Attachment C
Program Evaluations for Low Income Weatherization and Energy Education in Schools

PACIFIC POWER
A DIVISION OF PACIFICORP

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Final Report

Washington Low-Income Weatherization Program

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Pacific Power

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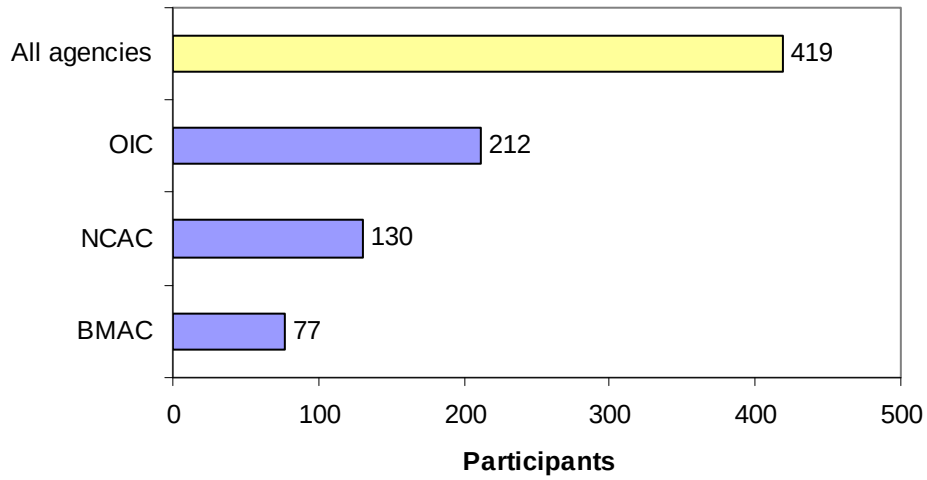
1. Executive Summary

Program Description

Pacific Power's Weatherization Program (the Program) in Washington assists low-income households in controlling energy consumption and heating costs through comprehensive home weatherization and energy education.

Between July 1, 2003, and June 30, 2005, the Program provided service to 419 Pacific Power customers. As shown in Figure 1, the majority of participants were served by the Opportunities Industrial Center (OIC) of Washington located in Yakima. The remaining participants were either served by the Blue Mountain Action Council (BMAC) in Walla Walla or the Yakima Valley Farm Worker's Northwest Community Action Center (NCAC).

Figure 1. Program Participation Among Agencies



Evaluation Approach

Pacific Power contracted with Quantec to conduct an impact and a process evaluation of the Program. The process evaluation was designed to assess Program delivery and efficacy, bottlenecks, barriers, and means of improvement. The impact evaluation assessed energy impacts, non-energy benefits, and Program cost effectiveness. The following were the major tasks associated with the evaluation:

Data Collection

Data that were provided by Pacific Power and the agencies included:

- Participant and non-participant billing histories
- Measure installations
- Program costs

Surveys were conducted with 65 Program participants to assess multiple aspects of the Program, including the value of the Program, Program delivery, client satisfaction levels, and customer recall of energy education recommendations.

In-depth discussions with key staff at each agency were conducted to ensure that all facets of Program delivery were assessed, including bottlenecks, client and agency satisfaction, methods of improving delivery, and agency assessment of non-energy benefits.

Finally, an interview was conducted with Pacific Power's inspector to provide insight into the issues identified through this evaluation and by the inspector, and to discuss improvements that have been made at the agency level.

Evaluation of Program Energy Savings

Estimated as well as actual Program energy savings were assessed in the following manners:

- Deemed Savings: A measure analysis to identify measure installation frequencies and estimated savings was conducted.
- Actual Savings: The Princeton Scorekeeping Method algorithm was run to estimate weather-normalized, Program-induced energy (kWh) savings based on participant and non-participant billing data.

Assessment of Non-Energy Benefits

In addition to those that were reported by the participants, numerous non-energy benefits in the areas of economic impact, environmental benefits, mobility, health and safety, and participant arrearages were analyzed.

Assessment of Cost-Effectiveness

An economic analysis of the Program, in accordance with the benefit-cost tests from the California Standard Practices Manual, was performed. Results are presented both with and without the inclusion of non-energy benefits.

Major Findings

Cost Effectiveness

The Program did not pass the traditional cost-effectiveness test. The Total Resource Cost (TRC) benefit cost ratios were between .60 and .65 depending on the stream of avoided costs used. However, when non-energy benefits are included, the Program passes the TRC with a benefit/cost ratio between 1.01 and 1.06.

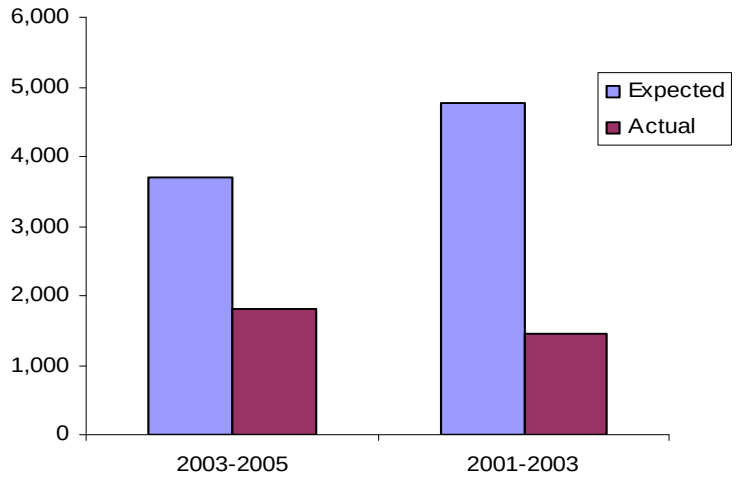
We did not find that cost-effectiveness is recognized by all parties as an explicit goal of this Program. Theoretically, only measures with a savings to investment ratio (SIR) of 1.0 or more should be installed. However, that is not the approach followed by the agencies. We discuss this issue further below in relation to the use of a Department of Energy (DOE) approved audit.

Electricity Savings

Overall, Program net annual energy savings are estimated at 1,840 kWh (12% of pre-Program energy consumption) per completed household. This is an improvement over the prior Program period, which had an evaluated net annual energy savings of 1,439 kWh (8% pre-Program energy consumption).

Estimated savings during the audit seem to greatly inflate the potential, as shown in Figure 2.

Figure 2. Actual and Expected Savings by Program Year



Non-Energy Benefits

The Program also provided non-energy benefits to participants, the environment, and the economy. At the participant level these included increased comfort (reported by 94% of survey respondents), improved health (66%), decreased work or school absences (43%), and more

money for non-energy necessities (83%). Additionally, while 68% of respondents reported that the Program had improved their ability to stay in their current homes, an analysis of participant billing data found that the Program may have helped to prevent approximately 68 participant moves (16%) . Other benefits included:

- An estimated 6 net job-years of employment
- Approximately $557,605 added to the Washington economy
- Approximately $22,809 worth of air emission reductions based on relevant market values as of August 2006
- A reduction in annual arrearages, totaling approximately $26,816

Energy Education

Great improvement was made in participant recollection of energy education materials in comparison to the previous Program period. In fact, 75% of the participants surveyed remembered receiving supplemental material compared to 35% in the previous Program evaluation. Additionally, most of the participants implemented at least one of the energy education tips. Participants reported that the agency and weatherization staff were courteous, and few problems or complaints were identified.

Although we requested from all agencies that we be allowed to participate in at least one energy education session, no such arrangements were made for us during our site visits. As such, we are unable to comment on the quality of the education. In general, we do not feel that energy education delivered through the auditor without a clear curriculum, materials, clear approach, training, etc. is considered good energy education. We feel that for the compensation received by the agencies, they need to develop a significantly more thorough energy education program.

Agency Program Assessment

During our interviews with the Agencies, we asked for an assessment of the Program and the relationship with Pacific Power. The answers were unanimous: all agency staff liked the Program and thought that Pacific Power was flexible and easy to work with.

Recommendations

While the Program did not pass our cost-effectiveness tests without the inclusion of non-energy benefits, we feel Program enhancements can greatly improve the results.

Specifications within the contract should be revisited, as it was simply extended without alteration, to July 31, 2007. The following are issues to consider for the next contract period:

1. The requirement to use the DOE approved audit on all homes needs to be fulfilled. The contract should state that every job must be analyzed using the DOE approved audit tool *in conjunction with the household's pre-weatherization consumption data*. Every invoice must

include the audit runs and clearly show that only measures with SIR of 1.0 or better are being installed. Failure to follow contract requirements should have a tangible consequence.

2. The "lookup tables" that have been used in previous programs should be destroyed to prevent continued use of this method of energy estimation.
3. Glass replacement should be moved from "Major Measures" to "Supplemental Measures," and should be allowed only if found to be cost-effective by a DOE approved audit, *with pre weatherization consumption incorporated*. The state is currently revising their specifications and as of Jan. 1, 2007 will just pay 25% of the cost of replacing windows. Since Pacific Power pays up to 50%, this will likely mean that windows will not be installed unless they are considered a repair.
4. Including rebates for dehumidifiers and air-to-air heat exchangers in the Program should be reconsidered. They are not currently being installed.
5. Stating that showerheads are always cost effective should be reconsidered. While this is nearly always the case, their cost effectiveness is a function of the frequency of use and water flow rates. In order to ensure that this measure is cost effective, these rates should be measured and replacement should be considered when frequently used showers have flows of greater than 2.5 gallons per minute.
6. With the decrease of the cost of compact fluorescent light bulbs, increasing the maximum number installed to 10 should be considered. Also, lowering the number of hours of use from three per day to as low as one per day should be considered; this would still be cost effective for the average home.
7. We do not believe that the energy education currently being provided by the agencies justifies the cost of $200 per home. With the auditor performing the service at the same time as the audit, $50 per home is more reasonable. To continue receiving $200 per home, it is suggested that agencies have a separate employee on staff to provide energy education, and that they should develop a model for providing energy education, attend training sessions, and have a checklist of items to be covered. There are proven energy education approaches that agencies need to follow.
8. Cost effectiveness acquisition of energy savings needs to be explicitly recognized by all parties as one of the Program goals.
9. All Program spending, including multiple funding sources, needs to be reported by the agencies. In order to improve the tracking of costs, Pacific Power should replace the "other funding" category and record each funding source in addition to the Program rebates. This is a common practice, and makes business sense.

2. Process Evaluation

Process evaluations tell the story of the program. They describe program delivery, bottlenecks, what worked and what did not, and provide overall assessment of program efficacy.

Program Services

Agencies employ energy professionals who are trained to evaluate and measure the performance of a home. They have the knowledge to identify the important energy-saving opportunities and measures that will result in the most savings. There is a high use of diagnostics in this Program with an emphasis on blower door testing. The energy professional also focuses on enhancing health and safety in the client's home. Other Program services include conservation and energy education. The goal of all Program services is to conserve energy, reduce clients' energy burden, and create a more comfortable living space for the client. All services are available in English and Spanish.

The Program installs a variety of measures to improve the efficiency of clients' homes, as listed in the impact evaluation. The same criteria are used for deciding which measures to install in all home types (site-built, manufactured home, etc.). Reasons for a "walk away" (deciding not to install any measures in a given structure) would include that a home was built after July 1, 1991, or that there existed physical barriers, structural damage, or unsafe/unsanitary conditions at the home.

Data Collection

Data collection for this portion of the evaluation consisted of:

- Agency visits
- Interview with a Pacific Power inspector
- Participant surveys
- Review of relevant program documents and filings

Agency Visits

Multiple interviews were conducted on-site with staff at each agency to ensure that all facets of Program delivery were assessed, including information regarding bottlenecks, client and agency satisfaction, methods of improving delivery, and agencies' assessment of non-energy benefits.

We attempted to schedule site visits to participating homes in order to observe components of Program services. Unfortunately, for various reasons, we were only able to visit one home in Toppenish.

Interview with Pacific Power Inspector

An interview was conducted with Pacific Power's inspector to provide insight into the issues identified through this evaluation and by the inspector, and to discuss improvements that have been made at the agency level. It was found that a number of issues identified in this evaluation had already been addressed with the agencies. However, many of the resulting improvements did not take place until after the close of the 2003-2005 Program period. For instance, the DOE approved audit TREAT, which is now in use by the agencies, was introduced in October, 2005 which was three months after the end of the contract period. Only that information which was found to be relevant for the evaluation period is included here, unless otherwise stated.

Participant Interviews

In addition to obtaining information on basic household characteristics, surveys were conducted with participants in an effort to assess the value of the Program, the Program's delivery, client satisfaction levels, and finally, to test participant recall of energy education recommendations. Surveys were also used to assess non-energy benefits, which are further discussed in Section 4.

Sample Selection Methodology

While the entire population of households that participated in the Program between July 2003 and June 2005 was eligible to interview as part of the evaluation, as a result of several filters, the final sample used to conduct the surveys consisted of 211 participants. Participants were removed from the sample of potential respondents based on the following criteria:

- Inability to match participant with Pacific Power customer information file (contains address, home number, etc.), possibly due to relocation
- Account inactive at time of survey effort
- Invalid or missing phone number
- Repeat participant at a different location

Table 1 details the attrition associated with each filter and provides the final sample size used for the participant survey.

Table 1. Sample Attrition Participant Survey

Metric	Number of Households	%	Number of Unique Participants Removed	Percentage of Total Unique Participants Removed
Total Program Participants	419	100%		
Matched to Customer Information File	340	81%	79	18%
Account "Active" At Time of Survey	225	60%	115	31%
Valid Phone Number	219	59%	6	2%
Duplicate Individuals*	211	57%	8	2%
Final Sampling Frame	211	57%		
*Different agreement number, but same person and phone number				

Sixty-five phone interviews were completed. Table 2 demonstrates the hard-to-reach nature of the Program participants.

Table 2. Sample Attrition

Metric	Number of Unique Participants Removed	Percentage of Total Unique Participants Removed	Number of Unique Participants	Percentage of Total Unique Participants
Total Program Participants			211	100%
Inactive Phone Numbers	84	23%	127	60%
Participant Refusal	11	5%	116	55%
Ineligible*	9	4%	107	51%
Unresolved**	42	20%	65	31%
Final Sample			*65*	*31%*

*Client moved into home after July 2003 or did not remember receiving weatherization services

**Defined by multiple calls resulting in the following: no answer, busy signal, answering machine, "not available," or request for call back

Review Program Documents

In order to get a better understanding of Program delivery intent, we reviewed the individual agency contracts with Pacific Power.

Process Findings

The following sections present our findings by major component of the Program services.

Client Eligibility

Customers are eligible to participate if they are Pacific Power customers who use electric heat and their household incomes do not exceed 125% of the Federal Poverty Guidelines (or do not exceed 60% of the state median income).[1] Households that do not heat with electricity are eligible to receive base load measures. Agencies identify qualified households primarily through their Energy Assistance programs. Other identifying sources are community centers, senior centers, schools, and government agencies. As discussed further in Section 3, it was thought that the screening process has resulted in making it more difficult for participants to qualify for the Program, and that this customer base is generally considered "hard to reach," making participation recruitment challenging.

[1] According to the agencies' contract with the Company, the Program applies to "residential customers residing in existing dwelling built before July 1, 1991, where electricity is their primary source of hearting energy. This is defined as an electric system that is operable and permanently installed with capacity to heat at least 51% of the dwelling."

Once an agency determines that a household is eligible, the following process is supposed to take place:

- Referral to weatherization staff
- Energy education (during intake process)
- Audit (which also includes in-home energy education)
- Agency crew scheduled
- Subcontractor scheduled (if necessary)
- Installation of measures
- Inspection of completed household

A number of these steps have been bypassed at the agency level due to lay-offs, lack of communication within each agency, and a lack of accountability. In particular, it was a finding of the Pacific Power inspector that in some cases weatherization projects had been left incomplete, as demonstrated when follow-up visits to the weatherized homes revealed as many as 80% of the homes in a specific region did not receive all of the services that were billed to Pacific Power. A new system of accountability, requiring agency staff to "sign-off" any work that is completed, was thought to be necessary to help guarantee that this issue be resolved. While this system was not formalized, discussions between the inspector and the agencies may have resulted in some improvements that could show up in future evaluations.

Energy Audit Specifications

This is the cornerstone of any energy saving program offering. The agency contract with the Company states:

> "To the extent that a Department of Energy approved audit determines that a major measure is cost-effective and such a major measure qualifies for installation, it must be installed if financial assistance will not be offered for any other measures."

It further states that "[m]easures must be determined through audit results to be fully cost-effective"

The intent of this language in the contract is clear:

1. A Department of Energy approved audit *must* be used
2. Cost-effectiveness is determined by the audit tool
3. Cost-effective measures must be installed

Energy Audit Realities

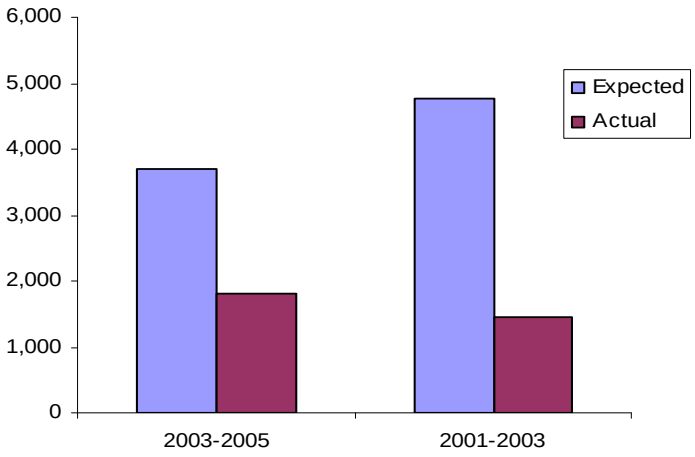
The agencies generally did not use any audit tools in estimating savings at individual sites. Instead, they used lookup tables that were provided by Pacific Power prior to the implementation

of the current tariff and contracts, and that have been outdated for many years. These tables drastically overstate the expected savings, which we noted in our 2001-2003 evaluation:

> *"We have found no reason for applying these (lookup table) numbers. The contract between Pacific Power and the agencies does not call for their use. They are highly inflated and should not be utilized. The agencies should estimate savings in accordance with the contract* (emphasis in original)*"*

In addition to the use of these "deemed values," the agencies do not make use of actual, pre-weatherization energy consumption data obtained from Pacific Power. This information, as valuable as it is, does not get used in estimating Program savings or in targeting Program services. For example, overall, the agencies expected to save 3,249 kWh/home, but actually saved about 1,840 kWh/home. In comparison, the average expected savings reported in the 2001-2003 evaluation was 4,775 kWh per home, while the actual was approximately 1,400 kWh/home. Figure 3 displays these numbers.

Figure 3. Actual and Expected Savings by Program Year



Case Studies

When examining data at the individual home levels, some rather extreme cases are observed, as displayed in Figure 4. These are not presented as being representative. Rather, they serve as examples of what can go wrong without the use of proper tools.

***Client A*:** This is a manufactured home with pre-consumption of 10,645 kWh annually. Based on installation of ceiling insulation (7,514 kWh estimated savings), floor insulation (2,184 kWh), window replacement (93 kWh), and insulated door (446 kWh), total savings were estimated at 11,170 kWh annually (105% of total pre-consumption). While this is obviously not possible, it was still recorded as such and the measures were installed. This is a result of the failure to use the DOE approved audit and not comparing savings estimates to pre-consumption. In this case, the total project cost was nearly $8,000, of which Pacific Power paid nearly $4,200. When actual energy savings are considered, estimated by Quantec to be 1,958 kWh, the dollar savings to the

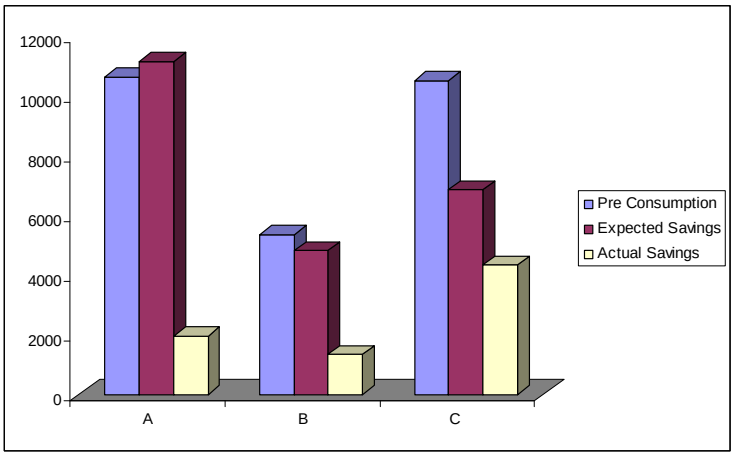
owner can be estimated at about $120 annually. Therefore, this project has a simple payback of nearly 68 years.

***Client B*:** This is a single-family dwelling with 5,358 kWh consumed during the 12 months preceding the weatherization. The audit produced an expected total of 4,821 kWh (90% reduction in consumption). Measures installed included ceiling insulation, wall insulation, window replacement, some infiltration measures, and insulated doors. Pacific Power's contribution was estimated at $2,217 plus a $332 administration fee. Total cost was over $4,750. Simple savings to investment ratio analysis would have shown doors and windows would not have been cost-effective.

***Client C*:** This is a single-family dwelling with 10,530 kWh consumed during the 12 months preceding the weatherization. The audit produced an expected total of 6,863 kWh (65% reduction in consumption). Measures installed included ceiling insulation, wall insulation, window replacement, some infiltration measures, and insulated doors. Pacific Power's contribution was estimated at $3,189 plus a $350 administration fee. Total cost was over $6,700. Simple savings to investment ratio analysis would have shown doors and windows would not have been cost-effective. Actual savings was estimated by Quantec at about 4,333 kWh. Given actual savings and the cost of installation, this project has a simple payback of over 25 years.

In all three cases, the DOE approved audit was not used. Cost effectiveness does not appear to be a consideration. The contract clearly states that this needs to be considered and provides measure lives to facilitate the calculation of cost effectiveness.

Figure 4. Examples of Extreme Cases



It was found by the Pacific Power inspector that even when an audit had been performed as required, the final stages of reporting would revert back to the use of the inaccurate lookup tables to input savings estimates, thereby corrupting any accurate data.

Introduction of TREAT

Starting in October 2005, after the close of this evaluation period, the State of Washington Community, Trade, and Economic Development began requiring the use of TREAT as an audit tool. The requirement is set at at least three homes per month. At this time it is believed that each of the agencies does apply TREAT to all homes, though this will need to be verified during the next evaluation. This is a positive step forward. *However, use of TREAT by itself does not solve the issue of inflated savings. TREAT, as well as all audit programs, will inflate savings if actual, pre-audit energy consumption is not used as an input.* Not using the actual consumption is a serious shortcoming.

Energy Education

Table 3 lists the contract requirements for energy education and compares these requirements with current agency activities. In most cases, energy education is provided by the auditor during the same visit and does not include a review of site-specific energy consumption. Table 3 displays, as best as we could determine, the contract requirements and services actually provided.

Table 3. Minimum Energy Education Required for Reimbursement

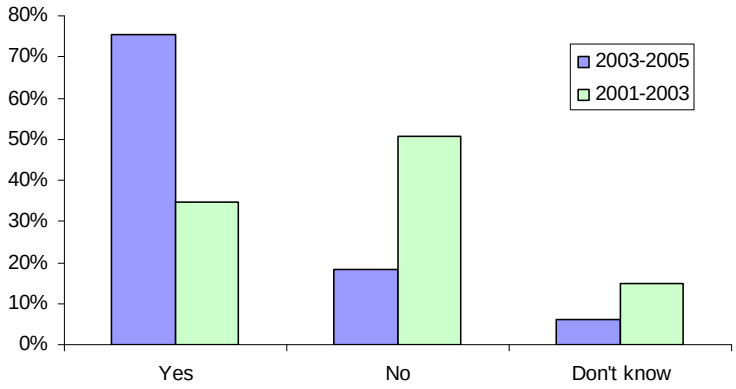
Energy Education Contract Requirements	Energy Education Activities Provided
1. Conservation tips and materials provided and site-specific energy consumption reviewed during intake session.	Each participant is provided with a Pacific Power "Bright Ideas" handbook.
2. Auditor or weatherization crew member describes measures to be installed and expected benefits to residents.	Participants are informed of measures installed and expected economic benefits.
3. An in-home education session is provided to household that includes conservation tips on a room by room basis, instruction on reading a meter, proper use of heating system, hot water usage and moisture control.	Client Assessment Survey and post-assessment. Hands-on participation. In-home education demonstration.
4. A post-weatherization session with household that addresses how to live in a weatherized home.	Follow –up home visit.
5. Follow-up contact with household is made with a discussion of the outcome of weatherization services, and energy conservation recommendations and actions.	Follow–up home visit.

We requested to attend energy education sessions at participating sites. However, these arrangements were not made for our staff during our agency visits. Therefore, our assessment of energy education is based on participant surveys and interviews with staff. From this review of the service, it was found that for the energy education currently being provided, the cost of $200 per home is not justified. With the auditor performing the service at the same time as the audit,

$50 per home is more reasonable. To continue receiving $200 per home, it is suggested that agencies should develop a model for providing energy education, attend training sessions, and have a checklist of items to be covered.

As part of the energy education materials, the agencies provide the Pacific Power "Bright Ideas" Handbook to serve as a reference for energy-saving tips. As shown in Figure 5, 75% of the participants surveyed remember receiving supplemental material, compared to 35% in the previous Program evaluation – a statistically significant difference.[2]

Figure 5. Participants Who Received Information Regarding Reducing Electricity Usage

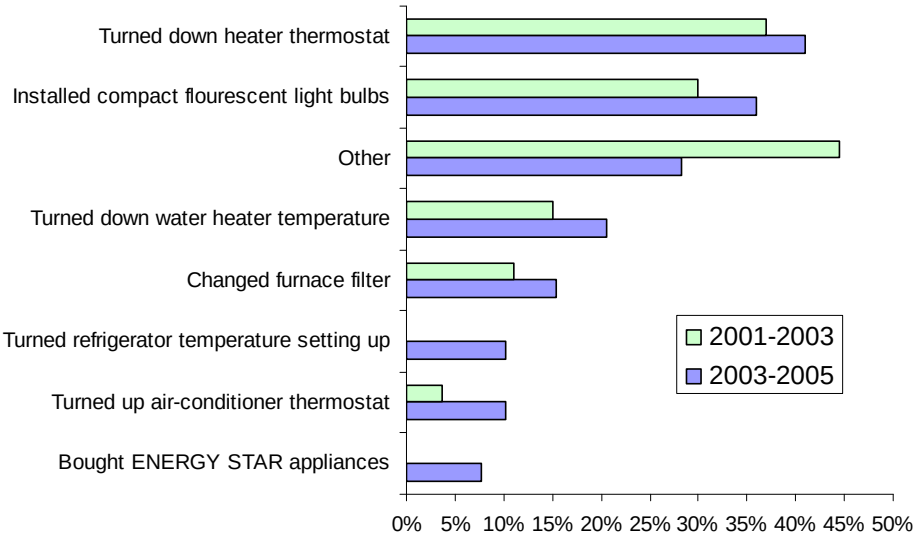


Across agencies, 85% of NCAC, 80% of BMAC, and 66% of OIC clients recalled receiving energy education.

Of the 49 participants that recalled receiving energy education materials, 94% thought it was easy to understand and 96% found it useful. Additionally, 80% had implemented at least one of the recommended actions, an increase from the previous evaluation. Actions ranged from adjusting thermostats to closing doors, and being more aware of leaving lights and appliances on when not needed. The most common action taken was changing the heating thermostat setting, as shown below in Figure 6. Of those who turned down their heater's thermostat, 18% provided before and after temperature information. The average original temperature setting of 73.2° was lowered to 64.1°, resulting in an average net change of 9.1°.

[2] z = -5.12 with a p-value of 0.001

Figure 6. Additional Actions Taken by Participants

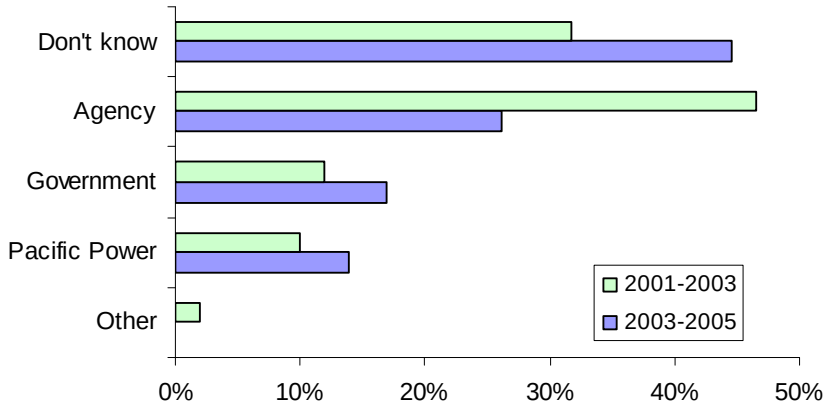


Pacific Power Involvement

This issue was examined from two perspectives. We asked the staff at the agency how they felt about their involvement with Pacific Power. The opinion was unanimous that Pacific Power was extremely easy to deal with.

We also examined it from the perspective of the client's awareness of the Company's contribution to the weatherization of their homes. This issue was a concern in the previous evaluation and continues to be so over the period of this study. As shown in Figure 7, only 14% of respondents correctly identified Pacific Power as a funding source. Though this is an improvement from the previous Program evaluation, the majority of respondents (60%) were unable to identify any funding source for the Program. It was suggested by one agency that having a flier or handout available to leave at the participating home would be helpful.

Figure 7. Sources of Weatherization Funding Identified by Participants



Perceptions of Agencies

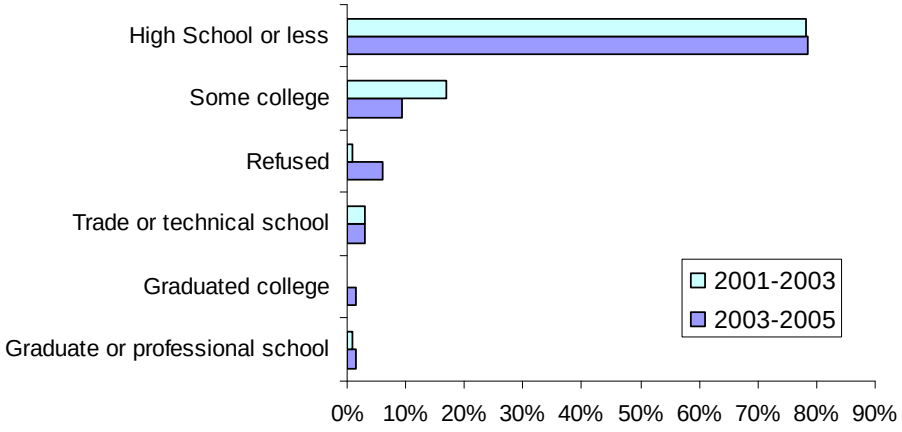
Participants gave high marks to the agencies that provided them with the weatherization service. With regard to courtesy, more than 95% of the respondents rated them positively.

Participant Demographics

Survey results indicate that the average number of people per household is between three and four (3.6) people. Only 8% of the participants said that this number had increased since receiving the service, which is unchanged from the previous evaluation. This percentage is possibly misleading, however, as discussions with agency staff have indicated that participants may be hesitant to reveal household size, especially when the household has increased.

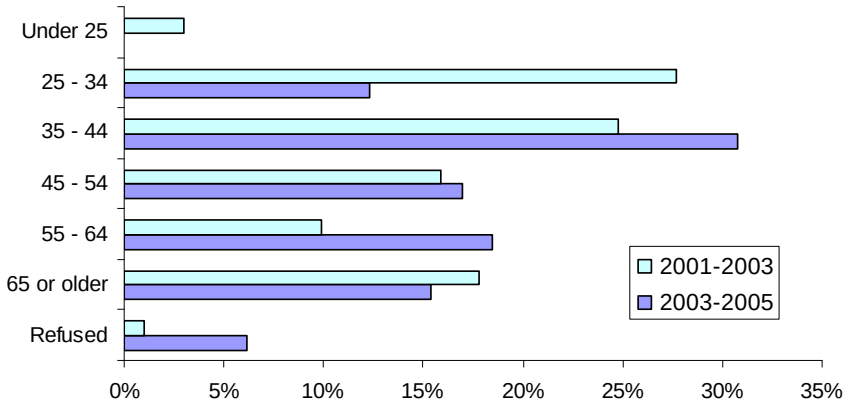
As shown in Figure 8, 78% of the participants had up to a high school education, 14% have completed some college or trade school, and one respondent had completed graduate or professional school.

Figure 8. Highest Education Level Attained by Participants



While the single greatest age category was 35-to 44-years-old, shown in Figure 9, most participants fell in the 45-and-over range. This represents a 10-year upward shift in the age demographic from the previous Program evaluation.

Figure 9. Age Distribution of Weatherization Program Participants



Overall Findings

Overall, we found the agencies were highly dedicated to providing the best services to the clients in the Program. We were alarmed, however, by the lack of understanding of the contract requirements. This is most troubling for the estimation of savings and for determining cost effectiveness. We feel that the agencies need to clearly understand the contract and follow it closely. There should be a clear consequence for failure to follow contract requirements.

Recommendations

Based on the review of the contract and discussions with the agency staff and the Pacific Power inspector, this section highlights some findings and recommendations.

The contract was simply extended to July 31, 2007. No language changes were made. The following are issues to consider for the next contract period:

1. The requirement to use the DOE approved audit on all homes needs to be fulfilled. The contract should state that every job must be analyzed using the DOE approved audit tool *in conjunction with the household's pre-weatherization consumption data*. Every invoice must include the audit runs and clearly show that only measures with SIR of 1.0 or better are being installed. Failure to follow contract requirements should have a tangible consequence.
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7. Cost effectiveness acquisition of energy savings needs to be explicitly recognized by all parties as one of the Program goals.
8. We do not believe that the energy education currently being provided by the agencies justifies the cost of $200 per home. With the auditor performing the service at the same time as the audit, $50 per home is more reasonable. To continue receiving $200 per home, it is suggested that agencies have a separate employee on staff to provide energy education, and that they should develop a model for providing energy education, attend training sessions, and have a checklist of items to be covered. There are proven energy education approaches that agencies need to follow.
9. All Program spending, including multiple funding sources, needs to be reported by the agencies. In order to improve the tracking of costs, Pacific Power should replace the “other funding” category and record each funding source in addition to the Program rebates. This is a common practice, and makes business sense.

3. Impact Evaluation

Impact evaluation data were obtained from a number of different sources, including:

- ***Program measures***: Pacific Power provided information regarding the Program's installed measures, including measure-specific saving estimates reported by the agencies and installation dates.
- ***Billing records***: Pacific Power provided participant and non-participant meter records from July 2002 through June 2006. Non-participants were defined as households that participated in the Low Income Home Energy Assistance Program (LIHEAP), but did not receive weatherization.
- ***Weather data***: Quantec collected weather data for the corresponding time period for both Walla Walla and Yakima counties from the National Weather Service (NOAA).
- ***Contact information***: For the purpose of conducting surveys, Pacific Power provided Quantec with all available contact information, including name, address, and phone number for participants.

Deemed Savings – Measure Analysis

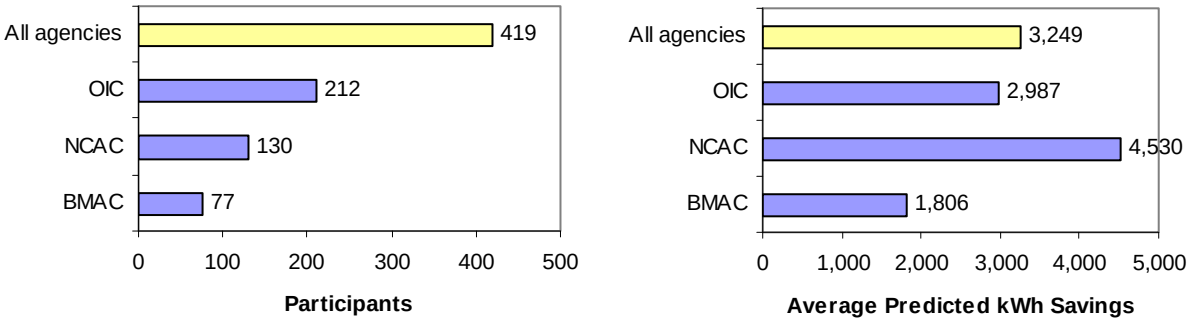
Between July 1, 2003, and June 30, 2005 (the two-year Matchmaker period), the Program provided service to 419 Pacific Power households. This represents a 35% reduction in participation in comparison to the previous Program period, which reported 635 participants. Interviews with the Pacific Power inspector and with the two agencies that exhibited a reduction in participation resulted in the following explanations:

- There was an increase in the cost per measure.
- The previous program (2001-2003) had full Matchmaker funding, while the 2003-2005 Program had half of that funding.
- There was a suspension of Program activity while waiting for funds to be redistributed.

Most of the homes were completed in 2004 (59%). Over half of weatherization participants were serviced by OIC. The average expected household savings was estimated at 3,249 kWh annually based on deemed savings values. This compares to an estimated average household savings of 4,775 kWh reported in the previous Program evaluation. The lower savings value may represent an improvement in the methods used for estimation, as the previous evaluation found that the savings estimates were inflated. However, as is discussed in this report, the expected savings continue to be overestimated.

Figure 10 shows the participation rate and energy savings across the three agencies.

Figure 10. Participant and Savings, by Agency



The most frequently installed weatherization measures were double-glass replacement and ceiling insulation, with 84% and 83% of all households receiving these services, respectively. The frequency of installation of window replacement and the increase of these installations from the last evaluation is unjustifiable, as they are rarely cost effective.

This is an issue that has been identified by the Pacific Power inspector and discussed with the agencies prior to this evaluation, with consideration given to removing window replacement as an option. The state is currently revising their specifications and as of Jan 1, 2007 will just pay 25% of the cost of replacing windows. Since Pacific Power pays up to 50%, this will likely mean that windows will not be installed unless they are considered a repair.

Table 4 shows the frequency of weatherization measures installed at the households in this Program period, as well as those reported in the last evaluation. Only 13 of the 23 measures listed had attributed kWh savings. Additionally, it was found that the agencies' reporting errors would occasionally result in measures that were generally associated with an estimate of 0 energy savings. For example, installation of ceiling insulation had an estimated savings value of 0 kWh in 18 households. Double glass replacement was estimated by the agencies as having 0 kWh savings in 16 households.

Table 4. Weatherization Measures and Frequencies

Measure	2003-2005	2001 - 2003 Evaluated Measures
Double Glass Replacement	84%	66%
Ceiling Insulation	83%	82%
Air Sealing/Infiltration	58%	21%
Thermal Doors[3]	45%	56%
Fluorescent Lights	40%	46%
Floor Insulation	36%	-
Faucet Aerators	36%	-
Low Flow Shower Head	32%	-
Wall Insulation	21%	25%
Refrigerator Replacement	20%	2%
Pipe Insulation	15%	4%
Water Heater < 50 Gallon	12%	-
Duct Sealing	9%	87%
Water Heater Blankets	8%	-
Weatherstrip Windows	5%	3%
Duct Insulation/Sealing	4%	6%
Ground Cover	3%	.2%
Attic Ventilation	3%	.3%
Dehumidifier	1%	-
Water Heater > 60 Gallon	1%	-
Weatherstrip Doors	1%	3%
Clock Thermostat	0.7%	-

Base-load Measures

The previous evaluation recommended that an increased emphasis should be placed upon base-load measures, which typically account for some 30% to 40% of total energy use. This evaluation found that an increased emphasis had been made, resulting in the installation of previously unevaluated measures such as energy efficient shower heads and faucet aerators, refrigerator replacements, and water-heater improvements. However, it was found that the number of fluorescent lights that were installed actually decreased. Continued emphasis should be placed upon these measures.

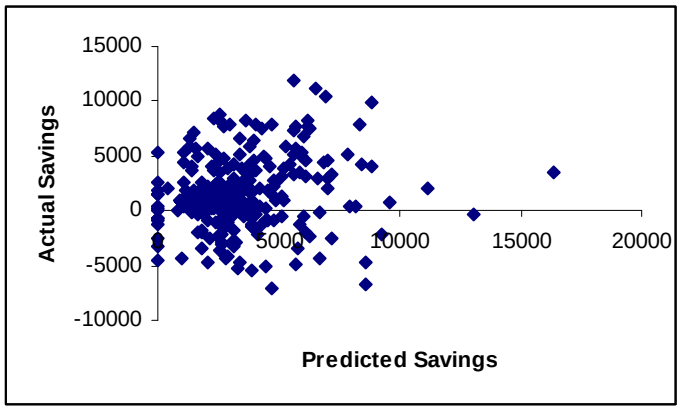
Audit-Based Savings Estimation

As discussed in the Process Evaluation, the lookup tables used during the audit process result in extremely overstated savings estimates.

[3] This was titled "Door Sealing" in the previous Program.

Figure 11 shows the lack of relationship between the audit-based estimates of savings and what actually occurred at the individual homes. One would expect some positive relationship between the expected and the actual savings; i.e., as predicted savings increase, actual savings would also increase. In a perfect world, this would be shown as a diagonal line between the x and y axis, but the relationship need not (nor will ever) be exact, due to behavioral factors that are beyond the capability of the auditor to predict. In this case, however, there is not even a positive relationship. This is a clear indication that these deemed numbers are invalid and should not be used. The agencies must, in compliance with the contract requirements, use audit generated savings. Furthermore, the actual consumption data provided by the Company needs to be used by the auditors in determining expected savings by measure.

Figure 11. Actual versus Predicted Savings (kWh) – All Agencies



Figures 11-13 illustrate the lack of correlation between deemed savings estimates and actual savings at the agency level.

Figure 12. Actual versus Predicted Savings (kWh) – NCAC

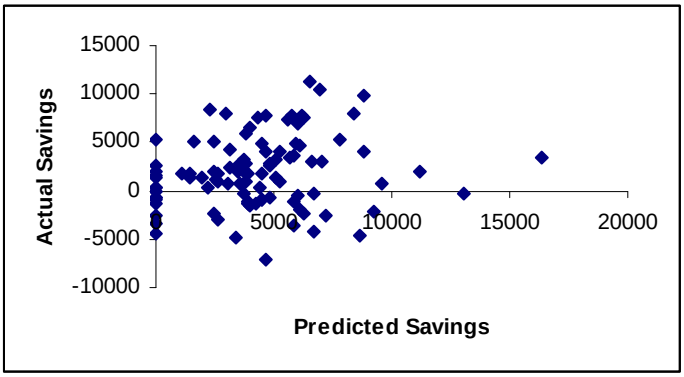


Figure 13. Actual versus Predicted Savings (kWh) – OIC

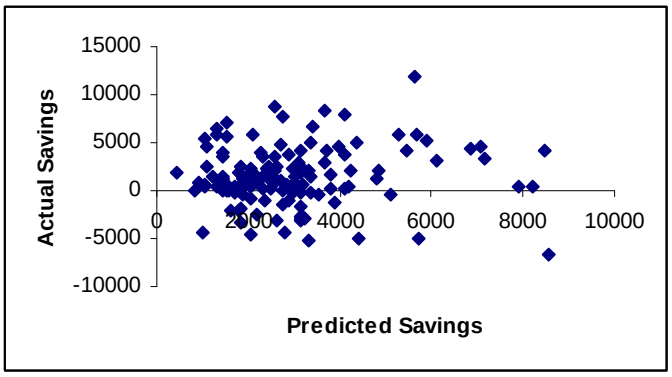


Figure 14. Actual versus Predicted Savings (kWh) – BMAC

Actual Savings – Billing Analysis

Methodology

Pacific Power provided data regarding the Program's 2003-2005 participants from 25 cities throughout Washington. Data were assessed, organized, and subsequently filtered to obtain complete customer profiles for evaluation using PRISM. (Princeton Scorekeeping Method). PRISM was used to estimate weather-adjusted annual energy consumption based on energy usage and outdoor temperature. In order to prepare the data for PRISM, several steps were taken.

Once the billing data contained only relevant meter readings, each participant's profile was split into pre and post periods based on the date his or her final weatherization measure was installed. To ensure that any consumption changes that may have occurred during the weatherization process itself were excluded from the analysis, any meter readings collected at the time of the installations were excluded. The participants' average completion date was then applied to all non-participants, creating artificial pre and post periods for them. Applying this break in periods allowed for the comparison of changes in post-weatherization energy consumption between the two groups over similar time periods.

In order to obtain accurate PRISM results, only participants and non-participants with a minimum of twelve eligible months of both pre- and post-consumption data were utilized for the analysis.

Lastly, the remaining participant and non-participant profiles were separated into Yakima and Walla Walla files in final preparation for PRISM.

Sample Data Attrition

We required the use of twelve months of pre- and post-participation data in order to achieve more reliable results. This eliminated 3 of the participants and 10 of the non-participants. In order to ensure that billing data for non-participants were distinct from participant data, all past participants of the Program were removed from the non-participant data set. Observations were eliminated from the analysis on the following grounds:

- **Outliers**: Unreasonable consumption levels were defined as those lying outside the 1st and 99th percentiles (less than 108 kWh or more than 4,433 kWh per month)
- **Insufficient Data Points**: Customers with less than twelve months pre-and post-Program data
- **Unable to Model**: PRISM is often unable to effectively model households exhibiting significant variance in consumption

Table 5 outlines data attrition. The final sample for the analysis contained 300 participants and 583 non-participants, 68% and 30% of the total sample, respectively.

Table 5. Sample Attrition

	Participants		Non-Participants	
	Removed	Remaining	Removed	Remaining
Original sample		371		1,927[4]
Unable to obtain billing data	42	330 (89%)		1,927 (100%)
Outliers	66	264 (71%)	156	1,771 (92%)
Insufficient data points	3	261 (70%)	10	1,761 (91%)
Geographic limitations	-	261 (70%)	1,161	600 (31%)
Unable to model with PRISM	8	253 (68%)	17	583 (30%)
Ineligible	1	252 (68%)	-	583 (30%)
Sample adjustment[5]	*48 (added)*	*300 (81%)*	-	*583 (30%)*
Final sample		300 (81%)		583 (30%)

[4] Non-participants who had received weatherization services in previous Program periods were removed from non-participant sample

[5] During the agency visits, it was discovered that predicted savings reported for one apartment were actually predicted savings for a forty-nine-unit apartment building. One unit's data was provided to Quantec and used in the PRISM analysis. The savings for that apartment was subsequently attributed to all units.

Overall Actual Savings

It was found that for the 300 clients with reliable consumption data, the gross savings were estimated at 1,452 kWh, as shown in Table 6. This gross estimate does not include any assessment of "what would have happened in the absence of the Program." We employed a comparison group of 583 clients who had received some form of energy assistance, but had not participated in the Program. During the same time span, these non-participants increased their consumption by 409 kWh, or 2.53% of their pre-Program consumption. We assume that, had our participants not been through the program, they also would have witnessed an increase in consumption of about 409 kWh. This process generates the *net* energy savings. **Overall net Program savings are estimated at 1,840 kWh per home.**

Table 6. Savings Summary

	Participants (n=300)	Comparison Group (n=587)
Pre NAC[6] (kWh)	15,343	16,161
Post NAC (kWh)	13,891	16,570
Gross Savings (kWh)	1,452	-409
Percent Change	9.46%	-2.53%
Net Impacts (kWh)	1,840	
Savings as % of pre	12%	

The analysis was also conducted by type of home, as shown in Table 7. The largest proportion of participating homes was single family.

Table 7. Savings Summary by Home Type

	Apartments (n=85)	Manufactured Home (n=86)	Single Family (n=129)	Overall (n=300)
Pre NAC	8,093	18,404	18,079	15,343
Post NAC	7,173	16,816	16,367	13,891
Savings	921	1,588	1,712	1,452
Net Savings	1,125	2,054	2,169	1,840
Net Savings as % of pre	14%	11 %	12%	12%

Overwhelmingly, apartments were the greatest energy savers for BMAC, as shown in Table 8, though it should be noted that 49 of the 50 apartment units that were serviced were located in a single apartment complex. Table 9 and Table 10 show the results for NCAC and OIC.

[6] Normalized annual consumption (NAC) reflects temperature adjusted consumption levels.

Table 8. BMAC Savings Summary by Home Type

	Apartments (n=50)	Manufactured Home (n=9)	Single Family (n=9)	Overall (n=68)
Pre NAC	5,221	17,927	16,807	8,436
Post NAC	4,395	16,349	16,029	7,517
Savings	825	1,579	778	919
Net Savings	958	2,032	1,203	1,132
Net Savings as % of pre	18%	11 %	7%	13 %

Table 9. NCAC Savings Summary by Home Type

	Apartments (n=1)	Manufactured Home (n=27)	Single Family (n=68)	Overall (n=96)
Pre NAC	15,053	18,666	19,418	19,161
Post NAC	13,157	16,571	17,613	17,274
Savings	1,897	2,095	1,804	1,887
Net Savings	2,278	2,568	2,296	2,372
Net Savings as % of pre	15%	14%	12%	12%

Table 10. OIC Savings Summary by Home Type (kWh)

	Apartments (n=34)	Manufactured Home (n=50)	Single Family (n=52)	Overall (n=136)
Pre NAC	12,113	18,348	16,549	16,101
Post NAC	11,081	17,032	14,796	14,689
Savings	1,032	1,316	1,752	1,412
Net Savings	1,338	1,781	2,171	1,819
Net Savings as % of pre	11 %	10%	13%	11%

When the results are broken down by home type, as shown in the following tables, the average savings between the agencies is noticeably variable. However, the sample size between the agencies makes direct comparisons unrealistic.

Table 11 shows the energy savings associated with apartment buildings treated under the Program. BMAC had a 49-unit apartment building weatherized, which dominates the calculated savings for those units. NCAC has the only apartment that was weatherized and experienced extreme savings. That apartment received the following measures: ceiling, floor, and pipe insulation; a low-flow showerhead; fluorescent lights; thermal doors; and double-glass window replacements.

Table 11. Apartment Energy Savings (kWh)

	Apartments				
	n	Maximum	Minimum	Mean	Median
BMAC	50	1,724	942	958	942
NCAC	1	2,278	2,278	2,278	2,278
OIC	34	5,438	-3,937	1,338	1,553

Sample size again plays a role in examining the savings of manufactured homes, shown in Table 12. The savings for BMAC are based on nine homes, one-third of those weatherized by NCAC and less than 20% of those weatherized by OIC. It is difficult to directly compare these saving when the sample sizes are so disparate.

Table 12. Manufactured Home Energy Savings (kWh)

	Manufactured Homes				
	n	Maximum	Minimum	Mean	Median
BMAC	9	8,888	-5,094	2,032	2,589
NCAC	27	11,210	-2,525	2,568	1,788
OIC	50	9,493	-4,938	1,781	1,651

The savings associated with single family households is more comparable between the agencies, as shown in Table 13.

Table 13. Single Family Home Energy Savings (kWh)

	Single Family Homes				
	n	Maximum	Minimum	Mean	Median
BMAC	9	4,855	-1,755	1,203	1,335
NCAC	68	12,151	-6,632	2,296	2,169
OIC	52	12,716	-6,082	2,171	1,335

4. Non-Energy Benefits

The non-energy benefits of low-income programs can be quite numerous and significant. As well as enabling positive change within the homes of participants, these benefits may have impacts on the environment, local economies, and society as a whole.

Participant interviews were used to assess non-energy benefits at the household level in the form of fewer work/school absences, the ability to remain in the home, fewer illnesses, more disposable income, and increased comfort. Additionally, billing data were used to estimate the Program's impact on arrearages and participant mobility. Environmental and economic impacts were estimated using appropriate software tools, as discussed further in this chapter.

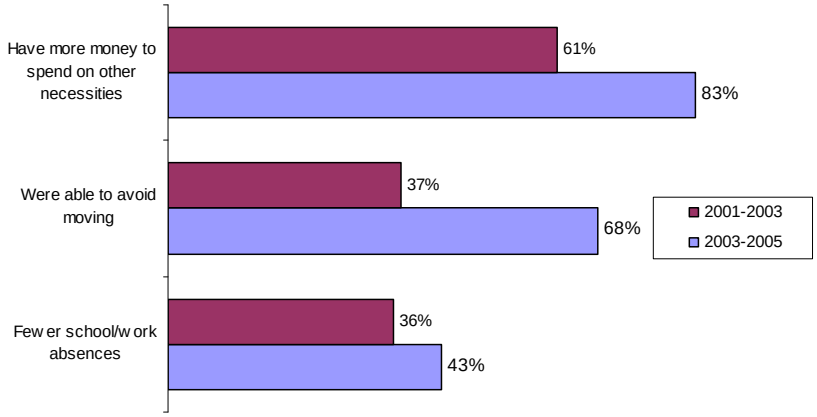
Participant Impacts

In addition to the information discussed in the process evaluation, surveys with participants were conducted to evaluate the non-energy benefits of the Program.

Energy Burden

Program participants reported having more money to spend on necessities and fewer absences from school or work, as shown in Figure 15. Additionally, participants reported that they were able to avoid moving as a result of the Program. Further analysis of mobility impacts was performed using billing data, and is discussed further in this evaluation. Each of these benefits exceeded those reported in the last Program period.

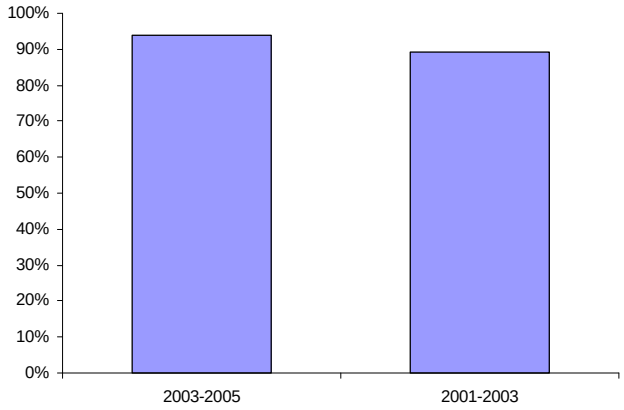
Figure 15. Program Impacts on Energy Burden, Mobility, and Absenteeism



Improved Comfort

When asked, nearly 94% of participants said they enjoyed increased comfort as a result of their participation in the Program, presumably because they were able to have the heating and cooling they desired. This is a slight improvement over the last Program period, as shown in Figure 16 below.

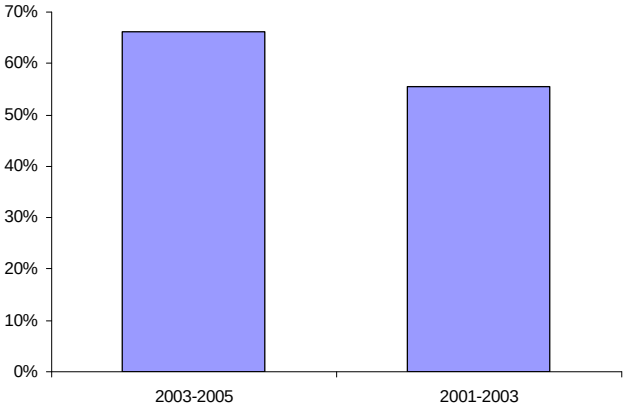
Figure 16. Program Impacts on Increased Comfort



Improved Health

For low-income families, critical needs may compete with very finite resources, resulting in trade-offs which may compromise the participant's health. As shown in Figure 17, 66% of respondents reported fewer illnesses as a direct result of receiving weatherization services, which was an improvement over the prior Program period. This may be due to the tangible benefits of home repairs and weatherization services, as well as the avoidance of arrearage related shut-offs. An analysis of the impacts on arrearages is presented further in this report.

Figure 17. Participants Reporting Fewer Illnesses



In addition, 12 (18%) respondents indicated that someone in their home suffers from asthma. Five of these respondents indicated that instances of asthma-related events had decreased since participation in the Program.

Mobility

When energy costs are high, household funds are diverted from other uses including food, medical care, and rent. Our research has shown that in some cases, high-energy bills may force occupants to move out of their current dwelling either to lower energy costs or to avoid paying an energy bill. In other cases, they may be evicted for inability to pay their rent or for having services disconnected. Not only are frequent moves expensive and inconvenient, they have other extremely serious effects. These may include increased school dropouts and inability to hold a job. Energy assistance and weatherization programs lower the energy burden of the participating low-income families and their forced mobility.[7] Mobility can be especially hard for the elderly and families with children. The value of reduced mobility can be as high as $1,460 per household.[8] In another national study, the cost of moving for low-income families was found to be between 10% and 20% of annual income.[9] These costs include moving expenses, rental deposits, bank fees, telephone connections, etc. We follow a conservative approach of assuming only $700 per move (less than mid-point of the Oak Ridge study and in line with Skumatz (1998)).

Methodology

Using the same sample of participants that were selected for the impact and arrearage analysis, mobility was assessed by using billing data to determine whether participants had moved into or out of their Program weatherized home within two years (both before and after) of participation.

Results

As apparent in Table 14, in the two years prior to participating in the Program 70% (n=238) of the participants matched to utility site level information (n=340) moved into the home that was weatherized. However, in the two years following the completion of weatherization work, only 50% (n=170) moved from the weatherized home. Therefore, the weatherization work conducted by the Program, and the lower energy bills that resulted, may have helped to prevent 68 participants from moving.

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7 Khawaja, M. (2001). Indiana REACH Evaluation. May. Portland, OR: Quantec, LLC.
In Indiana, as a result of participating in the Residential Energy Assistance Challenge Program, the participants received energy education that lowered their energy consumption by 12.5%, reduced their mobility by 52%, and reduced school absences by 18%.

8 Oak Ridge National Laboratory. (2002). Nonenergy Benefits from The Weatherization Assistance Program: A Summary of Findings from the Recent literature. April.

9 Howat, J. & Oppenheim, (1999). Analysis of Low-Income Benefits in Determining Cost-Effectiveness of Energy Efficiency Programs. http:www.consumerlaw.or/Energy/Energy&Utility/non_energy_benefits.htm

Table 14. Impact on Mobility

	Pre (2 Years Prior to Participation)		Post (2 Years Following Participation)	
Moved	N	%	n	%
Yes	238	70%	170	50%
No	102	30%	170	50%
Total	*340*	*100%*	*340*	*100%*

While other factors clearly contribute to the decision to move in either of the pre or post periods, there is a significant difference in the proportion of participants that moved prior to and after being weatherized. Using the conservative estimate of $700 per move noted above, and the estimated 68 prevented moves, the Program generated $ 47,600 for participants.

Arrearage Impact

In addition to having an immediate impact on participants' monthly energy bills, participation in the Program can also lead to an overall reduction in arrearages. Simply put, as a result of the reduction in monthly energy costs, participants are better able to put additional money towards their outstanding arrearage.

Methodology

In order to determine the net impact of the Program upon arrears, data regarding both customer bills and payments were collected for both participants and a select group of non-participants.

Table 15 details the sample attrition associated with the arrearage analysis.

Table 15. Sample Attrition: Arrearage Analysis

	Participants		Non-Participants	
	Removed	Remaining	Removed	Remaining
Original Sample		371 (100%)		1,927 (100%)
Unable to Match to Utility Records (Participants Only)	31	340 (92%)	---	---
Missing Installation Date (Participants Only)	33	307 (83%)	---	---
Not included in Billing Analysis Sample* (Non-Participants Only)	---	---	1,327	600 (31%)
Lacked Sufficient Billing or Payment Data**	129	178 (48%)	49	551 (12%)
Dissimilar Pre Period Arrearage*** (Non-Participants Only)	---	---	329	222 (12%)
Outliers****	24	154 (42%)	0	222 (12%)
Final Sample		154 (42%)		222 (12%)

* Prior to being analyzed in PRISM
** Minimum of 12 months meter and billing data in both pre and post period
*** Within ± 20% of the average pre participant arrearage level (defined as the percent of total bill paid by customer in pre period)
**** 1% and 99% tails of aggregated distribution

Results

Table 14 provides the results of the analysis. As evident in the table, participants arrears levels dropped by $35 (from $207 to $172). Conversely, once the non-participants pre-arrearage values were calibrated to the precise level of participants, it was determined the average non-participant arrearage amount actually increased by $29 (from $207 to $236). **As a result, the net impact of the Program is a decrease in arrears by an average of $64.**

Table 16. Program Impact: Arrearage Accumulation

	Average Arrearage Accumulated During Pre Period	Average Arrearage Accumulated During Post Period	Change
Participants (n=154)	$207	$172	$35
Non-Participants (n=222)	$207	$236	-$29
Net Impact			$64

Economic Impacts

This type of program has several economic impacts in addition to direct benefits such as decreasing the energy burden and increasing participants' disposable income. As incomes increase, so does spending on goods and services, leading to the creation of jobs. Weatherization work itself is also a source of job creation. Additionally, the Program affects the economy in several ways:

- It uses money from taxes and utility ratepayers to pay salaries and buy products used in the weatherization process
- Participants have lower energy bills and are able to use the extra money to purchase goods and services in other economic sectors
- Utilities receive less revenue due to lower energy bills for participants; this reduces the need for new electricity generation facilities

Input-output modeling was used to quantify the effect of each of these monetary shifts individually, as well as the impact on the Washington economy as a whole.[10] This method of modeling allows for an in-depth look at individual economic segments, as well as the effect that the entire economy sees. The economy is represented as a matrix that relates industries to each other so that effects of events can be tracked. In this case, these events are Program spending, changes in household spending, reduced utility revenue, etc. When an event is specified, the matrix tracks all direct, indirect, and induced effects on the economy. For example, the direct effect of participants having lower energy bills is effectively an increase in household income. The indirect effects are the redistribution of this income across the economy, thus creating more jobs in the industries where households are spending money. These new jobs create another

[10] IMPLAN Professional 2.0 was used for this analysis, utilizing state-level data for Washington from 2002.

increase in household income for the new employees and the induced effects are the redistribution of this new income across the economy. For the purpose of this evaluation, direct, indirect, and induced benefits have all been used to determine the benefits to the Washington economy.

Because the funding to pay for Program activities ultimately comes from tax dollars, this was modeled as a decrease to household income. This money is then distributed to certain industries that provide the materials and labor for weatherization. Modeling participant utility bill savings and utility lost revenue is somewhat more complex, because they do not completely offset one another. Although the participants' savings are equal to their full avoided utility payments, this amount is not all lost revenues to the utility because reduced sales to customers are offset by the amount that the utility reduces its purchases of required fuel or energy. Because the total energy savings are small in comparison to total energy sales in Washington, it is assumed that this will have no effect on ratepayers' payments towards the utilities' fixed costs, and that the portion of rates that are fixed is lost revenue to the utilities.

Results

In total, it was estimated that the Program created about 6 net job-years of employment and added $550,118 to the Washington economy. Though these numbers are small compared to Washington's economy and work force as a whole, this analysis shows that the Program has a positive effect on Washington's economy.

Environmental Benefits

Reducing participants' energy consumption also reduces the amount of pollution created by electricity generation and fuel use. In order to determine the total amount of avoided pollution and assign a dollar value to this environmental benefit, four steps were necessary:

1. Calculate the total Program kWh energy savings
2. Apply fuel mix specific to Pacific Power to determine the amount of fuel that was saved because of avoided electricity demand
3. Use Clean Air and Climate Protection Software[11] to calculate the avoided emissions attributable to the Program
4. Obtain dollar values by pollutant to determine societal benefit

[11] Developed and provided by the International Council for Local Environmental Initiatives (ICLEI), the State and Territorial Air Pollution Program Administrators (STAPPA) and the Association of Local Air Pollution Control Officials (ALAPCO)

Results

Table 17 shows fuel saved through avoided electricity generation, based on the fuel mix specific to Pacific Power. These are fuels that would have been necessary for the purpose of electricity generation had the participant's homes not been weatherized. The first column specifies the type of fuel. The second column is the avoided annual electricity generated, while the third column quantifies the annual fuel savings in the units commonly used for the respective fuel types. The last column is the total fuel savings over the 30-year life of weatherization.

Table 17. Total Energy Savings by Fuel Type

Fuel Type[12]	Annual Avoided Electricity Generated (kWh)	Annual Fuel Savings	Lifetime Savings
Natural Gas	98,297	9,693 therms	193,852 therms
Fuel Oil	100	7 gal.	145 gal.
Coal	332,338	116 tons	2,327 tons

Dollar values were assigned to the three most substantial air emission reductions based on relevant market values as of August 2006, and are summarized in Table 18. In total, an Environmental Benefit of $125,529 was estimated.[13]

Table 18. Avoided Emissions and Societal Benefits

Pollutant	Lifetime Avoided Emission (tons)	Value Per Ton ($)	Societal Benefit (2003 $)
NOx	1,321	$1800	$35,936
SOx	7	$670	$70,880
Carbon Dioxide	302	$4.10	$18,713
Total			$125,529

a Value from Seattle NOx price curve: August 18, 2006
b Value from Seattle SOx price curve: August 18, 2006
c Value from the Chicago Climate Exchange: August 22, 2006

[12] Pacific Power's fuel mix also includes nuclear, biomass, hydro, and other fuel types; however they do not generate significant emissions.

[13] CO2: Chicago Climate Exchange. "CCX is the world's first, and North America's only, voluntary, legally binding rules-based greenhouse gas emission reduction and trading system." (www.chicagoclimatex.com)
SOx and NOx: Evolution Markets Weekly Market Update. "Evolution Markets publishes a weekly report covering U.S. SO2 and NOx emissions trading markets and global greenhouse gas emissions markets." (www.evomarkets.com)

5. Cost-Effectiveness Analysis

As part of this evaluation, we conducted an economic analysis of the Program in accordance with the benefit-cost tests from the California Standard Practices Manual. Program costs and benefits were analyzed from the following perspectives:

- Total Resource Cost Test (TRC) – This test examines Program benefits and costs from the perspectives of Pacific Power and Pacific Power's customers. Benefits include generation cost reduction, and costs include those incurred by Pacific Power as well as additional funding from Matchmaker. A 10% conservation adder is applied to generation cost savings in Washington.
- Utility Cost Test (UCT) – From Pacific Power's perspective, benefits are in the form of reduced generation and line loss costs. Costs include any incurred administrative or measure costs.
- Ratepayer Impact Test (RIM) – All ratepayers (participants and non-participants) may experience an increase in rates to recover lost revenue. This test includes all Pacific Power Program costs as well as lost revenues. On the benefits side, this test includes all avoided energy and capacity costs.
- Participant Cost Test (PCT) – This test examines benefits from a Program participant perspective, including participant utility bill reductions. Costs include any measure costs incurred by participants and the net of any utility-generated rebates. For this Program, participants did not incur measure-related costs and did not receive any direct rebates. They did, however, realize energy savings from the measures and their own energy-saving behaviors.

The analysis results are presented in multiple ways, including:

- Levelized Cost per kWh – Cost of achieving each kWh of savings levelized over time. The levelized cost per kWh can be compared to the cost of alternate resources to assess the cost effectiveness of an efficiency investment.
- Net Present Value (NPV) – The difference between the discounted Program benefits and costs. A net present value greater than zero would indicate that Program benefits exceed costs.
- Benefit to Cost (B/C) Ratio – The ratio of Program benefits to Program costs. The benefits and costs are determined over the life of the Program impact and discounted to reflect the time value of money. A B/C ratio greater than 1.0 indicates that Program benefits exceed costs.

With the exception of Matchmaker funding, which was incorporated into the TRC as described above, cost data used for this analysis were limited to those provided by Pacific Power. Although multiple attempts were made to secure total Program cost data from each of the agencies, it was discovered that this information was not readily available.

Finally, the value of savings is determined by using various avoided cost scenarios. We used the following Pacific Power forecasts of avoided costs in our analysis: Pacific Power's official market price forecast for Mid-Columbia, the base case of June 30, 2006, and Pacific Power's updated IRP 67% load factor decrement. The IRP decrement represents the avoided cost as determined by Pacific Power's long-term resource plan. Table 19 shows the discount rates, line loss, and residential rates used in our analysis.

Table 19. Pacific Power Discount Rates

Parameter	Value
Discount Rate for TRC test	5.15%
Discount Rate for UCT, RIM, PART tests	8.74%
Line Loss	11.03%
Net Residential Energy Rate ($ per kWh)	$0.0516

The cost-effectiveness analysis results are shown in Table 20 and Table 21. Under the Base Case and IRP Decrement scenarios, the Program is not cost effective from any of the perspectives.

Table 20. Cost-Effectiveness Results: Base Case Forward Curves (Excluding Non-Energy Benefits)

Perspective	Total Discounted Benefits	Total Costs	Net Present Value	Benefit to Cost Ratio	Levelized Cost ($ per kWh)
Utility (UCT)	$633,647	$1,526,475	-$892,828	0.42	$0.170
Participant (PCT)	$575,505	$0	$575,505		$0.000
Ratepayer Impact (RIM)	$633,647	$2,101,980	-$1,468,332	0.30	$0.234
Total Resource Cost (TRC)	$990,189	$1,526,475	-$536,286	0.65	$0.170

Table 21. Cost-Effectiveness Results: IRP Decrement-Load Factor = 67% (Excluding Non-Energy Benefits)

Perspective	Total Discounted Benefits	Total Costs	Net Present Value	Benefit to Cost Ratio	Levelized Cost ($ per kWh)
Utility (UCT)	$557,514	$1,526,475	-$968,961	0.37	$0.170
Participant (PCT)	$575,505	$0	$575,505		$0.000
Ratepayer Impact (RIM)	$557,514	$2,101,980	-$1,544,466	0.27	$0.234
Total Resource Cost (TRC)	$917,319	$1,526,475	-$609,156	0.60	$0.170

However, these results do not incorporate the non-energy benefits that were analyzed in this evaluation, including the Program's impact on forced mobility, arrearages, economic, and societal impacts. These benefits are presented in Table 22.

Table 22. Total Program Non-Energy Benefits

Non-Energy Benefit	Program Impact	Perspective Adjusted
Mobility	$47,600	TRC
Arrearage	$26,816	UCT, RIM, TRC
Economic	$550,118	TRC
Environmental	$125,529	TRC
Total	$750,063	

As with the previous evaluation, when these benefits are included in the analysis the Program becomes more cost effective. As presented in Table 23 and Table 24, the Program passes TRC with a benefit cost ratio of 1.06 and 1.01 respectively.

Table 23. Cost-Effectiveness Results: Base Case Forward Curves (Including Non-Energy Benefits)

Perspective	Total Discounted Benefits	Total Costs	Net Present Value	Benefit to Cost Ratio	Levelized Cost ($ per kWh)
Utility (UCT)	$660,463	$1,526,475	-$866,012	0.43	$0.170
Participant (PCT)	$575,505	$0	$575,505		$0.000
Ratepayer Impact (RIM)	$660,463	$2,101,980	-$1,441,517	0.31	$0.234
Total Resource Cost (TRC)	$1,716,674	$1,526,475	$88,271	1.12	$0.170

Table 24. Cost-Effectiveness Results: IRP Decrement-Load Factor = 67% (Including Non-Energy Benefits)

Perspective	Total Discounted Benefits	Total Costs	Net Present Value	Benefit to Cost Ratio	Levelized Cost ($ per kWh)
Utility (UCT)	$584,330	$1,526,475	-$942,145	0.38	$0.170
Participant (PCT)	$575,505	$0	$575,505		$0.000
Ratepayer Impact (RIM)	$584,330	$2,101,980	-$1,517,650	0.28	$0.234
Total Resource Cost (TRC)	$1,643,804	$1,526,475	$15,401	1.08	$0.170

When normalized to the household level, the benefit-cost ratio is higher before the addition of non-energy benefits when compared to the results of the previous Program evaluation, as shown in Table 25.

Table 25. Normalized Cost Effectiveness Between Program Periods

Perspective (Base Case)	Normalized - Without Non-Energy Benefits			Normalized - With Non-Energy Benefits		
	Benefits	Costs	Benefit to Cost Ratio	Benefits	Costs	Benefit to Cost Ratio
TRC 2003 Program	$2,502	$4,606	.54	$5,652	$4,606	1.23
TRC 2005 Program	$2,363	$3,643	.65	$3,854	$3,643	1.06

While the addition of non-energy benefits raises each benefit-cost ratio substantially, the 2005 Program has a slightly lower ratio than what was reported for the 2003 Program. This may be a result of the more detailed assignment of non-energy benefits in the current evaluation, which utilized billing data to analyze Program impacts. This was not within the scope of work for the previous evaluation.

THE CADMUS GROUP, INC.

quantec

Date: October 8, 2009

To: Becky Eberle

From: Jamie Drakos and Meghan Lee

Re: Assessment of Washington Energy Education in Schools – 2008-2009 Program Year

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This memo provides an assessment of the Washington Energy Education in Schools Program, and includes the following:

- Program Structure
- Participation
- Data Collection Procedures
- Participant Characteristics
- Measure Installation and Adoption of Energy Savings Actions
- Program Impacts
- Program Cost Effectiveness

Program Structure

A total of 4,158 sixth-grade students received education through the local Community Action Agencies (Agencies) delivering the program. The following three agencies were responsible for Program delivery:

- Blue Mountain Action Council (BMAC), Walla Walla
- Northwest Community Action Center (NCAC), Toppenish
- Opportunities Industrialization Center of Washington (OIC), Yakima

Each of the agencies employs a certified teacher (or teachers) to promote the Program to school administrators and teachers in local school districts. The certified teacher serves as an Energy Instructor, delivering energy education in three classroom sessions. The energy education curriculum covers the basics of energy production and consumption, creates awareness of resource use, and instructs students in ways that they and their families can reduce electricity use. Participating students receive a kit of low-cost efficiency measures to encourage them to put their new knowledge into practice. The kits contained the following efficiency measures:

- 14 watt compact fluorescent light bulb
- High efficiency kitchen faucet aerator
- Wall plate thermometer
- Electroluminescent (EL) nightlight
- Shower timer
- Various measurement devices to assess baseline energy consumption including refrigerator/freezer temperature card, water temperature card and water flow bag

Agencies also distribute a high-efficiency showerhead to students that have electric water heating and do not already have a high efficiency showerhead installed.[1]

Participation

Participation across the three agencies and overall is shown in Table 1.

Table 1. Participation by Agency

	Student Participants		Percent of
	Estimate	Actual	Estimate
BMAC[2]	700	436	62.3%
NCAC	1,600	1,758	110.0%
OIC	1,800	1,964	109.1%
Total	4,100	4,158	101.4%

Both OIC and NCAC exceeded their participation estimates, by about 9%. (OIC exceeded their target by 164 participants, or 9.1%, while NCAC exceeded their target by 158 participants, or 10%). The Program met 101.4% of its overall participation goal of 4,100 students, with 4,158 participants across the three Agencies.

Data Collection Procedures

The Program utilized three data collection tools this year: Home and Appliance Characteristics Survey, Installation Survey, and Follow-Up Survey. These data collection tools were designed to:

- Increase awareness of electricity usage in the home and capture key household characteristics that impact electricity consumption

[1] Determined by pre-installation flow rates of 2.5 gallons per minute or higher. Students test flow rate with water flow bag included in kit.

[2] The actual participation for BMAC does not meet the target this year because they serve one school only every other year as the classrooms have a mixed 5th and 6th grade.

- Encourage and track the installation of energy efficiency measures and adoption of savings behaviors
- Document student learning and their efforts to share their new knowledge with other members of their household

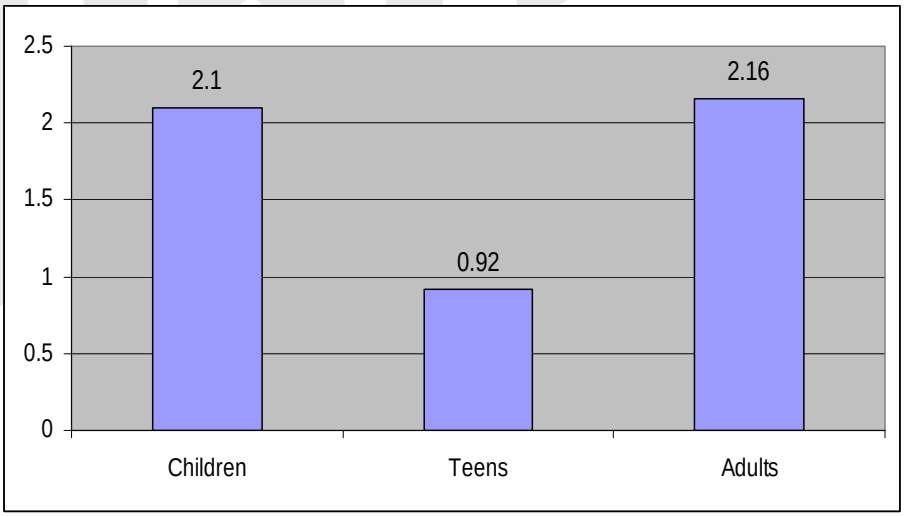
The data collected by students was entered into a database by Agency staff using a web-enabled interface. The data collection/survey instruments are refined on an annual basis to make them easier to use and more effective.

Key participant characteristics that define baseline consumption (type of appliances, occupancy, pre-installation usage factors), measure installation rates, and changes in electricity using behavior are analyzed in order to assess program impacts.

Participant Characteristics

The average participant's household had about 5 occupants as shown in Figure 1, below.

Figure 1. Average Household Occupancy by Age Group



Participants were asked to indicate the primary water heating, space heating and cooling sources in their home. Electricity is used by 80.4% of respondents for water heating, 18.0% use gas and 1.6% use other fuels. Table 2 indicates the percentage of households with each type of heating and cooling equipment.

Table 2. Types of Heating and Cooling Equipment[3]

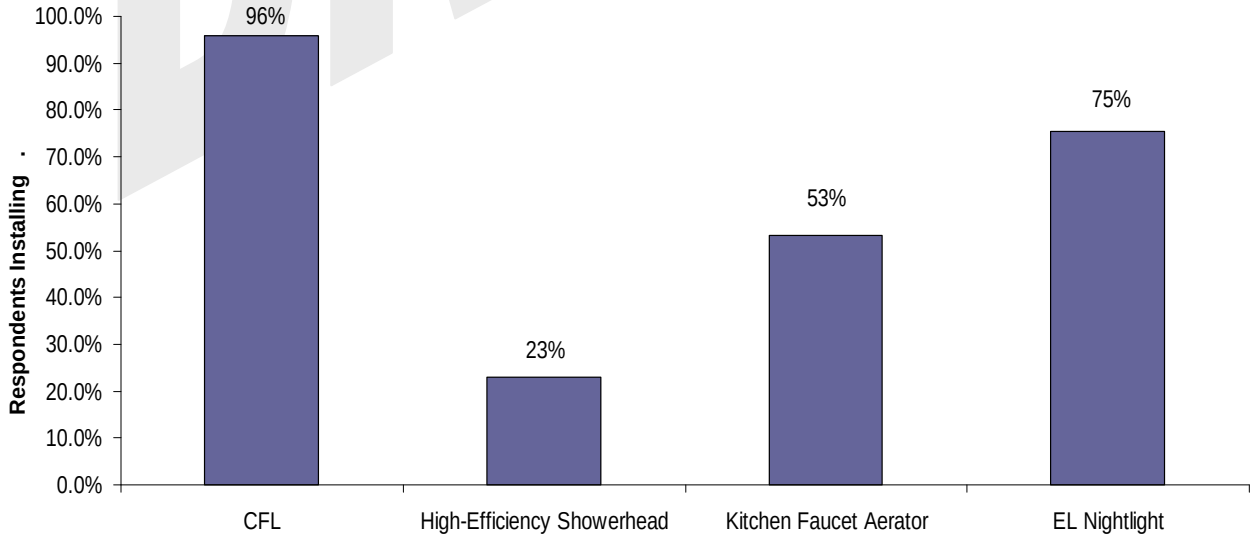
Electric Furnace	Gas Furnace	Other Electric	Oil Furnace	Heat Pump	Other
45.5%	22.7%	10.2%	2.0%	9.2%	10.4%
Central AC	**Room Fan**	**Heat Pump**	**Window AC**	**Attic Fan**	**No Cooling**
47.8%	20.0%	4.4 %	22.5%	1.4%	3.9%

The majority of the students (95.5%) indicated that Pacific Power provided electric service to their home. The second most common electric provider was Benton REA (3.8%). Nearly thirty-five percent (34.7%) of the participants reported having natural gas service, with Cascade Natural Gas as the most common provider.

Measure Installation and Adoption of Energy Savings Actions

Students reported back on their installation of measures from the energy kits. The education sessions are intended to encourage high installation rates of kit measures. Figure 2 shows the installation rates reported during the 2008-2009 school year.

Figure 2. Measure Installation Rates [4]



In addition, students also adopted several energy saving behaviors as encouraged by the energy education sessions. Key changes in energy using behaviors that were assessed included:

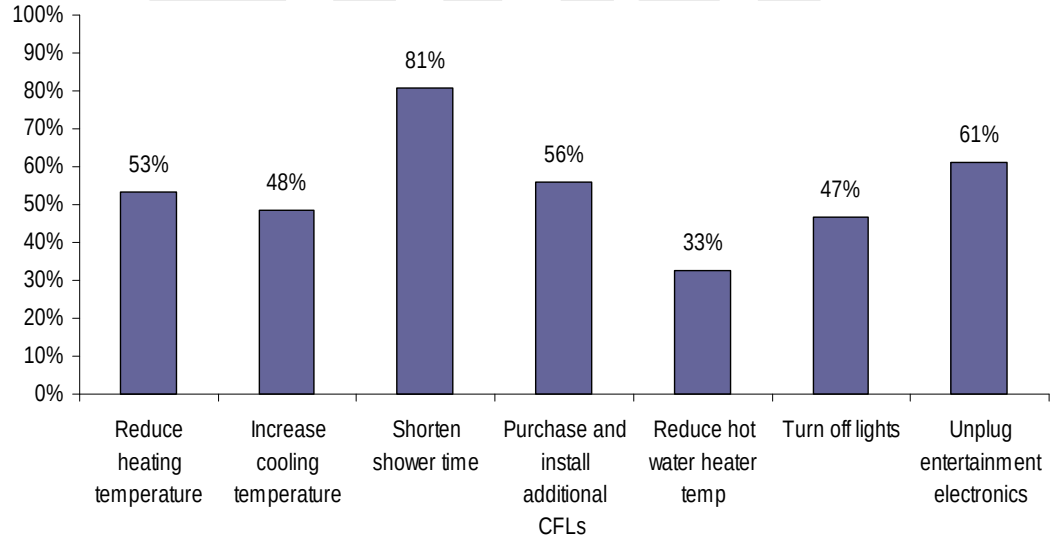
[3] Percentages may not add to 100% due to rounding.

[4] Showerheads are not distributed to all students. Based on results of flow testing, 28% of students received showerheads.

- Changing heating and cooling temperature settings (supported by the wall plate thermometer)
- Reducing shower length (using the shower timer)
- Purchasing and installing additional CFLs
- Reducing hot water temperature (based on temperature card)
- Turning off lights
- Unplugging entertainment electronics

The percentage of students adopting each of these energy savings behaviors is shown in Figure 3.

Figure 3. Adoption of Electricity Saving Behaviors



Program Impacts

We used the student completed surveys to determine baseline consumption characteristics, the installation of measures, and the adoption of energy saving behaviors. Based on their input, we then estimated the electric, natural gas and water savings of the program for the average participant and for the program overall. Table 3 shows the average annual savings per participant and Table 4 shows the total program savings.

Table 3. Average Participant Savings by Measure

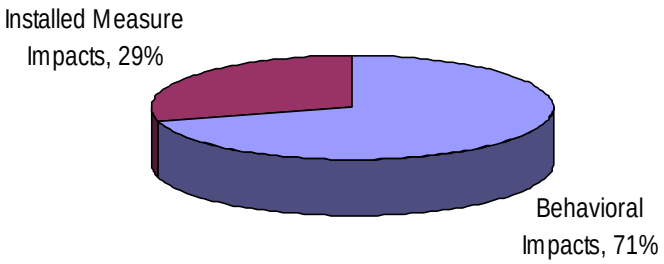
Measure	Average Annual Electric Savings (kWh)	Average Annual Gas Savings (Therms)	Average Annual Water Savings (Gallons)
Installation of Measures			
CFL	83		
Showerhead	284		2,532
EL Nightlight	16		
Kitchen Faucet Aerator	176	2.0	2,024
Install Additional CFLs	242		
Total Installation of Measures	801	2.0	4,556
Behavioral Impacts			
Shorten Shower Time	1,755	20.1	15,658
Adjust Heating Temp.	42	1.8	
Adjust Air Conditioning Temp.	26		
Reduce Hot Water Heater Temp.	21	0.4	
Turn off Lights	42		
Unplug Electronics	60		
Total Educational Impacts	1,946	22.3	15,658
Grand Total	2,747	24.3	20,214

Table 4. Total Program Savings by Measure

Measure	Annual Program Savings (kWh)	Annual Program Savings (Therms)	Annual Program Savings (Gallons)
Installation of Measures			
CFL	345,457		
Showerhead	1,179,581		10,525,034
EL Nightlight	68,335		
Kitchen Faucet Aerator	733,398	8,385	8,415,568
Install Additional CFLs	1,005,564		
Total Installation of Measures	3,332,335	8,385	18,940,602
Behavioral Impacts			
Shorten Shower Time	7,295,650	83,416	65,096,838
Adjust Heating Temp.	175,565	7,409	
Adjust Air Conditioning Temp.	108,683		
Reduce Hot Water Heater Temp.	85,749	1,503	
Turn off Lights	176,011		
Unplug electronics	250,998		
Total Educational Impacts	8,092,656	92,328	65,096,838
Grand Total	11,424,991	100,713	84,037,440

Of the per participant annual electricity savings, 801 kWh are attributed to the installation of measures, while 1,946 kWh are the result of behavioral changes. Figures 3 and 4 show the breakdown of savings between measures and behavioral changes.

Figure 4. Electric Savings Impacts



In addition to the electric savings, the Program also saves natural gas and water. Natural gas savings are attributed to adjustments in space heating thermostat settings, shower length and the installation of the faucet aerators. Water savings are attributed to shower length and the installation of faucet aerators and showerheads. The projected annual Program savings and dollar savings from installed measures and behavioral changes are shown below in Table 5.

Table 5. Annual Natural Gas and Water Savings

	Average Per Participant Savings	Total Program Savings	Total Dollar Savings
Electricity (kWh)	2,747	11,424,991	$771,187
Natural Gas (Therms)	24.3	100,713	$146,257
Water (Gallons)	20,214	84,037,440	$129,867
Total			$1,047,311

When the average participating household savings for electricity, natural gas and water are combined, the resulting first-year participant savings are $251.91, as shown below in Table 6.

Table 6. Average Participant Savings

	Annual Savings	Value of Savings ($)
Electricity (kWh)	2,747	$ 185.49
Natural Gas (Therms)	24.3	$ 35.18
Water (Gallons)	20,214	$ 31.24
Total		$251.91

Program Cost-Effectiveness

Using the calculated savings impacts and the program costs, we assessed the cost-effectiveness of the 2008-2009 Program. The costs to administer and deliver the Energy Education in Schools program during the 2008-2009 school year are shown below in Table 7.

Table 7. 2008-2009 Program Costs

Cost Category	Program Cost
PacifiCorp Administration	$ 5,460.72
Agency Costs	$ 309,045.92
Kits	$ 73,719.66
Data Tracking and Evaluation	$ 18,185.33
Total	$ 406,411.63

We calculate program cost-effectiveness for multiple scenarios and perspectives. For consistency and ease of comparison, we use the same scenarios employed in the analysis of the 2007-2008 school year. Specifically, we consider three scenarios related to program costs and savings:

- ***Scenario One*** – Savings from both installation of measures and behavioral changes are considered under this scenario. The cost of additional CFLs purchased by the customer was considered a positive participant cost. Kit costs, water, and gas savings are treated as a program benefit.
- ***Scenario Two*** – Savings from both installation of measures and behavioral changes are considered, but natural gas and water savings are not considered. Kit costs are treated as a Program benefit.
- ***Scenario Three –*** Only electric savings from measure installation are considered. Kit costs are treated a Program benefit.

A number of analyses were conducted to evaluate the costs and benefits associated with the Program, particularly:

1. ***Total Resource Cost Test (TRC)***: This test examines the Program benefits and costs from PacifiCorp's and PacifiCorp customers' perspectives. On the benefit

side, it includes reduction in generation costs. On the cost side, it includes costs incurred by both the utility and the participants. A 10% conservation adder is applied to generation cost savings in Washington.

2. ***Utility Cost Test (UCT)***: From the company's perspective, the benefits are in the form of reduced generation and line loss costs. The costs include any administrative or measure costs incurred by PacifiCorp.
3. ***Ratepayer Impact Test (RIM)***: All ratepayers (participants and non-participants) may experience an increase in rates to recover lost revenue. This test includes all PacifiCorp Program costs as well as lost revenues. On the benefits side, this test includes all avoided energy and capacity costs.
4. ***Participant Cost Test (PCT)***: This test examines the benefits from the Program participant perspective. Benefits include the participant utility bill reductions. Costs include any measure costs incurred by participants, net of any rebates received from the utility. For this Program, participants incurred no measure costs, and did not receive any direct rebates. They do realize energy savings from the various kit measures and the energy savings actions taken.

The results of this analysis are presented in multiple ways, including:

- ***Levelized Cost/kWh*** – Cost of achieving each kWh of savings levelized over time. The levelized cost/kWh can be compared to the cost of obtaining other resources to assess the cost-effectiveness of an efficiency investment. Energy efficiency resources that can be obtained for a levelized cost of $.04/kWh or less are generally cost-effective.
- ***Net Present Value (NPV)*** – The difference between the discounted program benefits and discounted program costs. A net present value greater than zero would indicate benefits of the program exceed costs.
- ***Benefit/Cost (B/C) Ratio*** – The ratio of program benefits to program costs. The benefits and costs are determined over the life of the program impact and discounted to reflect the time value of money. A B/C ratio greater than 1.0 indicates benefits of the program exceed costs.

Finally, the value of savings is determined using PacifiCorp's avoided cost scenario – that is, the cost to supply electricity that is avoided when it is saved through the Program. We use PacifiCorp's 2007 IRP decrement for the West with a 67% load factor in our analysis. The IRP decrement represents the marginal resource as considered in PacifiCorp's long-term resource plan.

Other key assumptions used in the cost-effectiveness analysis are shown in Table 8.

Table 8. Cost-Effectiveness Assumptions

Assumption	Value
Discount Rate	7.10%
Line Losses	9.94%
Retail Rate	$0.0675
Net Retail Rate	$0.0672

The results of the cost-effectiveness analysis for Scenario One are shown in Table 9.

Table 9. Scenario One: Cost-Effectiveness Results

	Levelized Cost $/kWh	Total Discounted Costs	Total Discounted Benefits	Difference	Total Benefit/Cost Ratio
Total Resource Cost Test	$0.0021	$78,837	$1,666,938	$1,588,102	21.144
Total Resource Cost Test (TRC) no Adder	$0.0021	$78,837	$1,515,399	$1,436,562	19.222
Utility Cost Test	$0.0107	$406,412	$1,515,399	$1,108,987	3.729
Rate Impact Measure (RIM)		$2,591,134	$1,515,399	$(1,075,735)	0.585
Participant (PCT)		$(327,575)	$2,201,835	$2,529,409	NA

Scenario One reflects savings from changes in household energy including behavioral changes. We also included the value of the kits as well as savings in natural gas and water costs as an additional benefit for the participants and the cost of additional CFLs purchased by the household is included as a participant cost. Non-electric and behavioral savings are not claimed by PacifiCorp.

The results of the cost-effectiveness analysis for Scenario Two are shown in Table 10.

Table 10. Scenario Two: Cost-Effectiveness Results

	Levelized Cost $/kWh	Total Discounted Costs	Total Discounted Benefits	Difference	Total Benefit/Cost Ratio
Total Resource Cost Test	$0.0095	$360,560	$1,666,938	$1,306,378	4.623
Total Resource Cost Test (TRC) no Adder	$0.0095	$360,560	$1,515,399	$1,154,839	4.203
Utility Cost Test	$0.0107	$406,412	$1,515,399	$1,108,987	3.729
Rate Impact Measure (RIM)		$2,591,134	$1,515,399	$(1,075,735)	0.585
Participant (PCT)		$(45,852)	$2,201,835	$2,247,686	NA

Scenario Two reflects savings from changes in household energy including behavioral changes but excluding natural gas and water savings. The value of the kit is included as a benefit to the participant and the cost of additional CFLs purchased by the household is included as a participant cost.

Finally, the results of the cost-effectiveness analysis for Scenario Three are shown in Table 11.

Table 11. Scenario Three: Cost-Effectiveness Results

	Levelized Cost $/kWh	Total Discounted Costs	Total Discounted Benefits	Difference	Total Benefit/Cost Ratio
Total Resource Cost Test	$0.0166	$360,560	$906,758	$546,198	2.515
Total Resource Cost Test (TRC) no Adder	$0.0166	$360,560	$824,326	$463,766	2.286
Utility Cost Test	$0.0187	$406,412	$824,326	$417,914	2.028
Rate Impact Measure (RIM)		$1,592,958	$824,326	$(768,632)	0.517
Participant (PCT)		$(45,852)	$1,208,095	$1,253,947	NA

Scenario Three does not reflect any savings from changes in household behaviors. Natural gas and water savings are also excluded from this scenario. The value of the kit is again included as a benefit to the participants and the cost of additional CFLs purchased by the household is included as a participant cost.

Conclusion

The attached presentation provides additional information on the performance of the program. In addition to providing cost-effective energy and cost savings, the Program also:

- Generated high levels of satisfaction amongst participating teachers
- Increased knowledge and awareness of the importance of energy efficiency among future energy consumers

The Washington Energy Education in Schools program continues to be a cost-effective initiative based on the standard cost-effectiveness analysis considered by the Washington Utilities and Transportation Commission and provides significant savings to participating families.