Documenting Energy Savings Enhancements from Energy Education Components of a Low-Income Weatherization Program

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Niagara Mohawk Power Corporation (NMPC) has joined the increasing number of utilities that are providing weatherization programs for their low-income customers. In order to determine the most effective elements to include in its system-wide program, NMPC asked the Alliance to Save Energy to design and evaluate a comprehensive low-income energy management pilot program, the Power Partnerships Pilot.

The Pilot targeted customers who were not only low-income but also payment-troubled. It provided not only weatherization and electric demand-side management (DSM) measures but also energy education, a money management exercise and an affordable payment plan. This report describes the energy savings, improvements in payment patterns, and cost effectiveness of three different treatments: weatherization, weatherization plus education and an affordable payment plan, and weatherization plus education, an affordable payment plan and a feedback device. These results were also compared to a no-treatment control group.

Introduction

Various organizations, ranging from the federal government to individual utilities to private businesses, have over the past 18 years educated consumers about energy choices. These activities have generally been considered difficult, if not impossible, to evaluate, and without data to support their effectiveness have given way in recent years to more focused marketing strategies. However, recent efforts to incorporate energy education into low-income weatherization programs have provided the opportunity to test the effectiveness of energy education to increase energy savings beyond those provided by weatherization alone.

This paper reports on the results of the Niagara Mohawk Power Corporation (NMPC) Power Partnerships Pilot, a comprehensive low-income energy management pilot program. This Pilot incorporated several innovative elements that can increase our knowledge of the best way to maximize potential savings from energy efficiency efforts in low-income households. Although several low-income weatherization programs incorporating energy education have been conducted around the country, they have not provided enough data to establish the most effective energy education methods. Even less data is available on the effect of money management education, in conjunction with weatherization, on improving payment behavior of payment troubled customers. A feedback device that provides immediate, cumulative information on gas cost in dollars has not been tested as an energy education method.

The goals of the Pilot were to 1) empower low-income participants to increase their control over their comfort, energy use and costs, 2) provide NMPC with information that will assist with the implementation of their system-wide program, and 3) field test a comprehensive package of energy management services including energy education, a money management exercise and an affordable payment plan to determine the extent to which education would further increase energy savings and improve payment patterns beyond those achieved from weatherization alone.

Research Methodology

Information in this report was ascertained from analysis of data relating to four groups of low-income, payment-troubled customers receiving the following services:

- Group 1 (n = 39)--Control Group--no services,
- Group 2 (n = 47)--Weatherization Group--New York State Weatherization Assistance Program (weatherization) only,

- Group 3 (n = 47)--Education Group--weatherization, energy management education and a money management exercise, electric demand side management (DSM) measures and an affordable payment plan, and

- Group 4 (n = 47)--Education Group plus Feedback--all the services Group 3 received and a feedback device.

Two hundred fifty five NMPC customers who were low-income, payment-troubled, lived in one- to four-unit buildings which were individually metered and had not been weatherized previously, paid their own utility bills, and had one year of pre-treatment data available at the same address were recruited for participation in Groups 2, 3 and 4.

Consumption and payment information was available from NMPC for the time period October 1988 through October 1991. The following 14-month periods were determined to be the best representation of pre- and post-treatment years:

Table 1. Gas and Electric Consumption

Pre-treatment Period	10/1/88 to 11/30/89
Post-treatment Period	9/1/90 to 10/31/91

The Princeton Scorekeeping Method (PRISM) was used to normalize consumption data. Inputs to PRISM included consumption data from NMPC and temperature data from the National Oceanic and Atmospheric Administration (NOAA) for the Syracuse and Albany stations. Output from PRISM, including normalized annual consumption (NAC), the heating component of NAC (HNAC), the reference temperature, heating slope, baseload and the R-square statistic, was merged with demographic data available for each household in the study. Fuel consumption was also examined in relation to payment patterns and arrearages in an attempt to determine the effect that changes in energy use may have on a household's ability to pay.

This report will answer questions addressed by the Pilot in the following areas: energy consumption reduction, payment pattern improvements, cost-effectiveness, and difficult-to-quantify benefits.

Services Provided

Weatherization

The weatherization was provided by the New York Department of State Weatherization Assistance Program (DOS WAP), through seven of its local sub-grantees. The standard weatherization audit and procedure was used, with the addition of the new Targeted Investment Protocol System (TIPS). This procedure analyzes the energy consumption data of the one-to-four-unit dwelling and characterizes the unit in terms of its comparative energy efficiency. This efficiency level then determines the level of investment in the unit based on its potential energy savings, and targets an appropriate workscope.

Electric Efficiency Measures

The Pilot identified electric DSM measures that could be installed in participants' homes to help conserve electricity. Since the two largest energy users in the home, space and water heating, were provided by gas, electricity savings were limited in magnitude. The major electric reduction retrofit consisted of the installation of two to five compact fluorescent bulbs to replace incandescent bulbs used at least four hours per day.

Education

The purpose of providing energy education to NMPC'S customers is to help them gain control of their energy use, their comfort and to help lower energy bills. The purpose of the money management exercise is to help them gain more control over spending habits, expand their awareness of the relationship of total income to necessary expenditures such as utility costs, and expand their awareness about the relationship of utility costs to other necessary costs such as housing, food and clothing.

The education provided took the form of three in-home sessions with as many family members as could participate. As a follow-up to the education sessions, participants' energy bills were accompanied by personalized letters noting how much energy was used during the month and how that related to the energy use goal set by the family; the previous month's payment was also noted. Reminders relating to energy conserving measures the family might take this month were noted, and when appropriate, families were reminded to apply for assistance funds.

The education component can be considered from two perspectives: content and process. The content emphasizes energy management information intended to expand the family partner's understanding that a house and its occupants both use and lose energy, but that there are certain actions that can be taken to gain greater control over energy loss.

The content used in this project is basic energy efficiency principles, with an emphasis on calculating dollar consequences of each household's specific energy habits and behaviors. Materials and directions were provided for self-help measures that each family could take to reduce the amount of energy used, while still maintaining or increasing comfort levels.

The education process is more complex, but more important to the goal of empowering customers to increase control over their energy use, comfort and costs. The process emphasizes behavior change, whereas the content emphasizes reliable information which encourages responsible energy use.

Education process and content were incorporated into each of the program's eight steps: (1) Intake, (2) Orientation, (3) Energy Audit, (4) Education Session One, (5) Weatherization, (6) Quality Control Inspection, (7) Education Session Two and (8) Education Session Three.

Affordable Payment Plan

Participants in Groups 3 and 4 participated in an Affordable Payment plan, in which a reasonable, sustainable payment amount was developed by the Regional Coordinators jointly with each family partner during the second education session. Participants were told that as long as they made that payment, even though it was not as high as their bill amount, their service would not be terminated. This second education session reviewed and reinforced the energy savings content of the first session, but was focused primarily on helping families understand where their money comes from and where it goes, and on developing a strategy for managing it better. Payments on energy bills were expected to be either third or fourth priority for most families, after food, housing and, if applicable, medical expenses.

Feedback Device

The only difference between the services received by Group 3 and Group 4 was the use of a feedback device as an additional educational tool for Group 4 participants. The feedback device, the Energy Log, is an electronic meter that mounts on the wall near the thermostat and shows how much has been spent--in dollars--on heating and, separately, on water heating, since the device was reset. This information, it was hypothesized, would help participants who are trying to control their energy use by letting them know throughout the month how they are progressing on achieving their savings goals.

Energy Consumption Reduction

Gas Savings

As shown in Table 2, participants in Groups 3 and 4 reduced their gas consumption by 25.9 percent and 25.5 percent, compared to 16.3 percent for the group that received weatherization only (Group 2); this represents a first-year increase in savings of 63 percent.

There was no statistically significant difference between the savings in Group 3 and Group 4. The feedback device does not seem to have resulted in additional savings beyond those achieved by the education sessions. However, two technical problems experienced with the device prevent the conclusion that feedback of this type is ineffective. First, due to heating system incompatibilities or installation problems, approximately 16 percent of the devices never worked properly for either space heating or water heating. Second, many more did not work properly

Table 2. Gas Savings -- Therms

Group	n	Pre-Tx	Pre-Heat	Saved (total gas)	Saved (heat only)	%Saved (total gas)	% Saved (heat only)
1	39	1682.4	1293.8	36.6	28.0	-1.6	-3.0
2	47	1729.2	1403.9	303.9	284.2	16.3	18.2
3	47	1641.6	1226.9	445.3	359.1	25.9	27.3
4	47	1956.9	1537.5	547.4	487.8	25.5	28.4

until after the second education visit, leaving only one visit to help participants understand how to use it.

Another perspective on this finding is that the package of services experienced by Group 3 represented extensive intervention; perhaps it was not realistic to expect one more energy management tool--electronic feedback--to significantly enhance the effectiveness of the total energy management package. Feedback in the form of individualized monthly follow-up letters noting the household's actual energy use are part of the Group 3 package. It would be useful to test an electronic feedback device in relation to other treatment groups that received less extensive services.

Because the difference in savings between Groups 3 and 4 was essentially non-existent ($T = -1.434$; probability $> |T| = 0.2561$), Groups 3 and 4 will be discussed in the balance of this section as a single group, "Education."

In interpreting these savings, it is important to understand that the Education Group participants also took part in an affordable payment plan which involved developing a family spending plan; on the basis of that plan the educators and participants jointly determined a reasonable and sustainable monthly payment amount. As long as the participants made that payment each month, they were guaranteed not to have their service terminated. This had the effect of decoupling the energy savings from the energy bill, removing any economic incentive for the participants to conserve energy. The Weatherization Group had no such disincentive. This makes the savings for the Education Groups all the more impressive.

Significance Tests. Several significance tests, including an Analysis of Variance and the Student's T were used to determine whether the difference between effects of the various treatments was significant. For the purposes of this report, a significance level of .05 was chosen as a criteria for rejecting the null hypothesis that there is no relationship between the treatment and savings. A significance level of 0.10 was thought to be worth mentioning, given the exploratory nature of the Pilot. The relationship of variables of interest and savings was judged using the same criteria.

Initially, each of the treatment groups was compared to Group 1, the non-treatment control group. The two combined Education Groups were then compared to Group 2, the Weatherization Group. The following table illustrates the results of the T-test for the comparison of percentage savings.

As Table 3 indicates, both the Education and Weatherization Groups experienced a significant savings when compared to the non-treatment Control Group (Group 1). The difference in savings between Group 2 and Education Groups was also significant. Significance tests were also used to examine the difference in means for 1) percentage savings for heating only, 2) savings in therms for total gas consumption and 3) savings in therms for heating only. Each of the tests found similar relationships as those illustrated in Table 3.

The variability of savings and of some participant characteristics in each of the groups is large enough to indicate that there may be differences between the households included in the Pilot that suggest the need for varying approaches to both weatherization and education. Study objectives include both quantifying savings associated with the Pilot and assisting in the identification of characteristics associated with the greatest potential for savings.

Other Factors Related to Savings. A considerable amount of information was collected in an attempt to understand the range of factors associated with peoples' choices on how to use and/or conserve energy. In order to

Table 3. Percentage of Savings -- T-Test Results

Group	n	Mean	Standard Deviation	SE Mean	Probability > T
Control	39	-1.6	20.1	3.2	
w/Weatherization	47	16.3	14.2	2.1	0.0001
w/Education	94	25.7	15.6	1.6	0.0001
Weatherization	47	16.3	14.2	2.1	
w/Education	94	25.7	15.6	1.6	0.004

determine what factors other than the treatment might have affected gas savings, information on a number of demographic and structural factors was collected and analyzed. The following factors were found to be related to savings: pre-treatment consumption, income, number of occupants, and square footage.

Pre-treatment Consumption. Pre-treatment consumption was the most significant factor affecting energy use other than the treatment, a finding consistent with other research. First, pre-treatment consumption was examined to determine whether there were differences between the NAC or HNAC for the Weatherization and Education Groups; neither was found to be significantly different between the two groups.

To get a better idea of how pre-treatment consumption is related to savings, consumption was divided into two categories: greater than 1600 therms per year, and 1600 therms or less per year. The following table (Table 4) illustrates the effect high or low usage had on savings in both Education and Weatherization houses.

The table illustrates the relationship between energy savings and high-usage households. It is not surprising that households with high pre-treatment consumption consistently saved more. The fact that percent savings for participants in the Education Group is not as strongly related to pre-treatment consumption, however, raises an interesting question. Does education result in significant savings in spite of the fact that participants with low pre-treatment consumption have lower potential for saving?

Two observations in relation to this finding emphasize the strength of the effects of the education experienced by the Power Partnerships Pilot participants. First, for both total gas use and heating only, low users in the Education Groups saved more in percentage terms than high users in the Weatherization Group. This may indicate that education has the potential to be an even more significant driver of savings than level of pre-treatment consumption. Second, the difference between low users and high users is smaller for the Education Groups (6.3 for total gas and 6.4 for heating) than for the weatherization group (9.6 for total gas, 12.6 for heating only). Education seems to have increased the predictability of energy savings.

Square Footage. A factor strongly associated with consumption is the size of the structure. An analysis of variance indicated that there was a fairly strong relationship between square footage and savings. To investigate this further, structures were divided into three categories: under 1000 square feet, 1000 to 1400 square feet, and over 1400 square feet. Savings was looked at by each of these three categories for both the education and weatherization groups. Consumption per square foot was calculated in order to better compare energy use in different size structures.

The nature of the relationship between square footage and savings in both the Education and the Weatherization Groups was not obvious until consumption was adjusted to account for the size of the structure. (See Table 5.)

For both the Weatherization and Education Groups, participants who live in smaller dwellings appear to have used more energy per square foot in both the pre- and post-treatment years than participants who live in larger structures. Participants in the Education Group, regardless of the size of the structure they live in, had pre-treatment consumption (adjusted for the size of the structure) higher and post-treatment consumption lower than Weatherization Group participants. However, for both education and weatherization households, the post-treatment consumption per square foot of smaller structures is still higher than either the pre- or post-treatment use per square foot of

Table 4. Effect of Pre-treatment Consumption

	Education Houses			Weatherization Houses		
Saved (therms)	High (n=52)	Low (n=42)	Sig. @	High (n=26)	Low (n=21)	Sig. @
NAC	652.6	303.0	0.0001	429.6	148.3	0.001
Heat Only	568.2	244.2	0.0001	417.5	119.0	0.001
Percent Saved						
NAC	28.1	22.8	0.10	20.6	11.0	0.05
Heat Only	30.7	24.3	NS	23.8	11.2	0.05

Table 5. Savings by Square Footage

	Small		Medium		Large	
Variable	ED (n=17)	WX (n=13)	ED (n=36)	WX (n=16)	ED (n=30)	WX (n=14)
Use/sq. ft. Pre-treatment	2.06	1.79	1.42	1.38	1.06	1.02
Use/sq. ft. Post-treatment	1.40	1.47	1.04	1.12	.78	.85
Saved	.66	.32	.39	.26	.28	.17
% Saved	29.2	15.6	25.7	17.3	24.2	15.3

larger structures, suggesting that there may be additional opportunity for energy conservation in these smaller houses.

Income. Income was not related to savings for the Weatherization Group, but in the Education Group participants with lower incomes saved more. In order to examine the relationship of savings and income, monthly income was divided into the following categories:

Low - $750
$751 - $1500
$1501 - High

Savings was examined by each of the income categories to determine whether there is a relationship between a household's ability to pay and that household's motivation to conserve energy. Education households with the lowest income saved, on the average, the most energy. This trend was not evident in the weatherization group. (See Table 6.)

It seems that even though the Affordable Payment Plan had the effect of removing a dollar benefit to the participant for saving energy, participants with lower incomes were trying to bring their use down closer to the amount of energy they could afford.

Table 6. Percent Savings by Income

	Low	Medium	High
Education	30.5	26.1	20.0
Weatherization	18.8	16.3	17.5

Number of Occupants. Number of occupants was not a factor in savings for the Weatherization Group but for the Education Group, savings was related to the number of people in the household. Households with one occupant saved more than households with more than one person.

Houses were divided into three categories:

Single Occupant
Two-person Households
Three-or-more-Person Households

There appears to be no strong linear relationship between the number of occupants and savings for participants in either the weatherization or education group; that is, as the number of occupants increased, savings either increased or decreased. Interestingly, one-person households in both treatment groups had higher pre-treatment consumption than two-person households or households with three or more people, suggesting that one-person households in both treatment groups had greater potential for savings than multi-person households.

However, one-person households in the Education Group saved more than households with one person in the Weatherization Group. Education households with pretreatment consumption of 2150 therms saved 27.1 percent of their pre-treatment consumption (656 therms). In contrast, weatherization single-person households with pre-treatment consumption of 1876 therms saved an average of 16.6 percent (284 therms).

This may indicate that the person who actually experienced the education was more motivated or simply more able to conserve than household members who heard about the education from another member of the household.

Electric Savings

As can be seen in Table 7, all three treatment groups reduced their use of electricity.

The differences between the Control Group and the treatment groups were significant, but differences between the Weatherization Group and the Education Groups were not significant. Since pre-treatment usage was quite low, it is not surprising that this difference is not significant.

Pre-treatment Consumption. As for gas savings, the single largest factor related to savings is pre-treatment consumption. One difference in consumption patterns between electrical use and gas use is the large variation in electrical usage, probably because of the range of electric appliances different participants had, such as electric dryers, microwave ovens and ranges.

A number of other factors were examined in relation to electrical savings. Two factors that were found to be significant--pre-treatment consumption and number of occupants--are discussed below.

Average pre-treatment use for houses in the Weatherization Group is quite similar to the pre-treatment consumption level of houses in the Education Group (19.9 kWh/Day and 20.3 kWh/Day respectively). However, the spread between the minimum and maximum usage, illustrated below, shows that there is a vast difference among households in both groups in their level of electrical use and, therefore, their potential savings. (See Table 8.)

Table 9 illustrates that pre-treatment use of electricity is a major factor in the savings that can be obtained through energy conservation efforts.

Number of Occupants. For Education households with one or two people, the average savings was 2.8 kWh per day (13.6 percent), compared to an average savings of 3.2 kWh per day (8 percent) for households with five or more people. Education households with three or four people saved, on average 1.5 kWh per day (5.0 percent). Pre-treatment consumption for education families of one to two, three-four, and five or more people was 15.7, 20.0, and 24.8 respectively. In spite of lower pre-treatment consumption levels, savings experienced by education households with one or two people achieved a greater percentage reduction in the use of electricity than was experienced by larger households. This relationship was not observed for participants in the Weatherization group. (See Table 10.)

Table 7. Electrical Savings by Group

Group	n	Pre-treatment kWh use/day	Saved[a]	% Saved
1	49	19.8	-0.74	-3.7
2	62	20.3	1.4	4.5
3	55	19.8	2.6	7.4
4	50	20.0	1.7	7.1

(a) Calculated on kWh use per day.

Payment Pattern Improvements

In addition to the reduction in energy use, the Pilot was interested in determining the effect the Pilot treatments had on payment and arrearages. This section will look at three aspects of the dollar benefit of the various treatment packages.

- the effect on payment practices;
- the effect on the growth of arrearages; and
- the effect on disconnection of services to customers.

Table 8. Range of Pre-treatment Consumption

	n	Mean (SE)	Min.	Max.
Weatherization	62	20.3	4.8	47.8
Education	106	19.9	4.0	76.7

Table 9. Effect of Pre-treatment Consumption

	n	Pre-treatment Per Day (kWh)	Adjusted 365 Days	Saved Per Day (kWh)	Percent Saved	T	Prob > T
Education							
High	48	28.4	10362.4	4.4	13.1		
Low	58	12.8	4689.7	0.3	2.4	2.9612	0.0038
Weatherization							
High	28	27.4	10013.7	2.4	9.1		
Low	34	14.5	5295.6	0.6	0.7	1.2203	0.2273

Table 10. Savings by Number of Occupants

Group	n	Pre-treatment Consumption by Day (kWh)	kWh Saved	Percent Saved
Education				
One or Two	25	15.8	2.8	13.6
Three or Four	40	20.0	1.5	5.0
Five or More	28	24.8	3.2	8.0
Weatherization				
One or Two	10	19.2	1.9	6.1
Three or Four	27	20.4	2.6	10.8
Five or Six	18	21.4	0.3	-2.0

Effect on Number and Amount of Payments

Group 3 and 4 participants almost doubled the total number of payments made by them or on their behalf to the utility during the post-treatment period, compared to the pre-treatment period (from 426 to 849 payments for Group 3; from 368 to 792 payments for Group 4). In contrast, Group 1 actually decreased the number of payments made and Group 2 increased the total number only slightly (from 404 to 446 payments).

The difference between groups is even greater when payments made only by customers are examined, (excluding the Home Energy Assistance Program (HEAP) and Department of Social Services (DSS) payments) indicating that Education participants relied more on their own resources in making energy payments than they had previously.

The average monthly payment amount decreased for all four groups in the post-treatment period. For the Education Groups, the amount of decrease was substantial, while for Groups 1 and 2 the difference was slight. This decrease in payments in Groups 3 and 4 is a direct result of the affordable payment amount negotiated by the coordinators with households; in many cases, the monthly payment amount negotiated was lower than the amount necessary to cover energy use, and for participants with very low incomes was as low as $10 per month. However, the increase in regularity of payments brought the average monthly customer payments to the utility above the amount paid by participants in Groups 1 and 2: $80 for Group 1, $75 for Group 2, $98 for Group 3, and $99 for Group 4 participants.

Corresponding to the average dollars per month, the total customer dollars paid to the utility also increased for the three treatment groups. Again, Group 2 payments increased slightly from $844 to $895. Group 3 increased its payment from $883 to $1174 and Group 4 increased from $968 to $1188.

Households in Groups 3 and 4 could miss a payment and not be dropped from the Affordable Payment Plan if they made arrangements with the NMPC Coordinator to make up the payment. Nevertheless, 31 households (18.2 percent) were dropped from the APP for not maintaining the agreement. Of these, the Coordinators, from their knowledge of the household's situation, characterized 10 as "can't pay" and 21 as "won't pay". Over 80 percent of Group 3 and 4 participants either made all payments on time, missed one and made it up, or missed only one payment.

DSS and HEAP Payments

The contribution of Home Energy Assistance Program (HEAP) and Department of Social Services (DSS) payments dropped for Group 3 and 4 participants during the post-treatment period. This drop resulted in an increase in the total dollars paid to the utility for Group 3 of $31 and Group 4 of $91, compared to a decrease of $26 for Group 1 and decrease of $102 for Group 2.

If households had received in the post-treatment period the HEAP and DSS dollars they received in the pre-treatment period, they would not have built up new arrears to the company.

Change in Arrearages

It was hoped, in the design of the program, that the combined effect of reducing usage, increasing regularity of payments and accessing all available public assistance dollars would result in a zero balance and that no new arrearages would develop. Since the affordable payment amount for many families was far below their actual energy usage and bills, it was understood that this was an optimistic hope. In fact, participants in all groups built up arrears in the post-treatment period. For Group 3 new arrears in November 1991 were $215, and for Group 4 were $207. Group 2 arrears were $11 in the same period and for Group 1 were $236.

The build-up of new arrears varies greatly according to the amount of the affordable payment amount, which, since it takes into consideration family size and other obligations, is a good reflection of actual disposable income. Participants who could only pay $50 or less in monthly payments built up average arrears of $920, almost exactly the same as their arrearage amount during the pre-treatment period. Participants who could pay between $50 and $100 built up arrears of $172, approximately half of their previous arrearage amount. The group that was able to pay over $100 built up arrears of $11, compared to a previous arrearage build-up of $487.

The build-up of new arrears seems to be closely related to ability to pay. Participants with very low income, reflected in low payment amounts, simply could not cover their full bill amount, even with the average reduction in their usage of over 25 percent. It may be that if a primary goal of the Pilot was to eliminate the build-up of new arrears, the original design of the Pilot would have been more appropriate. In this design, customers whose income put them in the category of "can't pay even with help" customers would not have been included; "could pay with help" customers would have been the primary target. This would, however, eliminate those customers who have the greatest need for a program such as this.

Two factors should be considered in relation to this issue. One is that customers with lower incomes in the Education Groups saved more energy, even though there was no financial incentive for them to do so. This indicates a personal commitment to fulfill their part of the partnership.

The second factor is that Group 3 and 4 participants did not apply for and receive the level of HEAP and DSS payments they were eligible for. If HEAP and DSS dollars had been received at the same level they had in the pre-treatment year, Education households would, on average, not have built up new arrears. The issue of how to encourage participants to apply for assistance dollars, and attempting to reduce disincentives and restrictions on receipt of those dollars, will be addressed in the ongoing Power Partnerships Program.

Disconnections

In the pre-treatment period, between six and seven percent of households experienced full months in which no consumption was recorded at the meter because service was shut off for non-payment. This reflects only a portion of households which had service terminated for nonpayment, since many households arrange to have service reconnected within a few days. This finding is consistent with the estimate by Response Analysis Corporation that 20 percent of all arrears households are shut-off for nonpayment in the course of a year.

While households in Groups 1 and 2 continued the pattern of six to seven percent experiencing full months of no service, Groups 3 and 4 experienced almost no shut-offs during the pre-treatment period; the six households that were shut off had dropped from the Pilot.

Cost Effectiveness

The original goal of the Pilot was to develop an effective, comprehensive low-income energy management program, rather than to focus on its cost-effectiveness. However, an examination of cost-effectiveness provides useful information for making future program decisions.

Cost-effectiveness was calculated for the actual education delivered, using three education sessions, and also for the model that was designed for and is being implemented in the continuing Power Partnerships Program by NMPC, which calls for two education sessions. It is not known, however, whether the savings would be the same in the two-session model.

Three standard test were used to calculate cost-effectiveness of the various treatments used in the Pilot: simple payback time (SPT), net present value (NPV), and cost of conserved energy (CCE). The formulas for these tests are:

- $SPT = I / (S * P)$
- $NPV = \sum_{j=1}^{n} (S * (P_j - C_j)) / (1 + d)^j$
- $CCE = (I / S) * [d / (1 + d)-n)]$

where I = Total Investment
S = Annual Energy Savings (equal to first year savings)
P = Local Energy Price
n = Lifetime of Measure
P_j = Real Energy Price in Year j
C = Annual Cost of Measure (in constant dollars)
d^j = Real Discount Rate

The assumptions used in the tests include a discount rate of 10.7 percent and longevities of 20 years for the weatherization and five years for the education. These assumptions were used because they had been used in NMPC's filing to the commission. It should be noted that the discount rate is unusually high and the assumption of longevity for education measures is not based on experience (no studies have been conducted on durability of education savings) and is probably optimistic. The cost of electricity was $0.0892 per kWh, and for gas was $0.5772 per therm.

The following chart (Table 11) details the costs and benefits that are used in the cost-benefit calculations.

The benefit figures used do not include several categories of difficult-to-quantify benefits--those subjective benefits such as added comfort, health, control over energy use; a positive relationships with NMPC; and the value of establishing good payment patterns with payment-troubled customers. (See Table 12.)

This Pilot was not designed to answer one important question relating to the cost effectiveness of education as a demand-side management tool--the durability of savings. The Pilot may or may not be an expensive program, depending on how durable the savings are.

Table 11. Assumptions -- Dollar Values

Group	Cost (Wx)	Cost (Educ)	Added Payments[a]	Avoided Cost	Saved Electric	Saved Gas	Environ Benefits
2	1857	0	0	0	68.37	15.41	12.03
3 (3 visits)	1926	449.75	232.80	70.71	106.47	23.55	18.74
4 (3 visits)	2118	549.75	176	70.71	78.79	29.50	13.87
3 (2 visits)	1926	374	232.80	70.71	106.47	23.55	18.74
4 (2 visits)	2118	474	176	70.71	78.79	29.50	13.87

(a) 80 percent of increased customer payment from pre- to post-treatment period.

Table 12. Standard Cost-Effectiveness Tests

Group	Simple Payback Time	Net Present Value	Cost of Conserved Energy
Weatherization Only			
2	8 yrs. 8 mos.	$530	$7.56
Weatherization Plus Education -- Three-Session Model			
3	5 years	$1107	$5.76
4	6 yrs. 6 mos.	$657	$7.13
Weatherization Plus Education -- Two-Session Model			
3	4 yrs. 10 mos.	$1183	$5.48
4	6 yrs. 2 mos.	$733	$6.86

Comparative Analysis of Service Package

This aspect of the analysis examined the statistical relationship between reduced energy bills, consumption, and reductions in future (post-treatment) participant arrearages. Conclusions are summarized as follows:

- There is no relationship between pre-treatment arrearages and energy savings.
- There is no relationship between energy savings and current arrears.
- There is no relationship between the amount of payment and energy savings.
- There is no relationship between missed payments and current arrears.
- There is a strong relationship between how much a participant could pay on his energy bill and the current arrearage owed to NMPC.
- Factors related to successful reduction of energy use are:
  - pre-treatment consumption level of the household
  - size of the structure
  - number of occupants, and
  - income.
- Income is the single factor that appears to be most directly associated with both payment amount and current arrears (people with lower incomes made lower payments and accumulated higher arrears).
- Larger families appeared less able to stay current with their energy bills than smaller families.
- Families with two or more people did not, on the average, save as much as single-person households.

Difficult-To-Quantify Benefits

The Power Partnerships Pilot involved more than simply providing information about how to reduce energy bills and increase utility payments to avoid shut-off of service. It involved helping people gain control--over their comfort, over their energy costs and over their money. The respectful and empowering interactions between NMPC Coordinators and Pilot participants produced benefits that did not appear in the savings and payment numbers.

The Pilot attempted to quantify these benefits in two ways. First, in order to get a feel for what these benefits were, Coordinators were asked to identify examples of benefits beyond energy savings from their observation of participants. Second, a follow-up telephone survey was conducted of participants in all three treatment groups plus the pool of households from which the control group was taken. The survey asked questions that determined whether and to what extent participants believed they benefitted in the various ways identified by the Coordinators.

The Coordinators identified the following areas of improvement: quality of life, household management, relationship with NMPC, emotional health and social skills, quality of housing stock, health, financial status, and access to available services.

The follow-up survey (n = 231) identified specific areas in which all treatment groups benefitted compared to the Control Group, and other areas in which the Education Groups benefitted more than the Weatherization Group.

Comfort in the Home During the Winter

Households in all three treatment groups reported that their homes were less drafty after the treatment. Education households reported a higher level of satisfaction with the results of the weatherization than do Weatherization households. Education households also kept their homes cooler than they did before the Pilot, and expressed more satisfaction with that temperature. (For Group 3, 51 percent kept their house cooler and 81 percent said that is the temperature they prefer.)

Health and Safety

Fewer households in the Education Groups (16 and 11 percent) than the Weatherization Group (26 percent) perceived that they had health problems caused by the house being too cold in the winter; even more households in the Control Group (36 percent) perceived that they had health problems related to home temperature.

Ability to Control Amount of Energy Used

Education households were more likely than Weatherization households to have taken some personal action to reduce energy use, and showed some awareness of what might cause increases in energy use. The percentage of Group 3 and 4 participants who felt that they have the ability to control their energy use (78 and 80 percent respectively) is significantly higher than that for Weatherization Group (57 percent) or the Control Group (45 percent).

Ability to Pay the Niagara Mohawk Bill

Three quarters of Education participants said that the bill had gotten easier to pay. In contrast, fifty percent of Control Group participants reported that their bill had become harder to pay, and about a third of Weatherization participants said their bills had gotten harder to pay. Forty five percent of Control Group households reported they feel "some" or "a lot" of control over their bill, 57 percent of Group 2 participants felt that way, and 78 percent and 80 percent of Group 3 and 4 participants respectively felt that way.

Skills in Obtaining Public Assistance Benefits

Group 3 and 4 participants accessed a high level of HEAP and DSS assistance during the program year, but did not appear to maintain that level during the post-treatment year. Twenty-eight percent of Education households reported being referred to other public assistance programs.

Attitudes Towards Niagara Mohawk

About 70 percent of Education participants felt that Niagara Mohawk was "very concerned" about its customers' well being, as opposed to one third of Weatherization and Control Group participants feeling that way. Half of Education participants gave NMPC the highest overall rating, compared to about 20 percent of other customers.

Quantification of Benefits

While the description of these benefits, and determination that some of them accrue in greater measure to Education households than to Weatherization or Control households, helps establish their existence and validity, it does not put a dollar figure on them. The important work of determining exactly how to account for these benefits in the mathematical equations used to determine cost effectiveness remains to be done.

Summary

The Pilot model seems to have succeeded in accomplishing increased control over energy use and costs, lower customer bills and larger and more consistent customer payments, and a positive relationship between low-income customers and the utility. It was not as successful in preventing the build-up of new arrears.

The Power Partnerships Pilot provides a wealth of information about the success of particular Pilot program elements that will be useful not only to Niagara Mohawk but also to other utilities. Observations include the following:

- The type of education provided largely accomplished its objectives: participants reported the services provided to be very useful, and changes in energy consumption and payment patterns bore out that usefulness.

- The feedback device did not demonstrate further savings beyond those provided by the three education sessions. While this finding does not indicate that feedback is not effective, it points out some of the difficulties involved in introducing a unfamiliar and technically untested electronic device.

- The strongest factor that influenced participant savings (other then education) was the level of pre-treatment consumption. Education programs should take the level of energy use into account in determining the content and extent of education provided. Also, the relationship between energy savings and income level suggests that money management as well as energy education might be useful components of a low-income energy management program, even if payment improvements are not part of the goal of the program.

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