

THE MASSACHUSETTS ELECTRIC REFRIGERATOR REBATE PROGRAM:
ACCOMPLISHMENTS AND PLANNING GUIDES

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ABSTRACT

The Massachusetts Electric Company Refrigerator Rebate Program was implemented as a pilot conservation program in 1986. This evaluation compared the participants with a control group of utility customers who also purchased new refrigerators in 1986. The comparisons covered the program's impact on attitudes toward energy-efficiency and selecting a new appliance, the refrigerator models purchased, and household electricity savings. The results summarized here are based on electric bill analysis and comprehensive customer surveys.

- . About 60% of eligible households (those purchasing refrigerators over the programs life) participated in the program.
- . About 70% of the participants, however, were "free-riders".
- . Participants were more likely to recognize the energy savings benefits over the appliance life and the value of comparing different models. Appliance salespeople were also more likely to promote energy-efficient models.
- . Based on manufacturers' data, the refrigerators rebated used, on average, 4% less electricity than the control group models. However, the difference in the reduction of total electricity consumed was not statistically significant.
- . Customers with highly efficient models (top 15%) had significant electricity savings over those with models qualifying only for the less stringent rebate standards.
- . The program was not cost-effective due to the high rebate amount (\$100), lenient qualifying criteria, and the large number of "free-riders". However, the bill and survey analysis of customers with highly-efficient refrigerators provided valuable information for planning future programs to educate consumers and effectively market energy efficient appliances.

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INTRODUCTION

In 1986, the New England Electric System (NEES) introduced a series of pilot conservation programs in part of the service territory of its largest retail subsidiary, the Massachusetts Electric Company (MECo). These programs, aimed at residential, commercial and industrial customers were offered throughout 1986 in twenty communities in north central and northwestern Massachusetts that were termed the Enterprise Zone. The Enterprise Zone project was an ambitious demonstration program for various options to reduce peak demand and energy usage. Three programs were offered in the Enterprise Zone for residential customers: an audit/electric conservation measure installation program, a similar but more heavily subsidized program for low-income customers, and a refrigerator rebate program, which is the subject of this evaluation study.

The Refrigerator Rebate Program offered customers a \$100 rebate for purchasing and installing a qualifying refrigerator within the Enterprise Zone between March 15, 1986 and December 31, 1986. MECo chose the then proposed Massachusetts Appliance Efficiency Standards Act as the efficiency standard for the rebate program. The Act went into effect in 1988 mandating that all refrigerators sold within the state meet these standards. The Massachusetts standards are based upon the California Energy Commission's November 3, 1979 standards, updated each year to include current models.

It should be noted at the outset that the Refrigerator Rebate Program offered high rebates with relatively lenient qualifying criteria. One of the program's objectives was to achieve a high penetration rate in its short life. While the program's design made it difficult to remain cost-effective, it did fulfill the objective of rapid penetration.

Enterprise Zone customers received 1008 rebates through the program. Lacking data on the actual number of refrigerators sold in the Enterprise Zone, a participation rate was estimated from general information. It was estimated that 32,000 households lived within the Enterprise Zone in 1986. Assuming an average life of 15 years for a refrigerator, approximately 2133 refrigerators would be replaced each year. Since the program ran for nine and a half months, 1689 refrigerators were estimated sold to the Enterprise Zone households. The program's 1008 rebates translate to a penetration rate of 60%.

OVERVIEW OF THE EVALUATION METHODOLOGY

The Refrigerator Rebate Program evaluation was designed to compare the program participants (the rebate group) to a carefully selected control group to determine the program effects in encouraging the purchase of energy-efficient refrigerators and achieving maximum energy savings from the refrigerator changeout. The two groups were compared in the following three areas.

- o the refrigerator model selected;
- o the household's electricity consumption before and after the refrigerator changeout; and
- o the consumers' perceptions, motivations and considerations in choosing a new refrigerator.

Selection of the Rebate Group

The rebate group used for the program evaluation was selected from customers who responded to a mail survey of all participants and had a complete billing history. Customers received a mail survey with their rebate checks covering the motivation and reasoning used to select the refrigerator, attitudes toward energy efficiency and economic/demographic characteristics. The survey had 428 respondents among the program participants from March through September, a response rate of 70%. Assembling complete billing history data for the rebate group proved to be more difficult. Since many households purchase a new refrigerator when moving into a new home, billing history would not be consistent for the periods before and after the refrigerator purchase. After eliminating customers with inconsistent usage data, including those with large gaps in their billing histories, the rebate group numbered 158 customers.

Selection of the Control Group

The considerations of the control group selection were similar to those for the rebate group in terms of complete survey and billing history data. In addition to both groups having purchased new refrigerators in the same time period, they also had to be similar in economic, demographic and housing characteristics in order to serve as a proper control.

The control group consisted of MECo customers living outside the Enterprise Zone. Appliance dealers in three northeastern Massachusetts towns (Lowell, Lawrence and Chelmsford) provided lists of customers that had purchased new refrigerators in March through September of 1986. Approximately 200 names were gathered with 137 customers having sufficient billing history for the energy usage analysis. A survey similar to that mailed to the rebate group was administered to the control group by telephone since it was felt that a mail survey would generate too low a response rate among households not receiving a rebate. However, even using the telephone, the control group had only 54 survey respondents. Except in comparisons of the survey responses

between the rebate and control groups, the evaluation uses all 137 control group customers.

The control group was divided into three subgroups for the survey and energy usage analyses. The first group consisted of households that had purchased highly-efficient refrigerators that would have qualified for both the Enterprise Zone rebate and the Bonneville Power Administration (BPA) "Blue Clue" Award. These refrigerators, matched with a list from The Top 15% Energy Efficient Refrigerators and Freezers (March 1987) assembled by the BPA for a marketing program, met more stringent energy efficiency criteria than those qualifying for the Enterprise Zone rebate. The second group of households purchased refrigerators that would have qualified for the Enterprise Zone rebate but not the BPA award. The third group purchased refrigerators qualifying for neither the rebate nor the BPA award.

A final note must be made on the comparability of the rebate and control groups. Despite our best efforts in selection, the survey responses pointed to several areas, particularly economic, where the two groups were different, mainly due to the unique, rural character of the Enterprise Zone. Since there is no comparable area in the MECo service territory that would yield a large enough control group, the latter was drawn from urban, suburban and rural areas.

The control group was more affluent than the rebate group: 35% of the households in the control group had income exceeding \$50,000 compared to 9% in the rebate group. The control group household head was also more likely to have graduated from college. A greater portion of the control group households had two adults employed full-time. Housing characteristics also varied; a larger portion of the control group homes had air conditioning with some using central air conditioning which was nonexistent in the rebate group.

Fortunately, the differences between the control and rebate groups tend to argue for the rebate group being initially less conscious of energy efficiency. At the very least, the rebate group was less able than the control group to afford the higher purchase price of an energy-efficient refrigerator model. Thus, the evaluation may well understate the effects of the rebate program.

FINDINGS OF THE ANALYSES

The Refrigerator Rebate Program evaluation consisted of three separate analyses covering purchase choices, electricity consumption and survey responses. The program's cost-effectiveness was then assessed from the energy savings estimated by the purchase choice analysis.

Analysis of the Purchase Choices

The refrigerators selected by the rebate and control groups were compared on the basis of total kWh consumed per year, total operating cost per year, volume and efficiency, defined as kWh consumed per cubic foot. Furthermore, the percentage of control group refrigerators that would have qualified for

the rebate had their owners lived in the Enterprise Zone and the percentage of refrigerators in both groups qualifying for the BPA "Blue Clue" Award were computed. This information was assembled from engineering estimates in the 1987 Consumer Selection Guide for Refrigerators and Freezers published by the Association of Home Appliance Manufacturers (AHAM). All analyses used T-tests to compare the differences between the means of the different measures for the rebate and control groups.

The analysis of the refrigerator purchase choices, summarized in Table I, found that the rebated refrigerators were significantly different from those selected by the control group. The rebated refrigerators were more efficient as measured by the kWh consumed per cubic foot, (AHAM engineering estimates) a 3% difference significant at the 90% confidence level. The rebated refrigerators also used less electricity annually, on average, with a resulting lower energy cost than the control group refrigerators, the difference being significant at the 85% level. The control group refrigerators were slightly larger than those in the rebate group, but this difference did not approach a reasonable confidence level.

TABLE I. Comparison of rebate and control group refrigerator purchase choices.

	Rebate Group	Control Group	Percent Difference	Confidence Level
Annual kWh Consumption(mean)	994.9	1033.2	3.8%	85%
Annual Electricity Cost(mean)*	75.0	77.9	3.9%	85%
Volume (mean cubic feet)	17.7	18.0	1.7%	50%
Efficiency (mean kWh/cubic ft)	56.1	57.8	3.0%	90%
Qualify for BPA award (%)	30.9%	22.6%	-8.3%	
Number of Refrigerators	96**	137		

* Based on the Mass. Electric average cost of 7.537 cents per kWh for residential customers in 1986

** Records of refrigerator serial numbers were not available for all rebate program participants at the time of this analysis. This random sample was part of an earlier analysis that had assembled this information.

As expected, the rebated refrigerators were also more like to qualify for the Top 15% BPA award than those in the control group. However, it is useful to note that a relatively small portion of the refrigerators purchased under the rebate, less than one in three, had this high efficiency rating.

An important finding of the purchase choice analysis was that 94 of the 137 control group customers or 69% would have qualified for the rebate if they had lived in the Enterprise Zone. This is one measure of the program's free riders; that is, customers who would have purchased an energy-efficient refrigerator without the incentive offered by the program. A comparison of the rebate group refrigerators to those purchased by the control group that would have qualified for the rebate found no significant differences. There is no evidence that the program induced its participants to buy more top-of-the-line efficient refrigerators, rather than the minimum required for the rebate.

Unfortunately, it was not possible to collect information on the total refrigerator sales in the Enterprise Zone during the program period. Such information would have allowed us to directly compare Enterprise Zone sales with purchase choices in the control group area. The purchase choice analysis that was done, however, pointed out the similarity of the models selected by the rebate and control groups. This similarity, and the resulting small difference in energy efficiency between the two groups, is indicative of the liberal standards used for the rebate.

The analysis of the differences between the means of selected measures was extended to the three control subgroups: those with refrigerators qualifying for the BPA (top 15%) award, those qualifying for the rebate but not the BPA award and those qualifying for neither the BPA award nor the rebate. The purpose of these comparisons, which are summarized in Table II, was to assess the magnitude of the differences along the spectrum of refrigerators from the most to the least efficient.

Table II. Comparison of means for the control subgroup refrigerator purchase choices.

	Consumption (kWh/yr.)	Cost (\$/yr.)	Volume (cu.ft.)	Efficiency (kWh/cu.ft./yr.)
I. Qualify for the BPA Award	948.5	71.5	17.6	53.8
II. Qualify for the Rebate but not the BPA Award	1009.6	76.1	18.2	55.8
% Difference, I and II	6.4%	6.4%	3.4%	3.7%
Confidence Level	90%	90%	75%	90%
III. Qualify for Neither	1129.0	85.1	18.0	63.7
%Difference, II and III	11.8%	11.8%	-1.1%	14.2%
Confidence Level	95%	95%	15%	99%

*Based on the Mass. Electric average cost of 7.537 cents per kWh for residential customers in 1986.

The differences in average consumption, cost and efficiency were significant among the three control subgroups. In all cases, the magnitude of these differences was greater than that between the rebate and control group shown in Table I. The differences in cost are illustrative. A refrigerator qualifying for the BPA award cost \$4.60 less to operate per year than one qualified for the rebate but not the BPA award. Refrigerators that did not qualify for the rebate, however, cost \$9.00 more than those qualifying for the rebate and \$13.60 more than those qualifying for the BPA award. By contrast, the difference in cost between all control group and rebate group refrigerators was only \$2.90 (from Table I). Thus, while significant savings are possible in very efficient refrigerators, the savings between a mixed group of customers such as the control group and the rebate group are small.

Analysis of Electricity Consumption

The second method of estimating energy savings due to the program was through a comparison of the electricity usage of the rebate and control groups before and after purchase of the new refrigerator. Here, the selection of a control group that purchased a new refrigerator in the same time period as the rebate group becomes important. The changeout of a ten or fifteen year old refrigerator will almost always result in some energy savings even if a relatively inefficient model is selected. The savings result from an across the board improvement of 30% to 40% in energy efficiency, according to AHAM engineering estimates, over the past decade. (Energy Efficiency and Consumption Trends Data, 1986)

The electricity consumption analysis compared the mean kWh usage, adjusted for weather effects, in the six months preceding the refrigerator purchase (October 1985 to March 1986) and the six months following the purchase (October 1986 to March 1987) for the rebate and control groups. Both groups used less electricity in the period following the refrigerator purchase. The key indicator of program impacts is the difference in savings between the rebate and control groups. The electricity usage changes for the three subgroups of the control group were also compared to determine if the billing history analysis used would pick up differences in refrigerator efficiency levels among these groups.

The electricity used over each of the six-month periods was adjusted for weather effects using an algorithm similar to that used by MECo to weather adjust the company's monthly sales. The total heating degree days for the period were subtracted from the total "normal", based on a thirty-year average, heating degree days. This difference was then multiplied by a coefficient representing the sensitivity of various residential customer subgroups. Separate coefficients were used for electric space heating and non electric space heating customers. The resulting adjustment was then added to or subtracted from actual usage. This methodology thus adjusted for varying proportions of electric space heating customers in the rebate and control groups. Furthermore, since only the colder months were used in the analysis, the higher portion of customers with air conditioning in the control group was not a factor. All customers whose weather-adjusted consumption had changed by more than 40% between the before and after periods were eliminated from the

analysis, based on the hypothesis that a major change had occurred in the household's living conditions making its data unreliable. The rebate group had 16 customers in this category and the control group had 13 such customers leaving 140 rebate group customers and 124 control group customers in the analysis of electricity consumption.

There was little difference in energy savings between the rebate and control groups and, as Table III shows, this difference had a relatively low confidence level. The rebate group used on average, 171 kWh less in the period following the refrigerator purchase while the control group decreased its usage by 158 kWh. The control group used significantly more electricity in both periods than the rebate group. This reflects the differences between the Enterprise Zone and the control group households already discussed.

Table III. Energy usage impacts: rebate versus control group

Rebate Group:	
Consumption 1985-1986 (kWh)	3753
Consumption 1986-1987 (kWh)	3582
Difference (kWh)	-171
Difference (%)	-4.6%
Number of Customers	140
Control Group	
Consumption 1985-1986 (kWh)	4329
Consumption 1986-1987 (kWh)	4171
Difference (kWh)	-158
Difference (%)	-3.6%
Number of Customers	124
Savings (Rebate less Control)	1.0%
Confidence Level	80%

These findings were not surprising as the purchase choice analysis had already indicated that the rebated refrigerators used, on average, 40 kWh less per year than the models purchased by the control group. Since electricity consumption by refrigerators is likely to be obscured in total household consumption, especially if the household uses electricity for space or water heating, the savings difference between the rebate and control groups was unlikely to be statistically significant.

The energy usage analysis found more pronounced differences among the control subgroups, as shown in Table IV. Households purchasing BPA Award qualifying refrigerators reduced their electricity consumption by 10% or 572 kWh. These households also had higher overall levels of electricity usage than any other group. Households purchasing refrigerators qualifying for the rebate but not the BPA Award reduced their electricity consumption by 5%, approximately the same savings as the rebate group. Households purchasing refrigerators that qualified for neither the BPA Award nor the rebate, on the

other hand, actually increased their electricity consumption. The energy usage analysis of the control subgroups thus leads us to the same conclusions as the purchase choice analysis. Highly efficient refrigerators, such as those that qualify for the BPA Award, are the most likely to yield significant electricity savings.

Table IV. Energy usage impacts: control subgroups.

BPA Award Group:	
Consumption 1985-1986 (kWh)	5516
Consumption 1986-1987 (kWh)	4944
Difference (kWh)	-572
Difference (%)	-10.4%
Number of Customers	27
Non Award, Rebate Only Group:	
Consumption 1985-1986 (kWh)	3597
Consumption 1986-1987 (kWh)	3405
Difference (kWh)	-192
Difference (%)	-5.3%
Number of Customers	55
Non Award, Non Rebate Group:	
Consumption 1985-1986 (kWh)	4524
Consumption 1986-1987 (kWh)	4678
Difference (kWh)	154
Difference (%)	3.4%
Number of Customers	42
Savings (BPA Award less Rebate Only)	5.1%
Confidence Level	85%
Savings (Rebate Only less No Rebate)	8.7%
Confidence Level	90%

Analysis of Survey Responses

The surveys of the rebate and control groups yielded several findings on customer motivation and decision-making useful in planning programs promoting energy-efficient appliances. The surveys addressed the free-rider issue by asking customers why they purchased an energy-efficient refrigerator. Of the rebate group, 31% of the respondents said it was the model they liked best and just happened to be energy efficient. Another 24% said the model seemed to have the best value in terms of quality and features. Only 28% said they selected a particular model to take advantage of the MECo rebate. In response to a similar question, 73% of the rebate group said they would have purchased the same refrigerator if the rebate were not available. Only 22% of the respondents would not have purchased the same model and 5% were not sure. The 73% free riders estimate is close to the 69% of the control group that bought rebate-qualifying refrigerators. Based on the similarity between these

estimates, we believe 70% is a fairly reliable estimate of the program's free riders.

The most apparent differences between the rebate and control groups were in the attitudes and considerations used in selecting a refrigerator. Not surprisingly, the rebate group was more conscious of the differences in energy efficiency among refrigerators and their value. For example, 63% of the rebate group agreed that the energy savings from an efficient refrigerator is worth an extra initial cost in the purchase price compared to only 36% of the control group. (The question was only put to control group respondents who bought a rebate-qualifying refrigerator.) Moreover, 64% of the rebate group reported using the yellow ENERGY GUIDE label attached to all refrigerator models to compare energy costs, while only 46% of the control group did so.

An interesting finding, with important implications for program planning, concerns the role of the appliance salesperson. A large portion, 59% of the rebate group, reported that the salesperson had a positive influence on the decision to purchase an energy efficient model, while only 29% of the control group with rebate-qualifying refrigerators reported a positive influence from the salesperson. Even the control subgroup portion selecting the most highly-efficient, BPA Award refrigerators reported no more positive influence from the salesperson. Clearly, the rebate program influenced the interaction between the salespeople and the customers. More salespeople promoted efficient refrigerator models in the Enterprise Zone to customers who may not have otherwise bought them. This may well be one of the most significant accomplishments of the rebate program and one that could be replicated in other programs. It also underscores the importance of working closely with trade allies in an appliance rebate program.

The survey analysis was extended to the control subgroups to see whether any distinguishing characteristics could be identified among the households that, without the incentive of a rebate, had selected high-efficiency refrigerators, such as those qualifying for the BPA award. It must be noted at the outset that the number of survey respondents in the control subgroups is too small to draw any statistically significant conclusions: of 54 survey respondents, 10 qualified for the BPA award, 22 qualified for the rebate but not the BPA award and 22 did not qualify for either rating. A study of the subgroups found that the BPA award group was highly conscious of energy efficiency, not unlike the rebate group when compared to the control group. The BPA award group was more likely to believe that an energy efficient refrigerator was worth the extra initial cost and more likely to use the ENERGY GUIDE label to compare models.

Finally, of the control group respondents who had not purchased a rebate-qualifying refrigerator, 42% said they would have selected a more energy efficient model with a rebate of \$50. When the rebate was raised to \$100, the amount offered in the Enterprise Zone, 62% said they would have bought a more efficient model. This points to rapidly diminishing returns for the extra \$50 in the rebate.

COSTS AND BENEFITS

The Enterprise Zone Refrigerator Rebate Program's benefits to the New England Electric System (NEES) consist of the energy saved by inducing the participants to purchase more energy-efficient refrigerators than they would have otherwise selected. These energy savings were purchased at a cost of \$100 rebated per refrigerator, excluding administrative costs. The purchase choice analysis was used to calculate the benefits of the Refrigerator Rebate Program since it was considered more accurate in isolating the effects of the new refrigerator on electricity usage. Accordingly, as shown in Table I, the mean annual kWh consumed per rebated refrigerator was 994.9 kWh compared to 1033.2 kWh per control group refrigerator, a difference of 38.3 kWh per year. While the program will yield these benefits every year over the average life of the refrigerator, the \$100 cost occurred only in the first year of the program.

Enterprise Zone programs used an avoided cost of 7 cents per kWh as a cost-effectiveness criterion. The Refrigerator Rebate Program exceeded this cost as its savings (undiscounted) were bought at 26.1, 17.4 and 13.1 cents per kWh under ten, fifteen and twenty year lives, respectively.

The Refrigerator Rebate Program cost-effectiveness was also assessed using the NEES Least Cost Model (LCM), a planning tool that values all energy savings at marginal cost and demand savings at the cost of deferred construction. The LCM produced even more unfavorable cost-benefit ratios of 9.9, 6.6 and 5.1 under a ten, fifteen and twenty year life, respectively; again, far in excess of a ratio of 1, the maximum for a cost-effective program.

The main reason for the program's costs outweighing its benefits by such a large margin was the lack of significant savings, due to the high number of free riders. The second reason for the lack of cost-effectiveness was that, at \$100 per rebate, the program's costs were too high. These program features lead to several recommendations for improving its cost-effectiveness, which are discussed in the next section.

CONCLUSIONS AND PLANNING GUIDES

The main conclusion of the evaluation was that, using cost-effectiveness as a criterion, the Refrigerator Rebate Program cannot be justified. However, the evaluation provided some insight into improvements for similar rebate programs, if a utility wanted to follow this course, as well as the usefulness of energy efficient appliance marketing programs.

One improvement to the rebate program would be to raise the standards for qualifying appliances. This would decrease the number of free-riders since fewer households would buy highly-efficient appliances without an incentive. A more stringent standard would also increase the annual savings attributed to the program. As the purchase choice and energy usage analyses showed, the households purchasing a BPA Award-qualifying refrigerator saved over twice as much electricity as the households purchasing Enterprise Zone rebate-qualifying refrigerators.

The other approach to improving a rebate program's cost-effectiveness is to lower the rebate amount; hence, the program's costs. Most refrigerator rebate programs have used \$25 to \$50 rebates, which are often tied to the efficiency level of the model selected. Indeed, the survey analysis showed diminishing returns for rebates above \$50.

An alternate course is away from a rebate program in favor of an intensive marketing program. The rebate program was very effective in several aspects. It did raise the consumer's consciousness of the value of energy-efficient appliances and the value of doing the cost comparisons among different models. Equally important, it got appliance salespeople to actively promote more efficient refrigerators. These objectives may also be pursued through an aggressive program of consumer education and cooperative advertising with dealers.

The New England Electric System companies currently have such a marketing/education program, modeled on BPA's Blue Clue Award program, under consideration. It would identify the most energy efficient refrigerators and possibly other major appliances. Such appliances would also be promoted to customers through direct mail. Dealers would be encouraged to highlight such models in their advertising and to help educate consumers about the energy savings over the lifetime of the appliance.

Many of us who implemented the Refrigerator Rebate Program or worked on its evaluation feel that such an innovative marketing/education program would be a successful application of the lessons learned from the Enterprise Zone Refrigerator Rebate Program.

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