Door-to-Door Compact Fluorescent Installations: The LADWP Pilot Program

Mark S. Shirilau, Aloha Systems, Inc.
Victor E. Espinosa, Jr., and George A. Kast, Los Angeles Department of Water and Power

The Los Angeles Department of Water and Power has an aggressive program, "A Better Idea," to install compact fluorescent lights in residences throughout the service territory. The program is based upon direct installation. A neighborhood is canvassed and appointments are set for an installation technician to visit within the week. The technician installs compact fluorescent lights where they are deemed appropriate, that is where they will fit, provide proper lighting, and be used for sufficiently long of a period to be cost-effective. Additional simple energy and water conservation measures such as low-flow showerheads may be installed at the same time.

Prior to opening up the program on a system-wide basis, a pilot phase of 8,000 customers was targeted. These customers were selected to represent a variety of the residential neighborhoods within the City of Los Angeles. Extensive studies were performed on the pilot phase.

This paper presents the results of the pilot phase studies, including information critical to energy savings calculations such as the size of incandescent lights replaced, the customer-reported hours of operation of the particular bulb replaced, and the numbers of bulbs placed in households. The study also reports marketing-oriented information such as customers' opinions toward compact fluorescents and energy conservation in general, their reasons for participation, and the relationship of such attitudes and opinions to demographic parameters such as income and house size.

The information gathered from this study is being used by the Department of Water and Power as it strategizes the major program and as it prepares evaluations of the program's affects on energy conservation and demand reduction. Since this information is perhaps the most comprehensive and recently available of its kind, it would also be useful to other utilities incorporating compact fluorescent lamps in their demand-side management efforts.

Introduction

The Los Angeles Department of Water and Power has undertaken an aggressive program to install energy- and water-saving devices in a large portion of its customer's homes. The program is based on a door-to-door campaign through which the program is made known to the customers and appointments for installations are set up. Actual installations typically take place within a day or two of initial contact.

The primary focal point of the program is giving away compact fluorescent light bulbs. A compact fluorescent bulb is installed by the representative in each place where the use of such a bulb is logical. The representatives verify that the bulbs will operate long enough to make them cost-effective. (This was generally determined at about 4 hours per day of operation, although not rigidly set, and the criteria were not discussed with the customers.) The installers also see that the bulbs are only given away for lamps in which they will fit and for which the electric requirements are appropriate. By relying on direct installation, there is greater assurance that bulbs given away will actually be installed and that they will be installed properly.

Other measures available from the field representatives are toilet bowl dye tests to check for leaking toilets, dams to reduce toilet water consumption, aerators for faucets, and low-flow showerheads. In addition, the representatives can also clean refrigerator coils to help save energy consumption.

A pilot test was conducted from August 5 to November 2, 1991. A total of 8,462 homes were visited for actual installation. The installations were done by two separate crews of DWP employees as well as crews from three separate vendors. Extensive research was done in conjunction with this pilot phase. This paper details some of the findings of this research. In this pilot phase, 21,650 compact fluorescent bulbs, 2,543 toilet bowl dams, 4,365 faucet aerators, and 3,195 low-flow shower heads were installed. In addition, 5,390 toilet dye tests were conducted and 3,283 refrigerators had their coils cleaned.

Quality and Customer Service

The different installation teams varied considerably in the number of measures installed per house. For example, the average number of lamps per house ranged from 2.92 for one of the DWP teams to 1.99 for one of the vendor teams. The vendors included two community-based organizations and one contractor. There were no specifically identifiable reasons for the differences in average bulb installations between the teams. Other services also varied from team to team.

Customer service is very important to a utility. The pilot phase survey ascertained the customers' opinions concerning the appearance and quality of the canvassing teams. A total of 3,185 follow-up interviews were conducted, either by telephone or in person. Of these persons, only 13, or 0.4%, responded that the canvassers and installers who had visited them were not polite, neat, and professional. The negative responses were distributed among the five teams. We can categorically conclude that all five teams presented themselves satisfactorily.

Customers were also given the opportunity to make general comments about the canvassers and installers. Very few made negative comments. The only significant error reported, and that one only once, was that an installer forgot to plug a refrigerator back in after cleaning the coils.

One of the main purposes of doing direct-installation was to ensure that the compact fluorescent lamps were installed properly in appropriate places. A total of 653 on-site follow-up visits were made, representing 1,858 installed lamps. Most of these follow-up surveys were completed within two weeks of the original installation. Only 13, or 0.7%, had been installed incorrectly. Nine gave inadequate light, two interfered with appliances, and two had "other" problems.

Energy Savings

The primary purpose of the project is to save energy. Since LADWP is a combined electricity-water utility, water-conservation measures were installed as well. The program design, implementation, and evaluation were conducted by the electric division of the utility, so no official water savings estimates were made.

Estimated energy savings are easily calculated from the data recorded. However, it must be carefully understood that a major component of these calculations--operation time of the lamps--was self-reported by the customers. When a customer said, for example, that a lamp operated an average of 4 hours per day, we had no other information to contradict that value and have, therefore, taken as just that--an average daily operation represent seven days a week, 365 days per year.

Although self-reported, the data do represent a very large sample (21,650 light bulbs). It should also be noted that they clearly do not represent the average light bulb, because compact fluorescents were only installed in those lamps with certain minimum operating times, typically at least four hours per day. Only through metered end-use research could we obtain more accurate data on the operations of such lamps. Until (if ever) such research is done, we will have to rely on the self-reported operating times in all of our energy and power calculations.

Residential lighting use follows some logical patterns. Lights are more often used during the night than during the day. Therefore, lights are operated for longer hours during the winter than during the summer. Furthermore, lights are operated more during the times when people are home. This could lead one to conclude that daytime use was very small. We must remember, however, that the customers to whom new lights were given do not represent the average customer. The Better Idea sample is biased toward those people who were home during the day to meet the canvassers and installers.

The lighting shift is so considerable, however, that we believed it best to allocate the annual savings through the months based upon both the amount of sunlight (which reduces lamp usage) and the number of days in the month. The total program at the 8,426 sites is estimated to save 1.95 GWh per year. Table 1 distributes this savings by month. The table also gives the multiplier that was used to calculate these monthly figures. This multiplier represents the portion of annual savings attributed to any given month. The sum of the multipliers over the twelve calendar months is 1.0000. Note that monthly savings are given in megawatt-hours (MWh) and the daily savings are in kilowatt-hours (kWh). All figures represent the total from the 21,650 lamps given away in the pilot test.

The calculation of the peak demand savings is based upon the September daily savings, because the LADWP system peak usually occurs on a hot day in September. It also must be based upon some assumed load profile. The

Table 1. Monthly Distribution of Savings

Month	Multiplier	MWh/mo	kWh/day
January	0.0968	188.7	6088
February	0.0826	161.0	5700
March	0.0866	168.8	5446
April	0.0789	153.8	5127
May	0.0764	149.0	4805
June	0.0690	134.5	4484
July	0.0733	142.9	4610
August	0.0784	152.9	4930
September	0.0808	157.5	5251
October	0.0886	172.7	5894
November	0.0907	176.8	5894
December	0.0979	190.9	6157
Annual	1.0000	1949.5/yr	5377/day

demand reduction in kilowatts is essentially the number of kilowatt-hours saved during the hour representing the system peak. If all hours are the same, i.e., a flat load profile, the kWh savings during the system peak hour would be 1/24 or 0.4167 of the daily savings. However, the load profile of one of these lamps is not likely to be flat, as lamps are used more often when (1) it is dark outside and (2) when occupants are both home and awake.

An exact load profile for these lamps is not available. However, an approximation can be gathered from some end-use research which Southern California Edison did on test homes. Figure 1 represents the aggregate average summer weekday whole-house load of the test homes with the air conditioner and refrigerator removed from the profile. The air conditioner and refrigerator are the two largest users in most residences. Furthermore, the air conditioner is highly temperature-dependent and tends to drive the profile even more disproportionately to the afternoon. The load profile of Figure 1, then, represents small appliances, lights, televisions, laundry equipment, and other end-uses. It shows a significant difference between the very early morning hours when most residents are asleep and the daytime and early evening hours. It is a fair (not perfect) representation of the compact fluorescent lamps in this test.

If we choose 2:30-3:30 p.m. as the system peak hour, we see that 0.047 of the daily energy is used during this hour. This is somewhat more than what would have been used if the load profile had been flat. The September daily energy use of the 21,650 bulbs is 5,251 kWh. Multiplying 5,251 by 0.047 shows that the expected coincident peak reduction of the bulbs is 247 kW.

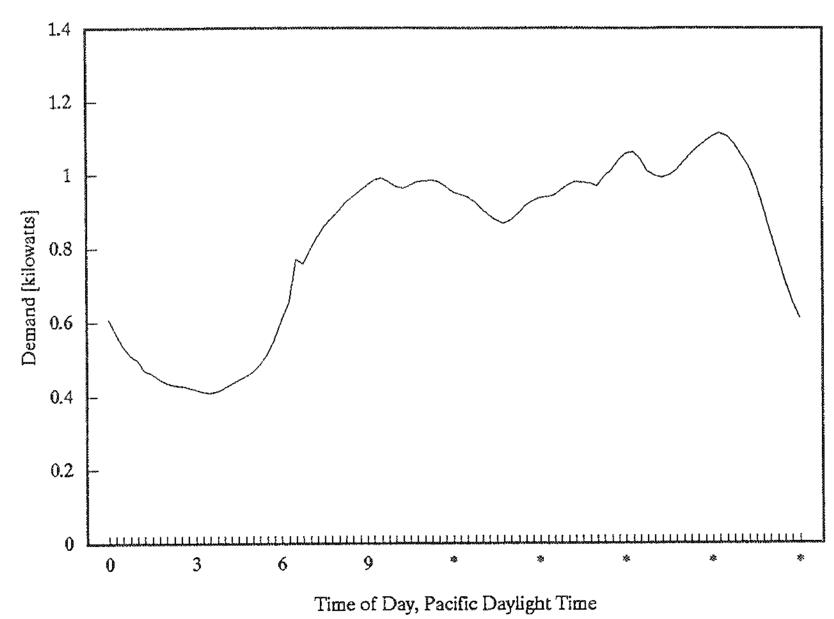

Figure 1. Summer Weekday Average Southern California House Minus Refrigerator and Air Conditioner

On a per-bulb basis, the energy savings was 90.0 kWh/yr and the coincident peak demand reduction was 11.4 watts. The average site had 2.57 lamps installed. Per-installation savings therefore was 231.3 kWh/yr with a coincident peak demand reduction of 29.3 watts.

Costs and Benefits

The program costs include (1) material costs for lamps and other items, (2) installation costs, and (3) administrative overhead costs. The benefits include (1) the energy and demand savings from the lamps, (2) the energy and demand savings from the refrigerator coil cleaning, (3) the water saving from the water measures installed, and (4) the energy savings associated with saving water.

The compact fluorescents were purchased for an average of $15.00 each. The vendor-supplied canvassing and installations were done by contract for the fixed price of $47.00 per site installation, regardless of how many bulbs were installed or how many houses were canvassed in order to get an actual installation. This figure, therefore, is the easiest to use for representing installation costs, as the actual costs of the DWP crews are much less easily determined, although they are known to be in this approximate range (one estimate used internally was $55.13 per site). The administrative costs will be ignored for now, as pilot program administrative costs are hardly representative of a fully operational program. Total costs per average household for lighting measures and installations are $85.55. (This is $47.00 for installation and 2.57 bulbs at $15.00 each.)

Assuming a compact fluorescent bulb lasts seven years, the average 2.57 bulbs in the average house will save 1619 kWh over the seven-year period. We can further assume that cleaning the average refrigerator coil saves 95 kWh during the first year, declining to zero after three years. (This value is derived from some Southern California Edison research in which the average refrigerator consumed 1,896 kWh per year and from the assumption that cleaning coils effected a 5% savings during the first year.) Because only 38.8% of houses visited actually had their refrigerator coils cleaned, coil cleaning adds another 73 kWh over the seven-year period ([95+63+31] x 0.388). The total seven-year energy savings per house from both compact fluorescent bulbs and cleaned refrigerator coils is 1692 kWh.

Participant Demographics, Beliefs, and Attitudes

Attitude Toward Energy Efficiency

Program participants were asked to indicate how their "general attitude toward energy-efficiency" was best described. The possible answers were (1) "It is good for the world and the environment"; (2) "It is a good way to save money"; (3) "We should do it because we are told to"; (4) "Convenience is sacrificed if I conserve"; and (5) "Indifferent."

"Good for the world and environment" was clearly the dominant choice, with 74.8% of the participants who answered the question choosing this response. Nearly all of the remaining participants (22.4%) chose the second option, "saving money."

A similar question asked "I would most likely purchase compact fluorescent lights because of ..." The possible responses were (1) energy savings, (2) environmental impact, (3) the quality of light they give, (4) being the latest technology, and (5) "other." Over 83% of the respondents who answered the question chose the first answer, "energy savings," while 10% chose the second, "environmental impact."

The exact meaning of "energy savings" was not defined. Although it clearly has financial overtones, it has environmental overtones as well. An unfortunate flaw in the survey for both of these questions is that the responses were kept in the same order on every questionnaire. It is almost certain that there is a bias toward the first answer, whatever that answer may be. It is uncertain how strong this bias is.

We have, however, demonstrated that the primary interest in conservation shifts from environmental to financial as the income of the household goes down. While 34% of respondents (who answered both the income and reason questions) in the "0 to $10,000 per year" category conserved because of saving money, 91% of respondents in the "over $75,000 per year" category conserved because of the environmental benefits. Figure 2 depicts this information.

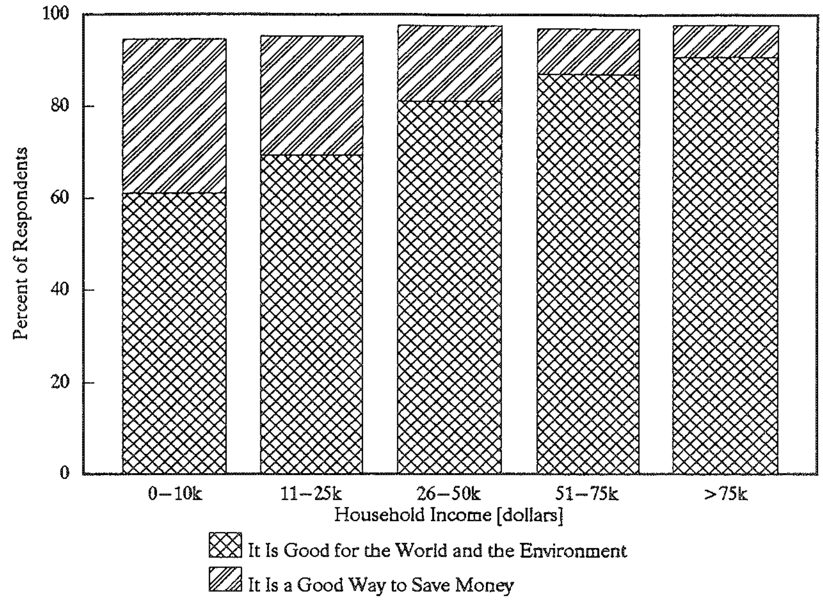

Figure 2. Reasons for Conserving Energy As a Function of Household Income

Familiarity with Compact Fluorescents

About two-thirds (65.4%) of the participants were not familiar with compact fluorescent bulbs prior to the Better Idea program. This was most true of persons with only an elementary school education (75.8%). Persons with college education were more likely to have heard about the bulbs, but the amount of college education was not correlated to familiarity.

Likewise, persons in middle and upper income categories were slightly more likely than low-income people to be familiar with the bulbs. Familiarity ranged from 43% for households earning over $75,000 to 27% for those earning less than $10,000.

Attitudes About the Program

The program was, in general, extremely well received by all participants. Satisfaction was high in all income, education, and house-size groups. Persons in all parts of the city and those served by each of the installation teams were all happy.

The only factor which bore any significant correlation to satisfaction was the number of bulbs installed in a given house. Those who received fewer bulbs reported lower satisfaction with the program. The reasons behind this are not entirely clear, but probably arise from a combination of two items.

First, installers had certain criteria for giving away bulbs. Those who received fewer bulbs probably had to be told one or more of their applications was not appropriate. They may have felt cheated, particularly if they knew how many lamps friends or neighbors received.

The other possibility is that some of these people were by nature difficult to please. It is possible that this attitude was apparent during the course of the house visit, and the installers were less likely to want to please someone who already had a poor attitude. In any case, however, those who were not pleased were clearly in the minority.

Other Demographic Observations

The data from these 8,426 houses supported many other demographic observations which are very intuitive. Of most significance to the program was the fact that larger homes were given more bulbs. This is essentially because they have more lamps which could be likely applications for a compact fluorescent bulb. Another interesting appliance observation which is rather intuitive is that refrigerator size is quite well correlated with house size.

Many commonly assumed hypotheses were validated by the data. Education, income, and house size are all related. Average household size varies among language groups. Household size decreases as education and income increase.

Bulb Replacement Statistics

Seven different sizes of compact fluorescent bulbs were included in the program. Table 2 presents a distribution of which size compact fluorescents were used to replace what size of incandescent bulb. Generally, larger compact fluorescents were used to replace larger incandescents.

Conclusion

The LADWP's "A Better Idea" Program was a tremendous success in the sight of the customers. Almost all of the participants were very pleased, both with the program and with the bulbs. It proved to be a very good educational tool as well, because nearly two-thirds of the people had been previously unaware of compact fluorescent bulbs.

Environmental concerns are apparently the most significant driving force in people's efforts to conserve. This is not entirely certain because of response order bias on the questionnaire, but it is probably safe to conclude that environmental concerns are more important than financial, especially for middle- and upper-income households.

The direct-installation program is marginally cost-effective from the purely economic view of demand-side management. However, when the benefits of customer relations and other aspects of the program are added, it is almost certainly a success.

Acknowledgments

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Reference

Quantum Consulting, Inc. *Residential Appliance End-Use Survey: Collection of Residential Appliance Time-of-Use Energy Load Profiles Interim Report*. Southern California Edison, 1989.

Table 2. Distribution of Compact Fluorescent Replacements

	Size of Incandescent Bulb Replaced					
Compact Size	0-40W	50-60W	65-75W	80-100W	>100W	Total
13W	475	3300	1589	667	85	6116
15W	42	171	49	28	2	292
18W	329	1266	2090	701	57	4443
20W	307	1039	1446	554	75	3421
22W	23	110	113	108	23	377
27W	88	377	555	3313	219	4552
28W	50	244	418	1644	93	2449
Total	1314	6507	6260	7015	554	21650