb wattage differential times the annual hours of usage. Hours of usage per bulb is equal to the self-reported hours of usage on a per bulb basis illustrated by Figure 3, Door-to-Door Giveaway.

If only the cost per CFL *delivered* was considered when determining cost-effectiveness, it would appear that delivering four (or more) CFLs per household would be the preferred approach. However, once declining installation rates and hours of usage are taken into account, it appears that giving out one to two CFLs per household may be a more cost-effective approach.

This analysis assumes that the program sought to achieve an equitable goal of serving a set number of households. Program planners should first determine equity versus energy savings priorities, and then weigh the incremental cost of delivering another CFL to the participant that has already been reached versus the cost of reaching another participant.

The cost per CFL *delivered* versus *installed* does not increase as dramatically for Reduced Price Programs as compared to the Powerwalk program. As mentioned previously,

the partial subsidy allows for the consumer to select the number, style, and size of CFLs that they plan to install, resulting in much higher overall installation rates (90% versus the Powerwalk's 77%), even with an average of six CFLs purchased.

Table 7 presents the delivery and installation costs per CFL for Reduced Price Programs. Both discount programs have a very low cost per unit installed as compared to Giveaway Programs. Note that the Point-of-Purchase rebate program resulted in a lower per unit cost than the manufacturer buydown programs. The scale of this program was much larger than the buy-down programs, contributing to a lower per unit cost.

Table 7. Costs for Reduced Price Programs

	Program Costs				Impacts		
Type of Rebate	**Avg # CFLs Purchased**	**Cost Per CFL Delivered**	**Cost Per CFL Installed**	**Cost Per Annual KWh[1] Saved**	**Avg. Hrs. of Use/Day/ CFL**	**Installation Rate**	**Volume of CFLs**
Manufacturer Buy-Down	6	$6-$7	$6-7	$ 0.12	3.4	90%	Medium
Point-of-Purchase	6	$3-$5	$3-$5	$ 0.07	3.4	90%	Large

[1]Assumes that 45 watts are saved per CFL installed.

In conclusion, when determining the number of CFLs to deliver and the type of subsidy, consider the following two findings:

- As the number of CFLs given away per participant increases, installation rates and hours of usage (i.e., per unit impacts) decline.
- Partially subsidized CFL programs allow for multiple CFLs per household to be delivered, but do not exhibit dramatic declines in per unit impacts.

A suggested approach for mitigating the effect of declining impacts while controlling the implementation costs of reaching residents is to give participants one to two free CFLs and provide discount coupons for additional CFLs. With this approach, the costs of reaching a target household or resident are justified in that the participant may install several CFLs as a result of the program. Impacts on a per CFL basis will be relatively high as well because only those that are most likely to install more than two CFLs will take the time to redeem the coupons.

Estimating Program Impacts

The number of households in California that use CFLs has increased over the years. In 1991, only around thirteen percent of households in the State had tried CFLs. As of November 2001, forty percent of households in California had installed CFLs in their homes. (XENERGY 2002) Within certain market segments that were heavily targeted by CFL programs last year, such as low-income households, one may find a very high percentage of households that are using CFLs. For instance, over ten percent of households living at 200 percent of federal poverty guidelines or less received CFLs through the Powerwalk program and the IOUs' Low Income Energy Efficiency programs last year.

As a result, future CFL programs, especially those targeting low-income households, will likely serve homes that already have CFLs installed. Two factors that may affect future CFL program impact assumptions are:

- Participants may replace an existing CFL when installing a program CFL, either because the existing CFL is old and in need of replacement, or because the newer CFL is of higher quality than the existing CFL.
- Participants may install program CFLs in relatively low-use fixtures if they already have CFLs installed in their highest use fixtures.

These two factors will affect potential program impacts in two ways. First, wattage savings may be overstated if it is assumed that each program CFL replaces an incandescent or halogen bulb. Second, hours of usage assumptions may be overstated if it is assumed that program CFLs are always installed in relatively high-use fixtures.

Further research should be conducted to better determine the extent to which program impacts may be affected by the increase in CFL usage,. A detailed on-site survey that explored bulb replacement among CFL program participants would refine bulb wattage assumptions. On-site metering of CFL usage among program participants is also recommended, allowing program planners to update their hours of usage assumptions.

In conclusion, examination of the major CFL programs offered in California provides insight into designing effective CFL programs in the future. Major recommendations are as follows:

- Program planners should consider implementing a suite of CFL programs if they seek to meet multiple objectives.
- When determining how many CFLs are provided and whether they are provided at no charge or a reduced price, program planners should consider that installation rates and hours of usage decline steadily as the number of CFLs given away per household increases.
- Finally, as more and more households in the State adopt CFLs, program planning impact estimates must account for the fact that CFLs may replace older, existing CFLs, and CFLs may increasingly be installed in relatively low-use fixtures.

Reference

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