Evaluation of Boston Edison's Small Commercial and Industrial Retrofit Program

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The paper presents the results of an integrated process and impact evaluation of Boston Edison Company's Small Commercial and Industrial Retrofit Program. The program offers a range of energy efficient lighting, cooling, heating, and other measures to existing commercial and industrial customers with maximum monthly peak demands of less than 150 kW. The primary objectives of the evaluation were (1) to determine and document the program's successes and potential improvements, and (2) to estimate electricity savings attributable to the program.

The impact evaluation estimated the average monthly energy savings from the 1990 and 1991 programs. The average monthly savings were estimated by means of a series of bill analyses of the changes in monthly electricity consumption of small commercial/industrial customers for the periods before and after their participation in the program. The analysis found that the average monthly change in consumption for 1990 participants was -469 kWh, and for 1991 participants it was -474 kWh. These are 80% and 31% of the engineering estimates of savings for each year, respectively.

The process evaluation found that the Small C&I Program has been successfully implemented: customers are satisfied with the program; BECo staff and contractor staff are enthusiastic and cooperative; and independent contractors are willing partners in the program process. The BECo Small C & I Program has gone through a variety of transitions before reaching the stage examined in the evaluation. However, in many ways, the program is still in a formative state. There are ongoing modifications to ensure improved service to customers. The changes envisioned for 1992 are expected to ameliorate some of the current limitations of the program and, because the program is still in its early years, there are several excellent opportunities for continued program optimization.

Introduction

Boston Edison Company (BECo or the Company) is an investor-owned electric utility serving 650,000 customers in the greater Boston area. The Company began implementing its Small Commercial and Industrial (C & I) Retrofit Program in 1990 to achieve cost-effective electricity savings. The program design resulted from the Company's collaborative agreement with several non-utility parties.

The following describes the impact and process evaluation of the Small C & I Retrofit Program after two years of program implementation.

Program Description

The program targets approximately 76,000 existing commercial and industrial customers each with a maximum monthly peak demand of less than 150 kW. The program targets all business types and attempts to focus primarily on those customers who do not frequently remodel.

The program design addresses participation barriers and the specific needs of small commercial and industrial customers. Customers in this target market often lease facilities and lack the financial motivation to overcome the first-cost barriers associated with energy efficiency improvements. In addition, these small customers generally do not have the technical staff to identify and manage energy efficient retrofits projects on their own.

Initially the program primarily offered lighting retrofits. Over the first two years of implementation, however, the program evolved into a very comprehensive utility demand-side management (DSM) program offering a wide range of lighting, heating, cooling, water heating, refrigeration and cooking electric efficiency measures.

Boston Edison Company promotes its Small C & I Retrofit program by initiating contact with customers. Marketing methods include mailings, cold calls, visits, word-of-mouth and community "energy days." The utility identifies cost-effective electric savings measures at customer facilities and arranges for installation of these measures at no cost to the customers. The qualifying measures are based on a list of prescribed measures tested for cost-effective applications during individual customer facility audits.

In addition, customers may submit their own proposals to BECo recommending the installation of energy efficiency measures. These customer-generated proposals are screened by the Company, and cost-effective measures are installed by a contractor selected by the customer at no cost to the customer.

The program components include marketing, site-specific audit and measure analysis, measure installation, installation verification and quality control, operations and maintenance assistance, and technical training of trade allies, as well as program evaluation.

After two years of program implementation, over 1500 customers have participated in the Company's Small C & I Retrofit program. The Company conducted a comprehensive evaluation at that point in time.

Evaluation Objectives and Tasks

The primary objectives of the evaluation were (1) to determine and document the program's successes and potential improvements, and (2) to estimate electricity savings attributable to the program.

The evaluation consisted of both an impact and a process evaluation. There were four major tasks performed: (1) an impact evaluation for 1990 and 1991, including estimation of gross and net energy (kWh) and demand (kW) program savings, (2) a process evaluation, including examination of program promotion, delivery and administration, (3) a program optimization study, including participant site visits to ascertain implementation quality, comprehensiveness, remaining resource and new opportunities, and (4) a program database review, including an analysis of database contents, quality control and general tracking effectiveness.

Due to regulatory filing requirements, Boston Edison needed to obtain results from the evaluation in early 1992. This schedule required the evaluation team to develop preliminary estimates of the 1991 program impacts before a full year of post installation consumption data were available. A preliminary 1991 impact evaluation was conducted on a limited series of billing data to meet the regulatory needs with an analysis on complete data scheduled for late 1992. As a consequence, the 1991 impact evaluation results should be considered preliminary and subject to revision after the final analysis is completed.

Evaluation Design

The evaluation was designed to maximize its usefulness by integrating all of the evaluation tasks. Multiple types of data were collected and analyzed by quantitative and qualitative techniques. The results of one analysis were typically utilized for more than one task. Thus, the data analysis and results were integrated throughout the evaluation study.

Data collected during this evaluation included telephone surveys of a sample of three hundred participating customers and three hundred non-participating customers. Non-participants were identified as those demanding less than 150 kW with a commercial/industrial rate. The sample of non-participants were selected from the utility's customer billing files. Data were also collected by in-person interviews with utility and installation contractor staffs and non-utility parties, a focus group and a survey of trade allies (electrical and HVAC contractors). On-site inspections of a sample of thirty participant facilities were also performed.

A thirty month period of customer billing data served as the basis for billing, regression and conditional demand analyses. A pre and post billing analysis with participants and a comparison group of non-participants proved most useful at this stage in the program's implementation and evaluation. The program database was also used to perform implementation analyses on 1990 and 1991 participants as part of this evaluation.

In addition, several other existing sources of data were utilized in this evaluation. The Company's on-going load research studies provided hourly load shape information representing the market of small commercial and industrial customers. BECo's latest C & I Customer Survey provided information on the average small commercial and industrial customers' business and energy usage characteristics.

The sections following the impact evaluation discuss how process evaluation analyses provided opportunities to explain unexpected impact results.

Impact Analysis

The impact evaluation estimated the average monthly energy savings from the 1990 and 1991 programs. The average monthly savings were estimated by means of a series of bill analyses of the changes in monthly electricity consumption of small commercial/industrial customers for the periods before and after their participation in the program.

Specification of Comparison Sample

The billing analysis requires data for a comparison sample of nonparticipants to provide baseline values against which to compare the changes by participants. The comparison sample was drawn at random from Boston Edison's billing system among customers with continuous consumption data since the beginning of 1989.

The average annual consumption of 1990 participants during the year immediately preceding the installation of measures was almost 105,000 kWh. The average for 1991 program participants was over 112,000 kWh. These compare to the average of slightly more than 50,000 kWh for the comparison sample during 1989. Clearly, the participants in both years are considerably larger in terms of electricity consumption, on average, than the typical customer in this program's target market (of those less than 150 kW).

The participant and comparison samples were stratified by pre-installation consumption as required for the billing analysis. The objective of the stratification is to group the participants into relatively homogeneous groups with respect to the pre-participation consumption variables so that year-to-year changes in energy consumption can be compared to those of nonparticipants with similar characteristics. The variables used for stratification were:

- Annual Electricity Consumption. For the participants, this was computed for the twelve months preceding program participation. For the comparison group, the annual consumption was estimated for the calendar year 1989.[1]

- Seasonality of electricity consumption. This was defined as the ratio of average monthly use during the summer versus the off season (spring/fall) period.

The overall distributions of 1990 and 1991 participants are significantly different from that of the nonparticipants. The seasonality of electricity use by participants is slightly lower than that of the average comparison group of nonparticipant customers. The percentage of participants in both 1990 and 1991 with annual consumption over 250,000 kWh per year is almost three times that of the comparison group. At the opposite extreme, almost half of the comparison customers used less than 15,000 kWh per year, while less than 30% of 1990 participants fall in these strata, and only 17% of the 1991 participants used less than 15,000 kWh.

These differences in the size distribution of participant and comparison customers affect the net impacts significantly. To account for this in the billing analysis, the nonparticipant observations are reweighted so that its distribution matches that of the participant sample each year. For example, for the distribution discussed above, in the 1991 comparisons the changes in consumption for large nonparticipant customers are given a weight of three times their proportion in the comparison sample, and the small comparison customers are reweighted to a third.

Billing Analysis of 1990 Program

The billing analysis for the 1990 participants was performed on monthly consumption data for the twenty month period spanning February 1990 through September of 1991. If a customer participated in July 1990, then the year-to-year changes would be calculated for August 1990 versus August 1989 and following months up to the period where the lagged consumption (i.e., 1989) immediately preceded the installations.

The analysis covered twenty months because 1990 program participants installed measures at different times throughout 1990. For a customer who participated in January 1990, the year-to-year monthly changes were computed for February 1990 forward. For a customer who participated in August, the changes were computed for the months starting with September 1990.

The results of the billing analysis for both 1990 and 1991 are summarized in Table 1. The gross average monthly change after participation for the twenty month period from February 1990 through September 1991 was -469 kWh. This represents the entire 1990 participant population for which the necessary billing data were available for analysis.

The average gross monthly change per customer in the comparison sample was -88 kWh over the same period. The standard error of this estimate is approximately 12.

The billing based estimates compare to the engineering estimate of approximately 600 kWh for average monthly savings. The average gross change based on the billing data is within 80% of the engineering figure.

Table 1. Net and Gross Average Monthly Energy Savings by Stratum

Participants Stratum by:			1990 Average Monthly Gross Change			1991 Average Monthly Gross Change		
#	Annual Use	Seasonality	Per Participant (kWh)	Per Nonparticipant (kWh)	Net Monthly Savings Per Participant (kWh)	Per Participant (kWh)	Per Nonparticipant (kWh)	Net Monthly Savings Per Participant (kWh)
1	0-15 MWh	1	(25)	(17)		(144)	(22)	
2		2	(8)	4		(163)	17	
3	15-45 MWh	1	(218)	(66)		(123)	(87)	
4		2	(95)	12		(165)	79	
5	45-100 MWh	1	(272)	(164)		(513)	(178)	
6		2	(72)	(40)		(166)	113	
7	100-250 MWh	1	(986)	(452)		(354)	(525)	
8		2	(700)	(37)		(576)	162	
9	+250 MWh	1	(3,215)	(1,587)		(2,039)	(2,131)	
10		2	(241)	(529)		(1,622)	(382)	
All			(469)	(88)	(262)	(474)	(83)	(241)

Note:
(1) Summer categories include summer to off-season use, where the category is (1) if the ratio was less than 1.15; and, (2) if the ratio was greater or equal to 1.15. Summer months are defined as June through September. Off-season months are defined as April, May, October, November.
(2) The monthly gross and net changes by stratum for 1990 are based on 20 months of consumption data (February 1990 to September 1991). For 1991, the gross and net changes are based on only 8 months of consumption data (February to September 1991).
(3) Parenthesis indicate a negative number.

The estimate of net savings is considerably lower. The estimated net savings was 262 kWh per month over the twenty month period covered by the evaluation. This implies that nonparticipants of comparable size were reducing their electricity consumption considerably at the same time that participants were realizing the savings from the program and other factors. The analysis of the 1991 program found a similar pattern.

Billing Analysis of 1991 Program

The preliminary estimates of the 1991 program impact on electricity sales by participants in 1991 were based on data for the changes in consumption for the calendar months of February through the end of September in 1991 versus 1990. The average gross change in electricity consumption before and after the installation of measures for 1991 participant was -474 kWh per month. This represents the average year-to-year changes in the monthly bills of participants during the period between February and September and after the completion of the installation of measures under the program. It is simply the sum of the changes from the pre-installation period for each monthly participant observation divided by the total number of post installation billing observations in the eight month period.

The gross change per customer from the bill comparisons (-474 kWh/month) is approximately 31% of the engineering estimates of average monthly measure savings per customer (-1,557 kWh/month) based on the information in the program database. However, it is almost 10% higher than the projected savings per participant in Boston Edison's program plan (-436 kWh/month).

The average gross year-to-year change for nonparticipants over the period from February through September 1991 was -83 kWh per month. This is based on the sample of monthly bills of nonparticipants. The changes by stratum are shown in Table 1. The average changes per customer are small in the lower strata (those with annual consumption less than 45,000 kWh), but they are larger for customers in some of the higher strata. Since the relative proportion of participants is small in the lower strata and large in the higher strata, these changes are reweighted significantly in the estimation of the net program impacts so that the energy usage characteristics of participants represents those of the comparison nonparticipants.

The overall average net savings, representing the average change per participant less the average change per nonparticipant by stratum, with each stratum average weighted by the distribution of pre-installation sales to

participants through September 1991, was 241 kWh per month.

Discussion of Gross and Net Billing Versus Engineering Estimates

The estimates of net savings imply that nonparticipants were reducing their electricity consumption significantly over the same period that participants realized savings from the program measures. Survey results will be used to investigate the causes of these reductions in detail once a full year of billing data are available. The estimate of total change in consumption before and after the program treatment is heavily weighted by consumption data during the summer months. Seasonal variations in the program impacts are reflected in the estimates. In the case of the Boston Edison program where most measures affect lighting, the seasonal patterns of lighting use would strongly influence the billing estimates. If lighting is used less than average during the summer because of the longer daylight hours or seasonal activity, then the actual savings would be less than they would be for a full year of data. These effects may be substantial for such buildings as schools with strong seasonal occupancy patterns and offices buildings where vacation schedules reduce summer lighting use in private offices.

The Process Evaluation

Process evaluation specifically focuses on the program implementation process. The process evaluation for the Boston Edison Small C&I Program included a variety of different data collection strategies and offered a broad based examination of the program process. The focus of the evaluation was the 1990 and 1991 program, with most cases being completed prior to October 1991. These included:

- Site visits to a sample of sixteen 1990 and fourteen 1991 program installation sites to examine installation quality, measure persistence, and appropriateness of the installation;
- Surveys of a sample of 300 1991 program participants and 300 nonparticipants to examine a variety of issues from attitudes to conservation, to conservation behaviors, and satisfaction with the program;
- Review of the program databases for 30 cases of 1990 participants and 67 cases of 1991 participants for accuracy in data entry and reasonableness of engineering estimates; and,
- Interviews with utility and contractor staff and focus group and telephone interviews with trade allies about the implementation process.

The process evaluation finds that the Small C&I Program has been successfully implemented: customers are satisfied with the program; BECo staff and contractor staff are enthusiastic and cooperative; and independent contractors are willing partners in the program process.

The BECo Small C & I Program has gone through a variety of transitions before reaching the stage examined in the evaluation. However, in many ways, the program is still in a formative state. There are ongoing modifications to ensure improved service to customers. The changes envisioned for 1992 are expected to ameliorate some of the current limitations of the program and, because the program is still in its early years, there are several excellent opportunities for continued program optimization.

To highlight the results of the evaluation the following discusses findings relative to the six objectives for this process evaluation.

Document the History and Progress of the Program in Meeting Program Goals. The primary goal of the program is to install cost-effective energy conservation improvements in eligible facilities to ensure that both BECo and program participants obtain maximum savings over time. Achievement of cost-effective savings is the most important goal of the program, and the impact evaluation is the primary means of assessing how well the program is meeting this goal. The impact evaluation findings suggest that BECo may need to increase participation rates to achieve its planning goals for measured savings. Given that BECo estimates the current benefit-cost ratio at around 4.0, it is likely that the program can absorb the costs for increasing participation rates.

Assess the Effectiveness of the Program's Promotion and Delivery in Gaining Customer Acceptance and Satisfaction, Inducing Participation, and Reaching the Target Market. The process by which the program achieves its conservation goals is to implement six program components:

- Marketing: market to previously audited customers; use personal utility/customer contacts;

- Site-specific measure analysis: use a two-level audit process that incorporates a simple screening method for measures generally found to be cost-effective and an investment screening tool for more complex measures;

- Measure installation: install measures at no cost to the customer; use contractors approved by BECo;

- Installation verification and measure testing: BECo staff conduct these tasks.

- O&M and energy accounting assistance: BECo can assist through direct contact as part of program participation and through bill stuffers and messages;

- Technical training of trade allies and program staff: training occurs at both the outset of the program and on an ongoing basis.

The process evaluation finds that all the program components are being implemented as designed except one. The one component not being implemented is provision of O&M and energy accounting assistance. Customers express low satisfaction with this area. At the same time, they exhibit an interest in cost control and the purchase of replacement energy-efficient equipment when needed. Thus, if BECo were to offer O&M and energy accounting assistance, it might satisfy this interest and increase customer satisfaction.

Some program difficulties were identified in the marketing approach. In 1991, BECo gave priority to high-bill complaints and service requests. Adoption of a first come, first served approach for all customers who are likely program participants could improve the efficiency of its customer service engineers in scheduling visits and might reduce the lag time now found in the program.

Examine the Roles Played by the Contractors, Trade Allies, and BECo Staff in the Design and Implementation of the Program. BECo staff and the collaborative nonutility representatives designed the program. The design process produced a program that is being implemented by BECo, its contractors, and independent contractors. The roles for each group are relatively well defined. In particular, BECo and its primary contractor work together to deliver the program. There appear to be no significant problems in either the program delivery process or the program administrative process.

The only problem concerns the appropriate role for independent contractors. The program is structured so that BECo manages access to the program through the audit process. Permitting independent contractors to conduct audits in the CGP option has produced more projects than BECo expected. There is a clear need for BECo to continue to manage access to the program where retrofit applications are occurring. Structuring the program so that independent contractors will focus on remodel and replacement market opportunities could provide a means to serve small C&I customers not currently targeted by this program, but important to BECo.

Identify the Barriers to Program Penetration. There do not appear to be any major barriers to program penetration. The customer survey found that nonparticipants are eager to participate in the program, when they are aware of it. However, nonparticipants may have different decision-making patterns than current participants because more nonparticipants depend on a landlord or absent building owner to make final decisions. This finding suggests that in the future the program may need to develop a method for effectively reaching landlords and absent building owners.

Assess the Effectiveness of the Installation Contractor in Delivering the Program. The installation contractors appear to be highly effective in delivering the program. However, there may be a problem with increasing lag times as program participation rates increase. As BECo implements the new database system, it should monitor lag times to ensure that they are kept at a reasonable level and do not interfere with customer satisfaction.

Our site visits found some problems with accurate data entry, but there was no consistent pattern. Similarly, we identified limited problems in the quality of installation. The contractor is addressing some of these problems (e.g., the need to clean fixtures before installation). The contractors should also be encouraged to carefully document the condition of the equipment both before and after installation, report any problems in the installation of recommended measures, and HVAC contractors should be encouraged to vacuum clean equipment (where possible) during tune-ups.

As the program evolved the database ceased to be adequate to record all data. Designed originally for a lighting program, the database was modified to include more complex measures. However, there are often insufficient fields to enter all the data collected during the energy audit. Similarly, the audit forms did not keep pace with the program. Completion of a new database that will be able to accommodate these needs is critical to the long term success of the program. In addition, linking the database

with laptop computers used for the audits will lead to increased accuracy and completeness of the database.

Evaluate the Comprehensiveness of the Program's Products and Services. The site visits found a steady increase in the comprehensiveness of the measures that contractors installed as part of the Small C/I Program from 1990 to 1991. The remaining DSM resource at participating facilities is diminishing as BECo includes more measures in its program and as BECo customer service engineers receive the appropriate training to identify these measures. The low number of complex measure installations by mid-1991, suggests that it may have been difficult for customer service engineers to identify these opportunities.

Integrating the Process Evaluation Findings

The evaluation team realized that the savings estimate from the preliminary impact evaluation of the 1991 program were lower than predicted by the engineering estimates. We reviewed the findings from the process evaluation to determine if there were reasonable explanations for the differences.

Findings from the site visits, the customer surveys, and the database analysis suggest that the most likely explanation for the differences in savings estimates is the hours of operation. The engineering estimates derive from the energy audit and are entered into the program database. These estimates assume that the hours that the equipment, mostly lighting, is used equals the hours of operation for the business. In addition, the hours of operation are assumed to be constant throughout the year, without accounting for seasonal differences.

The site visits findings for the 1991 projects indicated that the actual equipment operating hours during December are 27% less than the business hours reported in the database (see Table 2). The average usage rate for lighting during the summer is probably even lower. The recalculated engineering estimates of savings for the 1991 site visit cases using the equipment operating hours reported during the site visits were 36% lower than the engineering estimates in the database used for the impact evaluation.

The database analysis found comparable discrepancies between the actual Energy Survey Forms (used in the audit conducted prior to installation) and the database. The agreement between the hours of operation was 77% and hours open per week was 70%, while for all other fields in the database it was 90%. The reason for this discrepancy lies in the structure of the database. The structure of database fields provides one field for all weekday opening times and one for all weekend opening times. The Energy Survey Forms, however, provide more detail on hours of operation. If a business had different operating hours on different weekdays, or operated some equipment differently from other equipment, these conditions could not be represented in the database. The database provided the primary data source on operating hours for the impact evaluation. As a result, the discrepancies in these data fields were directly transferred to the impact analysis for the comparison of predicted and actual savings.

The customer telephone survey of participants provided further evidence that the hours of operation in the database were at variance with actual hours of operation. As part of the database analysis, we compared the database information from 67 1991 participants to their responses on the customer survey. The survey results had a 97% agreement to the database on the equipment installed, but only a 56% agreement on the hours of operation. The discrepancy again, appears to be attributable to the additional detail requested in the customer survey and not permitted in the program database.

Three other possible explanations for the findings may also be posited. A first deals with the participation pattern over the year. Boston Edison staff indicated that larger customers were treated later in the year under the 1991 program. The measures for these customers increase the engineering estimates of average savings per participant, but have a small effect on the average bill changes because they occurred late in the year. When the engineering estimates for each of the 1991 Level I participant were reweighted in proportion to the number of months since they received the measures, the engineering estimate dropped from 15,700 kWh per year to 14,400 kWh per year.

Another possible contributing factor concerns the actual operating wattage of the equipment that was replaced under the program. At this stage of the evaluation, there is no evidence that operating wattages for the replaced equipment were overstated in the database and associated engineering estimates. However, some evaluations of small commercial lighting programs at other utilities have identified patterns of replacing burnt out lamps and ballasts that would actually cause increases in electricity use rather than reducing it. In a survey of evaluations of DSM programs, Nadel and Keating identified this reason as a contributing factor in two out of four small commercial lighting retrofit programs, including a direct installation program conducted by Massachusetts Electric Company. ("See Engineering Estimates Versus Impact

Table 2. Comparison of the Annual Hours of Operation for Lighting Equipment Between the Program Database and the Site Visit Study

1991 Participants		Database: Equipment Hours:	Site Visit: Business Hours:	Site Visit: Equipment Hours:
1	Site 1	3,744	3,927	2,436
2	Site 2	3,588	3,075	1,968
3	Site 3	6,188	6,188	6,188
4	Site 4	2,340	2,250	2,250
5	Site 5	2,080	2,250	2,250
6	Site 6	5,096	4,368	4,368
7	Site 7	8,736	5,824	5,824
8	Site 8	5,096	4,998	3,426
9	Site 9	?	2,250	2,045
10	Site 10	2,808	2,754	2,754
11	Site 11	?	1,092	640
12	Site 12	4,680	4,055	3,920
13	Site 13	1,560	2,295	2,295
14	Site 14	8,736	8,736	1,845
15	Site 15	4,680	4,050	3,545
16	Site 16	2,340	3,200	2,153
17	Site 17	?	2,860	2,860
18	Site 18	?	2,080	2,080
Average Hours of Operation Per Participant		4,405	4,141	3,230
% of Equipment Hours Overestimated in Database		27%		

Note:
(1) Average based on those sites with hours of operation available in the database.
(2) In the database, the hours of operation were the same across different measures for a participant. For the site visits, the hours of operation are specific to each piece of equipment, so a weighted average is presented based on the reduction of kilowatts for the specific measures.

Evaluation Results: How Do They Compare and Why?", in *1991 International Program Evaluation Conference Proceedings.*)

Finally, there is some evidence to suggest that self selection contributed to noticeable consumption differences by nonparticipants. The customer surveys encountered a substantially higher rate of disconnected telephones in the nonparticipant sample compared to the participant sample. In addition participating firms were significantly more likely than nonparticipants to report that their firm's financial status was better than their local competition. These two findings suggest that healthy businesses may have been more likely to participate in the program than nonhealthy businesses. If businesses that faced the prospect of moving or going out of business were less inclined to apply for the program, then the consumption of nonparticipants might be expected to drop in the absence of the program. Comparing such nonparticipants to participants would mean that the differences in consumption would not accurately reflect the net impacts of the program, effectively understating the net effects of the program.

Difficulties in Using the Process Evaluation Results

The process evaluation findings clearly identified some possible explanations for the impact evaluation findings. Accessing this information, however, required significant communication among evaluation team members within a very tight time requirements to meet a regulatory filing deadline. The total evaluation team included Boston Edison monitoring and evaluation staff, staff located in three geographically separate offices of the project consultant and two subcontracting firms also geographically separated.

An unusual aspect of this evaluation was that the process evaluation analysis proceeded concurrent to the impact evaluation. The schedule for the evaluation placed the impact evaluation ahead of the process evaluation in order to meet filing deadlines with the Department of Public Utilities. This posed uncommon obstacles to the optimum use and collection of the process evaluation data. Most significant was the fact that problems associated with the database were not identified prior to conducting the impact evaluation. Subsequently, the impact evaluation identified additional process evaluation activities that could be conducted to provide greater understanding of the program. For instance, it could be useful to conduct additional site visits to buildings that entered the program later in the year, or to conduct additional interview follow-ups to further explore possible explanations for these discrepancies.

A difficulty that always occurs when using process evaluation findings resides in the imprecision of qualitative data. The site visit findings and database analysis clearly suggest that the engineering estimates may be off by 30% or more as a result of current assumptions in the database for hours of operation. However, these results are based on very small samples (14 site visits to 1991 participants, and a review of the data files for 67 1991 participants). These data provide strong evidence but do not prove that the hours of operation variable has significantly contributed to the discrepancy between the engineering estimates and the billing analysis estimates of savings.

Nonetheless, the process evaluation provides the means for examining the inputs to the impact evaluation. Using these findings, the next step is to pursue deeper investigation of the possible explanations and determine which are most plausible. As Boston Edison implements a new program database, currently being developed, we anticipate that the hours of operation variable will be revised in response to these findings. This has become a more significant concern as a result of the findings from the evaluation. Both the program staff and the monitoring and evaluation staff desire to meet their program goals both in engineering estimates and the billing analysis estimates of savings.

Conclusions and Recommendations

Program evaluation is a powerful tool for understanding the implementation process and the effects of the program on energy consumption. Results are often unexpected and sometimes can provide information that suggests the program is less effective than expected. DSM programs, however, are evolving and utilities use evaluation to improve their programs. Combining the data collection and analysis techniques of both process and impact evaluation provides the most effective means to understand the program results and identify opportunities to optimize the program.

Our experience has identified four factors for successful integration of process and impact data and results in a comprehensive program evaluation.

The utility should look for a team that can provide a comprehensive approach or provide the oversight to ensure that the evaluation is comprehensive. A comprehensive approach, in our view, means there is equal leadership for both the impact and process evaluation.

Unequal leadership can result in "lost" information or a failure to incorporate insights into the final product.

The second factor is a corollary to the first. In conducting the evaluation, the evaluators should focus on developing team coordination and communication. Coordination of efforts and frequent communication facilitate the transfer of information and provide the basis for developing a comprehensive assessment of the program. In addition, a commitment on the part of utility to clearly state their expectations for the evaluation means that the team can be responsive to these expectations throughout the analysis process.

Third, the utility and evaluators should conduct the evaluation providing sufficient time to accomplish each task. This particularly becomes a problem when evaluations are scheduled to meet regulatory requirements. Evaluations are complex. In addition, there are generally a variety of unexpected problems in preparing the data for the impact analysis. With sufficient time, the process evaluation can be used to identify and address potential problems in the database. On the other hand, once the impact evaluation is completed, new questions often arise that could be addressed in the process evaluation. By scheduling some process evaluation tasks to follow the impact evaluation, these new questions may be answered. The process evaluation can be used to identify potential problems in the database.

Finally, a corollary to the third factor. The utility should be prepared permit the evaluation to be flexible in terms of focus and resource allocation. Clearly, this is not an open invitation to examine every issue. Evaluation plans are often conceived some months prior to the initiation of the evaluation. During the evaluation additional issues may surface. Flexibility is required to adapt to these circumstances in order for the evaluation to be both timely and useful.

Endnote

1. If we had chosen to compute the participants' annual consumption levels for calendar 1989 (rather than the twelve months preceding program participation), several observations would have been lost due to incomplete billing data.