EVALUATION OF INFORMATIONAL CONSERVATION PROGRAMS FOR COMMERCIAL AND INDUSTRIAL CUSTOMERS

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ABSTRACT

Evaluations were conducted on two informational conservation programs for commercial and industrial customers. In both the Walk-Through Survey Program and the Energy Management Partnership Program, customers received a building energy survey, recommended energy conservation measures for increasing the building's energy efficiency, and estimated energy savings, costs, and payback periods for these measures. Major evaluation findings were:

- The programs increased conservation activities. Customers reported in telephone surveys that they took more conservation measures following program participation. The majority of the measures taken were with the lighting and heating, ventilating, and air conditioning systems.

- For the Walk-Through Survey Program, there were energy savings for large participants but not for small or medium ones. The average savings for the 115 program participants was 23,179 annual kilowatt-hours, a 6 percent pre- to post-program reduction. These savings are based on statistical comparisons of the pre- to post-program consumption change for small, medium, and large program participants with like groups of nonparticipants.

- The average energy savings for 18 Energy Management Partnership Program participants was 122,109 annual kilowatt-hours, a 2 percent pre- to post-program reduction. These savings were derived by statistically comparing each customer's pre- and post-program electrical consumption. In each analysis, the effects of weather variations, business activity level, new equipment purchases, and consumption trends were taken into account. In addition, the consumption for program participants was compared with the consumption for a group of nonparticipants.

- The programs were cost-effective. A net present value analysis showed that both programs were cost-effective from the viewpoints of the Pacific Northwest region and Seattle City Light.

These evaluations demonstrate reliable, economical energy savings for commercial and industrial customers who participate in informational conservation programs. They also illustrate key evaluation issues which are encountered in evaluating conservation programs for commercial and industrial customers. These issues include the usefulness of telephone interviews for administering questionnaires to customers and evaluation designs for the electrical energy savings analyses.

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INTRODUCTION

Electric utilities in the United States have emphasized informational and financial subsidy conservation programs for residential customers. For example, at Seattle City Light initial conservation efforts were informational with free energy audits for homes and advertising campaigns in which residential customers were exhorted to reduce their electricity consumption. Later the Home Energy Loan Program was begun in which customers were offered zero-interest loans for installing weatherization measures in their homes.

Researchers have shown considerable interest in evaluating the impact of these conservation programs on residential customers. A substantial body of literature has developed on the effect these programs have on customers' attitudes toward the programs (e.g., Olsen & Cluett, 1979) and energy savings (e.g., Hirst, White, & Goeltz, 1985; Weiss & Newcomb, 1982). Additional work has focused on the cost-effectiveness of the programs from the perspective of the society, the utility, and the customer (e.g., Weiss et al, 1983).

Electric utilities have also offered a variety of informational and financial subsidy conservation programs for commercial and industrial customers. For example, Seattle City Light provided building energy surveys to commercial and industrial customers through the Walk-Through Survey Program and the Energy Management Partnership Program. Seattle City Light will soon begin a financing program for these customers in cooperation with the Bonneville Power Administration. A three-year pilot program will be conducted in which financial incentives are made available to commercial customers for installing energy conservation measures in their buildings.

Although a variety of conservation programs exist for commercial and industrial customers, very little systematic work has been done on the impact of these programs on customers. Exceptions to this rule are recent evaluations of Southern California Edison's rebate program for commercial and industrial customers (Train, 1985; Train, Ignelzi, & Kumm, 1985) and the Commercial Building Energy Audit Loan Program (Miller et al, 1984).

At Seattle City Light two evaluations were conducted on informational conservation programs--the Walk-Through Survey Program and the Energy Management Partnership Program. The purpose of the present paper is to describe the methods and results for these evaluations. Specifically, information is presented on program impacts on the conservation measures taken by customers and on the customers' energy savings. The cost-effectiveness of each program is also presented.

Another purpose of this paper is to discuss several evaluation issues that arose during the course of the evaluations and how these issues were resolved. Issues discussed include the usefulness of telephone interviews for administering questionnaires to commercial and industrial customers and evaluation designs for analyzing energy savings for program participants.

Seattle City Light provided technical conservation assistance to each Energy Management Partnership Program participant over a six to twelve-month period. This assistance included developing an energy utilization index with the customer; conducting an energy audit in the facility; researching and identifying tuning, maintenance, operation, and retrofit measures that would aid the customer in reducing their energy usage; and providing estimates of costs, payback periods, and energy savings for these measures. The program was targeted at large commercial and industrial customers. Typically, customers in this program used more than 1,000,000 kilowatt-hours in a year.

In contrast to the six to twelve-month assistance provided to participants in the Energy Management Partnership Program, participants in the Walk-Through Survey Program received a onetime energy audit of the lighting, space heating, space cooling, hot water and other energy systems in their business facilities. They also received a letter from Seattle City Light which identified energy conservation measures that, if implemented, would reduce the facilities' energy consumption, and the potential costs, payback periods, and energy savings for these measures. The Walk-Through Survey Program was for smaller commercial and industrial customers whose annual electricity consumption was less than 1,000,000 kilowatt-hours.

ENERGY CONSERVATION MEASURES

A questionnaire on energy conservation measures taken by program participants was administered through telephone interviews. Although the telephone interview is somewhat costly and time-consuming, it has the advantage of overcoming customer resistance to completing mail surveys. This resistance exists in part because customers think that they fill out too many surveys and have busy schedules that cannot be altered for a survey.

The response rate for telephone interviews with commercial customers is substantially above that for mail surveys. For mail surveys at Seattle City Light the response rate has been between 40 and 50 percent (Coates, 1981; Coates, 1985). In contrast, the response rates for telephone interviews with customers in the Walk-Through Survey Program and the Energy Management Partnership Program were between 80 and 90 percent.

For the Walk-Through Survey Program telephone interviews were conducted with 115 commercial customers, 62 with program participants, and 53 with a sample of nonparticipants drawn from all of Seattle City Light's commercial customers. The participant and nonparticipant customers were stratified into subgroups on the basis of their annual electrical consumption. Small customers included all metered accounts with annual consumption below 40,000 kilowatt-hours, whereas large customers were above this consumption level.

Table I presents the mean number of conservation measures taken by participant and nonparticipant customers. Both large and small program participants were more conserving than their counterpart nonparticipants on the total number of electrical and nonelectrical measures. These differences were statistically significant. In addition, program participants took significantly more conservation measures after receiving conservation information from Walk-Through Survey Program staff. The energy conservation measures taken by customers were primarily with the lighting and space heating systems. A few actions were also taken with space cooling and hot water.

Telephone interviews were also conducted with 18 of the 20 customers who participated in the Energy Management Partnership Program between December 1979 and December 31, 1982. The number of electrical and nonelectrical measures taken by customers increased from the pre- to post-program period (means for electrical: pre-program = .43, post-program = 3.42; means for nonelectrical: pre-program = .32, post-program = 2.21). Separate t-tests for electrical and nonelectrical measures revealed that these increases were statistically significant.

Table I. Mean number of electrical and nonelectrical conservation measures for participant and nonparticipant customers.

	Electrical			Nonelectrical		
Group	Pre-Program	Post-Program	Total	Pre-Program	Post-Program	Total
Large Customers						
Participant (N=23)	.22	2.30	2.52	.26	2.09	2.35
Nonparticipant (N=23)	-	-	.79	-	-	.57
Small Customers						
Participant (N=17)	.12	2.00	2.12	.35	1.00	1.35
Nonparticipant (N=25)	-	-	.64	-	-	.24

Note: Dashes in the table indicate that no data were collected in the survey. The pre-program period is from June 1980 through May 1981 whereas the post-program period is from June 1981 through May 1982.

ENERGY SAVINGS

Walk-Through Survey Program

As described above, the evaluation design for the Walk-Through Survey Program consisted of participant and nonparticipant customers who were stratified into small and large consumer groups. Since a Mann-Whitney test showed that the pre-program electrical consumption for participant customers was significantly higher than the consumption for nonparticipants, the evaluation design was modified so that large customers were subdivided into large and medium subgroups. With this design the energy savings analysis consisted of statistically comparing the pre- to post-program electrical consumption change for large, medium, and small program participants with the consumption change for like groups of nonparticipants.

This evaluation design solved several problems that are encountered in assessing the impact of conservation programs on commercial customers' electricity consumption. First, there is considerable variability among these customers in electricity consumption. In order to reduce this consumption variability and thereby improve the energy savings estimates that can be attributed to the Walk-Through Survey Program, participant and nonparticipant subgroups were formed by dividing the customers on the basis of their electrical consumption during the preprogram period. Second, there are several nonprogram factors which complicate any energy savings analysis. These factors include variations in business activity level, changes in weather, remodeling of the business facility, new equipment purchases, and increases in the price charged for electricity. Each of these factors could be responsible for a decrease in electrical consumption from the pre- to the post-program period, a decrease that could be misinterpreted as "program energy savings." The use of a nonparticipant group in the evaluation design removes much of the impact of these nonprogram factors on electricity consumption. These factors are removed because they are likely to have an effect on both the participant and nonparticipant groups.

Table II shows the mean kilowatt-hour consumption for the participant and nonparticipant customers during the pre- and post-program periods. Electrical consumption for large participant customers decreased from the pre- to post-program period whereas the consumption for large nonparticipants increased over this time period. A Mann-Whitney test revealed a statistically significant difference between the two groups in their pre- to post-program consumption change scores.

Table II also shows that the electrical consumption for small and medium-sized customers increased from the pre- to post-program period. Mann-Whitney tests were performed comparing small and medium-sized participant customers with like groups of nonparticipants on their pre- to post-program consumption change scores. These tests revealed nonsignificant differences between the participant and nonparticipant groups.

Energy savings for large program participants were calculated by subtracting the percentage consumption change scores for large participant

and nonparticipant customers and multiplying by the participants' pre-program electrical consumption. This energy savings figure was then adjusted to an annual energy savings for all program participants. With these calculations, the mean annual energy savings for each of the 115 program participants was 23,179 annual kilowatt-hours. These savings are a 6 percent reduction in electrical consumption from the pre- to the post-program period.

Table II. Mean kilowatt-hour consumption for participant and nonparticipant customers during the pre- and post-program periods.

Group	Pre-Program Period	Post-Program Period	Difference
Program Participants			
Large consumers (N=46)	269,549	265,824	-3,725
Medium consumers (N=47)	28,288	29,169	+881
Small consumers (N=94)	4,280	4,419	+139
Program Nonparticipants			
Large consumers (N=167)	470,260	495,702	+25,442
Medium consumers (N=168)	56,789	58,576	+1,787
Small consumers (N=356)	10,575	10,604	+29

Note: N refers to the number of metered accounts in Seattle City Light's Customer Information Service system. The consumption for nonparticipant customers covers the 12-month period before and after June 1, 1981, whereas participant consumption is based only on comparable portions of these time periods. For example, consumption for a customer who received their energy audit in December 1981 would be collected for January-May 1981 and January-May 1982.

Energy Management Partnership Program

As described earlier, there are several factors which complicate any consumption analysis for commercial and industrial customers, including variations in business activity level, weather, remodeling of the business facility, and new equipment purchases. Two approaches were used in this evaluation to ensure that any pre- to post-program declines in electrical consumption were due to the customers' participation in the Energy Management Partnership Program rather than to these factors. The first approach was to directly control for the influence of weather variations and the pre-program trend on the customer's electrical consumption. This control was achieved by including both of these factors in a multiple regression analysis on each

customer's electrical consumption. The regression analysis also included two dummy variables. The firt variable was for program participation (zero for months prior to participation, one for months following participation). The second variable, which was included in the analyses for 5 of the 18 customers, was for the customers' business activity level, new equipment purchases, or facility remodeling.

Information on the customers' business activity level, new equipment purchases, and facility remodeling was obtained in the telephone survey. The measure of weather variations was heating degree days. Trend is the overall upward or downward movement of the customers' electrical consumption during the pre-program period. For example, a customer might have a steady month-to-month increase in electrical consumption during the pre-program period.

Since customers could enter the program at any time, the pre-program consumption for the 18 customers ranged from 16 to 51 months, and the post-program consumption ranged from 5 to 46 months. A total of 56 months of consumption was available for each customer. Table III presents the mean monthly kilowatt-hour consumption for participant customers during the pre-program period and their pre- to post-program consumption change. When the influences of heating degree days, pre-program trend, and business activity level/new equipment purchases were held constant in the multiple regression analysis for each customer, 7 of 18 customers experienced a statistically significant pre- to post-program consumption decline. In addition, two customers significantly increased their electrical consumption from the pre- to post-program period. These increases cannot be explained by survey data on changes in the customers' business activity level or new equipment purchases during the post-program period.

The multiple regression analyses also showed that heating degree days were an important influence on the electrical consumption for program participants. The heating degree variable was statistically significant for 13 customers with 9 of the 13 customers having higher electrical consumption during colder weather. In contrast, pre-program trend and business activity level/new equipment purchases were of negligible importance in the customers' electrical consumption. Trend was statistically significant for three customers with the consumption for each customer declining across the pre-program period. New equipment purchases were associated with higher consumption for one customer.

In the multiple regresson analysis for each program participant, R^2 was calculated on the relationship of program participation, pre-program trend, heating degree days, and, when appropriate, business activity level/new equipment purchases with electrical consumption. The R^2 values for participants ranged from .10 to .91 with a median value of .58. The R^2 values thus show a moderate, positive relationship between the independent variables and participants' electrical consumption.

Table III. Monthly pre- and post-program electrical consumption and annual energy savings for program participants.

Customer	Mean Monthly Kilowatt-Hour Consumption Pre-Program Period	Mean Pre- to Post-Program Consumption Change		Annual Kilowatt-Hour Energy Savings
		Kilowatt-Hour/Month	Percent	
A	185255	- 35410	-19.11*	- 428220
B	247248	- 10477	- 4.23*	- 132924
C	240090	- 7409	- 3.09*	- 96228
D	58842	+ 1088	+ 1.85	+ 11292
E	342582	+ 15509	+ 4.53	+ 175956
F	1257170	+ 43416	+ 3.45	+ 482748
G	653634	- 70627	-10.81*	-1140456
H	199980	+ 9659	+ 4.83	+ 26400
I	75794	+ 3486	+ 4.60	- 7908
J	3329	+ 388	+11.66*	+ 3168
K	81285	- 13869	-17.06*	- 242338
L	83800	- 6934	- 8.96*	- 168444
M	232468	- 484	- .21	- 223164
N	4483315	+120649	+ 2.69	-2743788
O	880000	+118263	+13.44*	+ 586080
P	34572	+ 7824	+22.63	+ 61560
Q	216309	- 29840	-13.80*	- 578604
R	991425	- 9475	- .95	-1120704
S	65211	0	0	- 66276

Note: The asterisk (*) in the table indicates that the pre- to post-program consumption change for the customer was statistically significant at the .05 level.

With the multiple regression analysis, a preliminary energy savings (or lack of savings) figure is produced for each program participant. To further ensure that these savings were due to customer participation in the Energy Management Partnership Program, the savings were adjusted against the electrical consumption for a control group consisting of all commercial customers who did not participate in the program. This adjustment rules out the possibility that the energy savings were due to factors, such as Seattle

City Light rate increases, that were not controlled in the multiple regression analyses. Four regression analyses were conducted on the nonparticipants' electrical consumption, with the pre- and post-program analysis periods corresponding to analysis periods for program participants. Variables in the analyses were heating degree days, pre-program trend, and a pseudo dummy variable for program participation. Consistent results were obtained in the analyses. For each analysis, more heating degree days were associated beyond a chance level with greater electrical consumption, whereas pre-program trend was not. In three of the four analyses, there was also a statistically significant increase from the pre- to post-program period. In percentage terms, these increases were .25, 3.73, 7.79 and 8.47 percent.

The next step in the analysis was to apply the percentage increase in the nonparticipants' pre- to post-program consumption to the participants' monthly energy savings. The percentages applied to each customers' energy savings (or lack of savings were): customers A through F, .25 percent; G through J, 3.73 percent; K through P, 7.79 percent; Q through S, 8.47 percent. This procedure resulted in adjusted pre- to post-program kilowatt-hour consumption change scores for each customer. These scores were then converted to an annual savings figure by simply multiplying the monthly energy savings by 12. With these adjustments, the average annual savings for all program participants was 122,109 kilowatt-hours, a 2 percent reduction from the pre- to post-program period. These program savings are based on the nine customers for which the multiple regression analysis had shown a pre- to post-program consumption decrease (increase) that was beyond a chance level. These nine customers are customers A, B, C, G, J, K, L, O, and Q in Table III.

COST-EFFECTIVENESS

One important measure of a program's success is the cost-effectiveness of the electricity savings. Cost-effectiveness analyses were conducted for both programs. In each analysis, a net present value was calculated by comparing the program's costs and benefits over the lifetime of the energy conservation measures that were installed in the customers' facilities. The average life of the installed conservation measures was assumed to be ten years.

The net present values were calculated from two perspectives; the Pacific Northwest region and Seattle City Light. From the regional perspective, the value of the electricity savings is based on the cost of energy obtained from gas turbines and a coal plant. To Seattle City Light, the value of the energy savings is based on the cost of electricity from a gas turbine and the Bonneville Power Administration, minus customer revenue valued at customer rates. The costs to the region include program operation costs and the conservation measures costs. Since the financing of conservation measures is the customers' responsibility, the utility costs are only for program administration.

Table IV presents the net present value per program participant from the perspectives of the Pacific Northwest region and Seattle City Light. As

shown in this table, both programs were cost-effective from these two viewpoints. These economic analysis results show that the electricity saved through the two programs is less costly than energy produced through thermal generation, the marginal cost of energy to the region, or through the combined cost of power purchased from the Bonneville Power Administration supplemented by a gas turbine to meet peak demand, the marginal cost of electricity to Seattle City Light.

Customers who participate in informational conservation programs must pay for the conservation measures that they install in their buildings. With the customer bearing the cost of the conservation measures, positive net present values to the utility were found for the two informational programs. In contrast, for financial subsidy programs the utility must bear the costs for program administration and the conservation measures. Research is needed on financial subsidy programs to determine whether these programs are cost effective to the utility.

TABLE IV. Net present value per program participant from two perspectives (1982 dollars).

	Region	Utility
Walk-Through Survey Program		
Present value of benefits	$11,694	$ 3,102
Present value of costs	-2,927	-1,242
Net present value	$ 8,767	$ 1,860
Energy Management Partnership Program		
Present value of benefits	$72,908	$19,445
Present value of costs	-24,512	-8,172
Net present value	$48,396	$11,273

CONCLUSION

It was found in two evaluations that informational conservation programs can provide reliable, economical energy savings for commercial and industrial customers. The average annual energy savings for Walk-Through Survey Program participants was 23,179 kilowatt-hours, a 6 percent reduction from the pre- to post-program period. In the more comprehensive Energy Management Partnership Program the average savings was 122,109 kilowatt-hours, a 2 percent pre- to post-program reduction. These energy savings results are supported by customer surveys of the conservation measures taken in their buildings. Customers in both programs took more conservation measures

following program participation. It was also found that both programs were cost-effective from the viewpoints of the Pacific Northwest region and Seattle City Light.

Several evaluation issues were discussed in this paper. These issues include the resistance of commercial and industrial customers to completing questionnaires and appropriate evaluation designs for the energy savings analyses. The successful resolution of these issues was critical in increasing the customer response rate for the questionnaires and producing credible estimates of the electrical energy saved by program participants.

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