Low-income Baseload Energy Efficiency Program Gets Results

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ABSTRACT

Massachusetts Electric Company (MECO) recently introduced an innovative energy efficiency program targeting low-income customers. This paper presents initial process and impact evaluation results. Key features of the Appliance Management Program (AMP) are: 1) it is fuel-blind, and 2) it offers a combination of education to influence customers' energy-consuming behavior and measure installations, including free replacement of inefficient refrigerators. Program delivery involves coordinated efforts of utility staff and Community Action agencies both in marketing/outreach and education/installations. The program evaluation was based on staff interviews and telephone surveys of participants and nonparticipants. Findings from the evaluations were: 1) Participants are satisfied with all aspects - the educational materials and the software tool designed for the program - and the measures received; 2) Program delivery allows for good communication and ongoing problem solving; and 3)Impacts, based on econometric analysis of billing histories, demonstrated a realization rate of 93% and net annual savings of 973 kWh per customer. Future extensions of this program should include creative outreach to hard-to-reach customers (those with language barriers, severe time-constraints, and negative attitudes toward the utility) and exploring savings opportunities in "mystery houses" - those with inexplicably high usage.

Introduction

In the spring of 1996, the Massachusetts Electric Company (MECO,) a NEES Company, introduced its pilot version of the Appliance Management Program (AMP), one of a new generation of DSM programs targeting the low-income sector. The purpose of this paper is to describe key features of the AMP program, summarize findings from an evaluation of the program, and present conclusions resulting from experience with the program to date.

Background

Like most utilities during the past decade, MECO has provided some DSM services to low-income consumers. These programs consisted of free home energy audits and the installation of measures such as window and door seals, water conservation measures, and automated heating controls. Most of the traditional audit and measure programs were based on the knowledge that low-income families generally live in older housing, which is less well-insulated and often in need of repairs. Energy-efficient measures were one means of assistance which could also indirectly reduce arrearage, if energy consumption could be cut substantially.

In the Electric Industry Restructuring Plan: Model Rules and Legislative Proposal (D.P.U. 96-100), the Massachusetts Department of Public Utilities recommended a continued commitment to low-income consumers under any restructuring plan. Among other things, this commitment includes continuation of a low-income discount for residential customers and efforts to address the market barriers that specifically prevent low-income customers from purchasing energy efficiency services and products. The D.P.U.'s

May 1 statement also proposed that each distribution company develop an energy efficiency program for low-income customers to be delivered in coordination with the local weatherization-assistance program agencies. The AMP program exemplifies these continued efforts to serve low-income residential customers.

Program Design And Implementation

To be eligible for AMP a customer must be on the R-2 (low-income) rate, have baseload consumption of a minimum 15 kWh per day and have an account which is either paid-in-full or less than three months in arrears. To be eligible for the pilot program, an eligible customer also had to live in one of four Community Action Program (CAP) service territories chosen for the pilot and could not have electric heat. In 1997 the program was expanded to serve anyone eligible within the MECO service territory.

It is difficult to estimate the size of the population of customers eligible for this program with accuracy, because the population is mobile and also customers go in and out of arrears. Roughly speaking, the eligible population comprises 5 to 10% of the total MECO residential customer population of 800,000, or up to half of MECO's customers at or below 175% of poverty.

Key features of AMP are 1) that it offers a combination of education leading to recommended changes in customers' energy-consuming behavior and measure installations, including free removal of inefficient refrigerators and replacement with a new appliance, and 2) that it emphasizes partnership between the customer and energy manager from the CAP agency.

Outreach and marketing are coordinated efforts. The utility identifies a list of eligible customers, while the energy managers from the CAP agencies have responsibility for making initial contact with the customers, conducting the in-home visits, and making follow-up calls or visits. The utility developed the software, produced an educational booklet available in English and Spanish, and trained CAP energy managers to use the software, monitor appliances, and to conduct other aspects of the in-home visits.

The in-home visits accomplish several objectives. They provide customers with a detailed appliance assessment. With the use of the custom-made software, the energy manager and customer together develop a profile of all of the electric appliances and how they are used. Customers are given a computer printout of this information, which illustrates how the household's activities generate the monthly electric bill.

The in-home visit includes monitoring the kWh consumption of major appliances such as refrigerators. Customers with high-use refrigerators are eligible to receive a free replacement. There is some flexibility in this offer, so that, for example, a freezer or a secondary refrigerator and a primary refrigerator could be replaced by one larger primary high efficiency refrigerator. Customers can choose from a variety of models and sizes of appliances. Roughly 40% of the customers in the pilot received replacement refrigerators and a few customers received replacement freezers. The appliances being replaced were removed and dismantled.

A screening tool was developed to establish guidelines for deciding which refrigerators and freezers are eligible for replacement. The screening tool identifies threshold values (minimum daily kWh consumption of the inefficient units eligible for replacement), which vary depending on the price and the kWh usage of the new replacement appliances. All of the appliance swaps are required to have a B/C ratio greater than or equal to 1.0.

Other measures which were provided to customers at no charge include:

- Refrigerator cleaning brushes;
- Domestic hot water conservation measures (showerheads, aerators, and wraps);
- New waterbed mattresses;
- Compact fluorescent bulbs;
- Air conditioning filters;
- Removal of existing secondary refrigerators.

During the in-home visit, the energy manager also provides detailed education about energy usage. Working together the customer and manager design an "action plan" for energy savings tailored specifically to the customer's home and habits. This includes such actions as using cold water instead of hot water laundry cycles, substituting air-drying for drying clothes when appropriate, and turning off televisions and lamps in unoccupied rooms.

Program Participation. Of the 3,500 qualifying customers in the four service territories chosen for the Pilot, 240 customers participated during the 8 months duration of the Pilot in 1996 and 1,100 customers participated in 1997.

Process Evaluation

The consulting firm Research Into Action was contracted to conduct a process and impact evaluation of the pilot program. Telephone surveys were conducted with 112 program participants, 100 nonparticipants, and 307 potential participants who are low-income customers living outside the pilot program area. The surveys addressed customer satisfaction with the utility and the Community Action Program (CAP) agencies delivering the program, participants' satisfaction with program components, responsiveness to program marketing and delivery, reasons for participation or nonparticipation, and participants' implementation of action items. The surveys were conducted 3 months after the end of the program year. Participants were served in the program from 3 to 11 months prior to the survey; however the majority of the participants were served near the end of the program year, 3 to 6 months prior to the survey .

In addition to the customer surveys, key CAP agency and utility staff were interviewed by telephone. The objective of these interviews was to assess the effectiveness of processes, including tracking, training, and program delivery.

Program Management. Overall, participants responded favorably to the delivery of the program, particularly with the performance of the CAP energy managers. While some customers had difficulty understanding the computer printout profiling appliance usage, most participants who received new measures such as refrigerators or waterbed insulation reported high levels of satisfaction with the delivery and installation. The combination of highly effective utility and CAP agency staff and innovative software and educational materials contributed to the pilot program's success.

The CAP agency staff, including energy managers, were favorably impressed with the intensive training sessions prior to start-up of the program. However, most felt that more training time should have been devoted to the energy-survey software, computer use, and on finding ways to save energy in customers' homes. Record-keeping and, where appropriate, provision of additional services, such as translation services or flexible hours to serve younger households, are areas which could be improved.

Program Participants. The demographic profiles of pilot participants differed from those of nonparticipants and potential participants. Participants tended to be older homeowners in one- or two-

person households who have had previous favorable experiences with multiple CAP programs. Their primary reasons for participating are "to reduce their electricity bill" and "to save energy."

By comparison, the population of potential participants is younger and has larger (four or more-person) households. While they have less previous experience with other CAP or utility programs and lower levels of satisfaction with CAP agencies and the utility, they have some interest in energy conservation. Nonparticipants, eligible customers who chose not to participate, were likely to be younger than participants. They were less likely to own or live in a single family home. They expressed lower overall satisfaction with CAP agencies and utilities and had less previous experience with other programs. Based on these profiles, the evaluation suggests that additional outreach efforts may be required to successfully serve a broad cross-section of the low income population.

Reasons cited for not participating included the following: no need for a new refrigerator; not contacted; the electric bill was not that high; and, could not make the three hour daytime commitment for the home survey. In addition, the study found that language issues and attitudes toward the utility are also barriers to participation.

Education. Customer education is a central part of the AMP program. An educational booklet is distributed to each participant. In addition to the home survey itself, a list of action items to assist customers in saving more energy is developed jointly by the energy manager and customer during the home visit.

Over 75 percent of the participants surveyed found all three educational components - the home survey, action items, and booklet - "very helpful". The study also examined the extent to which the action items were implemented. Overall, an average of 3.5 actions were recommended per customers, and 2.5 actions were implemented.

Open-ended questions were used to obtain more insight into the effectiveness of the action items. Results indicate most customers followed up on action items by changing their behavior systematically. This included: using the refrigerator coil cleaning brush; turning off television and lights not in use; changing laundry, dishwashing, and cooking practices; and changing the use of their refrigerators (unplugging seasonally), where appropriate.

Free-Ridership and Persistence. Free-ridership for the AMP program was determined for lighting measures and refrigerator replacements - two measures which were installed in a significant proportion of participants' homes. A series of questions that probed participants' level of knowledge and willingness to buy these products on their own was asked. To qualify as a free rider, the customer would have had to plan to purchase the same or similar equipment at the same time or earlier than when it was installed by the program. Free-ridership was estimated at 7.7 percent for lighting measures and 6.8 percent for refrigerators.

Persistence of all measures installed through the program was high. Only one customer reported removing any measure, and that was a faucet aerator removed to enable a dishwasher to be attached to the faucet.

Impact Evaluation

The impact evaluation of the 1996 Appliance Management Program (AMP) pilot relies on an econometric framework that combines customer bills with program tracking information and data developed from participant and non-participant surveys. The approach recognizes that two customer

decisions—participation in the AMP program and implementation of energy-efficiency measures—and the level of energy consumption, are interrelated:

- Whether to participate in the program. This decision is influenced by customer characteristics, including energy usage.
- How much energy to use. Energy consumption depends on a host of factors, such as income, household, size, weather, etc. Additionally, consumption depends on whether customers implement AMP program measures.

Therefore, the impact evaluation employs two models: (1) a binary logit participation model using customer characteristics from AMP program surveys and pre-program electricity usage; and (2) an electricity usage equation (i.e., billing analysis) to determine measure impacts.

AMP program participation was estimated as a binary logit model using pre-program electricity usage and the following customer characteristics from the telephone surveys:

- Age of respondent;
- Own or rent;
- Single or multifamily;
- Participation in previous utility programs;
- Participation in previous CAP programs (number of programs);
- CAP satisfaction; and
- MECO satisfaction.

The model explained more than 20% of the variation in participation, and the 1995 usage coefficient (significant at the 90% level) indicated that the probability of participation increases with electricity consumption.

The electricity usage model can be specified in a standard regression format as:

$$E = \lambda + \delta C + \eta * M_1 + \varphi * M_2 + \ldots + \pi * M_n + \epsilon,$$

where:

E = average daily electricity usage;
λ = the intercept term;
C = the set of household characteristics affecting usage;
δ = the vector coefficients associated with characteristics set C;
M_1 through M_n = measures provided to participants through the AMP program;
Coefficients η, φ, ... π represent the *net* savings from each measure; and
ϵ = the regression model error term.

The following variables from the surveys were included in the energy consumption equation along with the inverse Mills ratio:

- Household size;
- Ratio of adults to total household size; and,
- February; March; April (binary variables reflecting monthly differences in energy consumption) (e.g., different intercept terms for each month).

The inverse Mills ratio is derived from the binary logit choice model results and is used to correct for participation bias.

To correct for multicollinearity resulting from inclusion of many measures installed in a large proportion of homes, only two variables describing energy savings were used. One called

Get_meas (equal to 1 for 1997 months if participants received something besides a new refrigerator/freezer, and 0 otherwise) was included in the final regression specification along with an engineering savings estimate for new refrigerators/freezers (Newrefr). This participant-specific engineering estimate was based on the difference between the measured consumption of existing units during the AMP audit and the manufacturer's "Energy Guide" estimates of energy consumption. Thus, the final model reflects a combination of conditional savings analysis (CSA) and statistical adjusted engineering (SAE) methods.

The model used data for 184 customers (98 participants and 86 nonparticipants) with at least three months of pre-program and three months of post-program billing histories were available for the final billing analysis sample. Table 2 compares the measures received by participants in the final sample with the AMP pilot participant database.

Table 2: Summary of AMP Measures Received

Participant Category	Final Billing Analysis Sample	All Pilot Participants
Total Number of Participants	98	241
Participants Receiving at Least One Measure Other than a Refrigerator/Freezer	94	228
Participants Receiving Refrigerators/Freezers	42	101
Participants Receiving Education Only	3	10

The AMP electricity consumption model is presented in Table 3. All of the model coefficients are the right sign, and most are statistically significant. Note that the new refrigerator coefficient is positive because the engineering estimate of savings is a negative number. Its value of 0.876 is significant at the 99% level. Multiplying the refrigerator coefficient by the average engineering estimate of 1,546 kWh/year yields a statistically adjusted engineering estimate of 1,354 per year.

The coefficient showing the impact of receiving other measures besides a refrigerator is negative because Get_meas is a 0/1 binary variable. The value of -1.176 kWh/per day is significant at the 80% level. Multiplying this figure by 365 days yields an annual savings estimate of 429 kWh for other AMP program measures.

Table 3: Average Daily Electricity Consumption Equation for AMP Participants and Nonparticipants

Parameter	Estimate	t-ratio	Prob>|T|
Intercept	0.1961	0.090	0.928
February	4.9744	5.799	0.000
March	3.6819	4.301	0.000
April	2.2452	2.625	0.009
HHsize	4.5625	17.201	0.000
Adult_ratio	13.0988	8.137	0.000
Mills	1.1353	2.874	0.004
Get_meas	-1.1758	-1.389	0.165
Newrefr	0.8756	3.856	0.000
R-Square	0.2199		
Number of observations	1,471		
Number of participants	98		
Number of nonparticipants	86		

Overall gross AMP program savings are determined by multiplying measure savings by their respective share of participants. Savings from new refrigerators and from all other measures are calculated as: Refrigerators = 1,354 * 101 refrigerators / 241 participants = 567 kWh

Get_meas = 429 * 228 Get_meas / 241 participants = 406 kWh

Net savings per AMP participant are thus 973 kWh annually. Comparing this figure to the 1996 AMP engineering estimate of 1,050 kWh annually yields a realization rate of 93%.

These results are summarized in Table 4, which also includes 80% and 90% confidence bounds around each estimate.

Table 4: AMP Billing Analysis Results Summary *

Measure	New Savings	80% Lower Bound	80% Upper Bound	90% Lower Bound	90% Upper Bound
Get_mea	406	31	781	-75	887
Newrefr	567	379	756	325	809
Total	973	410	1537	250	1696

*Some savings components do not add to totals because of rounding.

The model provides estimates of net rather than gross savings because participant and nonparticipant data are included. Gross savings can be derived by applying the appropriate free-ridership rates from the AMP process evaluation, as follows. Using the refrigerator rate of 6.8% and the CFL rate of 7.7% as a proxy for all other measures, gross savings are equal to:

Refrigerators = 567/ (1.0 - 0.068) = 608 kWh

Get_meas = 406/ (1.0 - 0.077) = 440 kWh

Gross savings per AMP participant are equal to 1,048 kWh annually. To put these results in perspective, customers who use 15 kWh/day and received refrigerator and other measures save 19% of their prior year's usage, while customers who use 15 kWh/day and received the other measures save 8%.

Conclusions

The AMP pilot program provided an excellent learning year for the CAPs and for MECO. The impact evaluation revealed that significant savings are possible. The program as a whole was not cost-effective, with a B/C ratio of approximately 0.80. However, it is likely that costs will decrease in future years. The costs of the pilot included evaluation costs and start-up costs including purchases of several computers as well as administrative costs and measure costs. In future years, with larger participation levels, the pilot program can take advantage of economies of scale and more competitive bidding in procuring materials. If the savings remain at this level or higher, the program can be cost-effective.

The evaluation revealed that the majority of participants were older homeowners with more experience and satisfaction with the CAP agencies. By contrast, nonparticipants were younger and included a higher proportion of renters. The potential program population also differed significantly from the pilot participants in ways which have implications for future program implementation. Specifically, the potential population has more negative attitudes toward the utility, less experience with energy programs offered by other utilities or the CAP, is more varied demographically with respect to age, and homeownership, and does not report high levels of need for assistance with their bills. However, there are also more large households in this population and more homeowners.

To obtain high participation among a broad base in this customer class will require additional efforts from MECO and the CAP agencies. The evaluation revealed that MECO and the CAP energy managers worked closely and successfully to solve issues and continually revise the program to ensure high quality program delivery in the pilot. Participant satisfaction and the implementation of energy saving measures and actions indicate that this was successful. Continuing the ongoing, interactive relationship between the CAPs and MECO is key to allowing the AMP program to reach its goals and achieve greater energy savings in a broader low-income customer base in the future.

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References

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