
Washington Low-Income Weatherization Program Evaluation Report

For Program Years 2011-2012

Prepared for Pacific Power by

Smith&Lehmann
CONSULTING

and
H Gil Peach & Associates

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Table of Acronyms

Acronym	Meaning
AAPOR	American Association for Public Opinion Research
AC	Apartment Complex
ARRA	American Recovery and Reinvestment Act
BMAC	Blue Mountain Action Council
BPI	Building Performance Institute
BTU	British Thermal Unit
CFL	Compact Fluorescent Light Bulb
CSA	Conditional Savings Analysis
COOP	Cooperation Rate
DSM	Demand Side Management
FPL	Federal Poverty Level
kWh	Kilowatt-hour
LIHEAP	Low Income Home Energy Assistance Program
LIW	Low Income Weatherization
MH	Mobile Home
NEB	Non-Energy Benefit
NCAC	Northwest Community Action Center
OIC	Opportunities Industrialization Center of Washington
PCT	Participant Cost Test
PTRC	PacifiCorp Total Resource Cost Test
RIM	Ratepayer Impact Measure Test
RIMS-II	Regional Input-Output Modeling System
RR	Response Rate
SD	Single-Family Dwelling
SIR	Savings-to-Investment Ratio
TRC	Total Resource Cost
TREAT	Targeted Retrofit Energy Analysis Tool
UCT	Utility Cost Test
USDHHS	United States Department of Health & Human Services
USDOE, DOE	United States Department of Energy
WADOC	Washington Department of Commerce
WAP	Weatherization Assistance Program
WIDS	Weatherization Information Data System

REPORT SUMMARY

Introduction

Pacific Power's Low-Income Weatherization (LIW) program in Washington focuses on the installation of permanent energy efficient materials and is intended to maximize the efficient use of residential electricity by customers who meet income guidelines.¹ Pacific Power's contract for weatherization services is held by three weatherization agencies: Blue Mountain Action Council (BMAC), Northwest Community Action Center (NCAC), and Opportunities Industrialization Center of Washington (OIC). All agencies implement the program in Pacific Power's service territory, with administrative oversight from the Washington Department of Commerce, Community Services and Housing Division (WADOC). WADOC is the link between the weatherization agencies and the federal funding system, which is largely the United States Department of Energy (USDOE) and United States Department of Health and Human Services (USDHHS). Agencies manage various funding sources to provide energy saving improvements and installation at no cost to qualifying low-income households.

From a utility perspective, coordination of support for Low-Income Weatherization with the State Weatherization Assistance Program (WAP) is a best practice because the substantial federal and state contributions are viewed as leverage. This process establishes high standards, provides training to weatherization specialists, ensures quality control and takes into account the health, safety, repair and replacement problems endemic to the low-income portion of the housing stock.

Agencies coordinate by providing weatherization specialists and crews to deliver services directly aimed at improving energy efficiency of the home.² Each agency leverages funding from Pacific Power, USDOE, USDHHS, Matchmaker Program and other sources to achieve comprehensive weatherization of low-income customers' homes. The Matchmaker Program allocates State capital funds to local weatherization agencies, and requires local agencies to match funding dollar for dollar.

Evaluation Approach

Pacific Power contracted with Smith & Lehmann Consulting, Inc. to conduct a process and impact evaluation for program years 2011 and 2012. The process evaluation assesses program delivery and opportunities for improvement. The impact evaluation will provide an assessment of energy impacts of the program and the specific inputs for calculating program cost-effectiveness. Some of the components of the evaluation approach are discussed below.

◆ Data Collection

Pacific Power provided program participant and energy-saving improvement (measure) data, as well as program cost data and reported (ex-ante) savings. Pacific Power also produces annual reports of expected energy savings and program cost-effectiveness. To complete the analysis of

¹ Pacific Power & Light Company Schedule No. 114, Residential Energy Efficiency Rider- Optional for Qualifying Low Income Customers, July 1, 2013.

² **Energy Efficiency** - The use of less energy to provide the same or an improved level of service to the energy consumer; or the use of less energy to perform the same function.

evaluated energy savings, Pacific Power provided program participant (treatment group) and nonparticipant (comparison group) billing and payment histories.

◆ **Process Approach**

Smith & Lehmann Consulting conducted telephone interviews with the WADOC, BMAC, NCAC, and OIC. The evaluation team also conducted a telephone survey with a random sample of Pacific Power customers who received weatherization services to assess customer satisfaction with program delivery and efficacy, verify program services, and obtain opinions on various program components.

◆ **Evaluation Approach to Program Energy Savings**

Planned Energy Savings: The evaluation team collected and is reporting Pacific Power's program (*ex-ante*) estimates of energy savings.

Evaluated Energy Savings: Smith & Lehmann Consulting developed a pooled conditional savings analysis (CSA) regression model of energy (kWh) savings associated with the energy-saving improvements (measures) installed. The regression model was run to estimate weather-normalized, program-induced net energy (kWh) savings based on participant and nonparticipant billing data.

According to WADOC, approximately 72% of weatherized units in Washington have an electric heating source; consequently, Pacific Power measures installed by the program are often whole-home weatherization (insulation), energy-efficient electric lighting (compact fluorescent lights (CFLs) and infiltration measures (e.g., air sealing including blower door assisted sealing).

◆ **Evaluation Approach to Non-Energy Benefits (NEBs)**

Smith & Lehmann Consulting analyzed participant payment behavior and arrearages under a simple pre/post analysis design using a comparison group. This provided an assessment of the utility's non-energy benefits generated by the program. Repairs made to the homes are included as a NEB and quantified as a cost-offset to the program. Smith & Lehmann Consulting also used RIMS-II software to analyze the impact of economic NEBs.

◆ **Cost-Effectiveness Assessment**

Cost-effectiveness was assessed using five different perspectives. Smith & Lehmann Consulting provided cost-effectiveness inputs to Cadmus, who performed the calculations of Benefit/Cost Ratio and Levelized Cost for each of the program years and for the total evaluation period.

Conclusions and Major Findings

- ◆ Pacific Power's Low-Income Weatherization program exemplifies a utility best practice in that it is coordinated with USDOE, USDHHS, and WADOC. This provides leverage to each utility dollar

provided in this joint effort to serve low-income customers. Pacific Power’s decision to coordinate its weatherization efforts with Washington’s subgrantee agencies provides leverage to each utility dollar and should be continued.

- ◆ Overall, this evaluation demonstrates that the program is operating as planned within the design parameters outlined in Pacific Power & Light Company Schedule No. 114, State of Washington.
- ◆ The agencies also administer payment assistance. The partnership between Washington’s Low-Income Home Energy Assistance Program (LIHEAP) payment assistance and WAP is beneficial to both programs: LIHEAP certification streamlines the application process and WAP helps clients to decrease their energy burden by weatherizing their home. This decreases not only the energy burden to the client but also the burden placed on LIHEAP to help the client over future heating seasons. Using LIHEAP qualification as proof of eligibility also reduces program costs considerably and allows for easier access to statewide programs, as clients can qualify for multiple services under LIHEAP processes. The Washington State Low-Income Weatherization Income Eligibility Guidelines allow for the service of homes up to 200% FPL; however, by running intake for weatherization through LIHEAP those served are limited to 125% FPL.³
- ◆ Ex-post savings from program participation as evaluated through billing analysis are 542,452 kWh for program years, 2011-2012. This amount represents a 120% realization rate of Pacific Power reported energy savings of 450,800 kWh, across the 2011 and 2012 program years (see Table 1).

Table 1. Net Program Savings (at Site) 2011-2012

Program Years	Reported Savings (kWh)	Evaluated Savings (kWh)*	Net Realization Rate
Total (2011-2012)	450,800	542,452	120%

*Evaluated savings are the results of the billing analysis and are discussed in detail in the *Impact Evaluation* section of this report.

- ◆ The Washington Low Income Weatherization program was found to be cost-effective from the perspectives of PacifiCorp Total Resource Cost Test (PTRC) and Total Resource Cost Test (TRC). The program was not cost-effective from the perspective of the Utility Cost Test (UCT) and Ratepayer Impact Measure (RIM) test. The Participant Cost Test (PCT) is determined “Not Applicable” for the purpose of evaluating a low-income program with a zero cost to the participant. Further description of the individual tests and respective results can be found in the *Cost-Effectiveness Analysis* section of this report.

³ Washington State Low-Income Weatherization Program – Income Eligibility Guidelines, 2015.

Table 2. 2011-2012 Low-Income Weatherization – Cost-Effectiveness including Non-Energy Benefits

Cost-Effectiveness Test	Levelized \$/kWh	Costs*	Benefits*	Net Benefits	Benefit/Cost Ratio**
PacifiCorp Total Resource Cost Test (PTRC)	\$0.1432	\$1,072,589	\$1,576,515	\$503,926	1.470
Total Resource Cost Test (TRC) No Adder	\$0.1432	\$1,072,589	\$1,494,279	\$421,690	1.393
Utility Cost Test (UCT)	\$0.1432	\$1,072,589	\$846,330	(\$226,259)	0.789
Ratepayer Impact Measure (RIM) Test		\$1,715,359	\$846,330	(\$869,030)	0.493
Participant Cost Test (PCT)		\$0	\$1,600,404	\$1,600,404	N/A
Discounted Participant Payback (years)					N/A
Lifecycle Revenue Impact (\$/KWh)					\$0.00001044

*Smith & Lehmann provided evaluated costs and benefits necessary to calculate cost-effectiveness

**Cadmus is responsible for results of the cost-effectiveness summary

Recommendations

- ◆ If agencies continue to serve apartments and/or condominiums in multifamily buildings, Pacific Power should separately analyze energy savings to determine deemed savings specifically attributed to the weatherization of apartment units. Smith & Lehmann Consulting’s analysis of apartment complex (AC) cases discovered no detectible savings under a typical billing analysis. To obtain more accurate results of AC-specific savings, Smith & Lehmann Consulting recommends the use of an engineering analysis of savings on an individual measure or per-unit basis. To accomplish this, Smith & Lehmann Consulting also recommends Pacific Power track the specific quantities of measures installed in all apartments weatherized in the future (e.g., sq. feet of insulation). This will ensure sufficient data to perform an engineering analysis of evaluated measure-specific savings.

If agencies continue to serve apartments and/or condominiums, Pacific Power should discuss existing commercial DSM programs with agencies, and also consider developing an option for full building upgrades. For example, individual dwelling units could continue to be served through the current program while common area and building systems could be covered under an alternative Demand Side Management (DSM) program with energy savings allocated separately to the weatherization program and to a commercial building program.

- ◆ Pacific Power should continue to collaborate with agencies in an effort to find solutions to service more Pacific Power homes, and develop deeper levels of energy savings. Smith & Lehmann Consulting also recommends the other agencies join NCAC in their effort to collaborate with local community health and asthma clinics, as well as the Health Home Program to reach out to potential priority clients.

- ◆ Brand Pacific Power’s weatherization program. Client survey results indicate 19% of participants remember or recognize that Pacific Power contributed to the weatherization work they received. Pacific Power should consider whether it is important that customers recognize Pacific Power’s contribution to the weatherization services received. If so, Pacific Power should continue to provide a branded item concurrently with weatherization services to increase customer recognition.
- ◆ Agencies indicated increasing repair costs, typical of most low-income cases, as a major barrier in the delivery of program services. Agencies report an average deferral-rate between 50%-65% of all clients that apply to the program, and report availability of funds to cover repairs as the main reason homes are “deferred” from receiving services. While some of these clients will return to the program, many will not be able to afford the repairs necessary to move forward with weatherizing the home. In an effort to mitigate this effect, agencies are collaborating with the State attempting to utilize Matchmaker funds to establish a home repair program outside of typical weatherization funding.

Pacific Power reimbursements related to home repairs are limited to 15% of the annual cost of total jobs performed (i.e., funds spent) by each agency.⁴ Despite this allowance for repairs, Pacific Power reports agency rebates for repairs at approximately 6% of total funds spent in both 2011 and 2012 program years. Smith & Lehmann Consulting recommends Pacific Power initiate a discussion with WA WAP agencies aimed at increasing the percentage of total rebates claimed for repairs. Accomplishing this will allow agencies to service more of the homes they interact with, thus increasing the efficiency of funding already utilized by the program.

⁴ Pacific Power & Light Company Schedule No. 114, Residential Energy Efficiency Rider- Optional for Qualifying Low Income Customers, July 1, 2013.

IMPACT EVALUATION

Pacific Power's LIW program in Washington is implemented by three weatherization agencies: BMAC, NCAC, and OIC. All three agencies administer the program in Pacific Power's service territory, with administrative oversight from WADOC. WADOC is the link between the weatherization agencies and the federal funding system (USDOE and USDHHS). Energy saving improvements and measure installations are provided at no cost to qualifying low-income households.

Pacific Power contracted with Smith & Lehmann Consulting to conduct a process and impact evaluation for program years 2011 and 2012. The impact evaluation assesses energy impacts and inputs to calculating program cost-effectiveness. This section describes the approach used to develop reported and adjusted energy savings based on utility electric billing data.

Methodology

An energy usage analysis (regression analysis) was conducted by Smith & Lehmann Consulting to determine net kWh savings and realization rates for the LIW program for 2011 and 2012 program years.

Measures most frequently installed include: CFLs, air sealing and infiltration control, water pipe insulation, and floor insulation.

The savings estimate was determined from a pooled CSA regression model. This model included data from a group of nonparticipant homes, which served as the baseline (comparison group). Impact evaluation data were obtained from a number of different sources, including:

- ◆ **Program Database:** Pacific Power provided information regarding the program's participants and installed measures. Specifically, these data included participant contact information and lists of measures installed per home, as well as associated reported energy savings.
- ◆ **Billing and Payment Records:** Pacific Power provided participant and nonparticipant account records from December 2009 through January 2014. The comparison population was identified based on their eventual receipt of weatherization services post-evaluation timeframe. For example, in analyzing homes weatherized in 2011 (treatment group), Smith & Lehmann Consulting was provided data on homes weatherized in 2013 for comparison. Furthermore, in analyzing homes weatherized in 2012 (treatment group), Smith & Lehmann Consulting was provided data on homes weatherized in 2014 for comparison. To be considered "nonparticipants" for the comparison group, the homes could not have received weatherization with Pacific Power funds during the program period 2011-2012.
- ◆ **Weather Data:** Smith & Lehmann Consulting collected weather data from three representative weather stations for the corresponding time period from Weather Data Depot.⁵ Weather

⁵ Weather data was pulled from Weather Data Depot available at: <http://www.weatherdatadepot.com>

stations were selected based on proximity to Pacific Power service territory. Smith & Lehmann Consulting also considered relative topological elevations and local weather patterns when matching zip codes to their respective weather stations.

The evaluation team first matched participant accounts from program accounting data to billing records. This separated billing records into treatment and comparison groups. Monthly heating and cooling degree days were then matched by zip code to each of the respective calendar months in the billing data for use in a weather-adjusted CSA model.

Data and Document Review

The following data and information was reviewed to determine the average savings and participation levels as well as the distribution of measures over the 2011 and 2012 program years.

◆ Participant Data

Pacific Power provided the initial program database for participants weatherized in 2011-2014. The database was comprehensive and included participant contact information, participant identifiers, measures installed, kWh savings per measure, year of installation, and agency and cost information. Data were summarized by measure and year.

The initial data extract from Pacific Power included program participant information and account numbers that did not always match corresponding billing and payment information. The evaluation team relied on site-ID to match the participants with the billing and payment data.

◆ Invoice Data

The program data provided by Pacific Power did not track invoice or project completion dates and only included the dates the completed weatherized homes were entered into the database. Delays between completion dates, invoice dates, and the date the job was entered into the system made it difficult to determine which program year each job was completed. It was determined that Pacific Power's protocol is to enter projects into the tracking system during the same month they were invoiced and so this information was used to assign homes to completion years.

◆ Quantity and Cost Data Collection

Pacific Power's program database tracked measure codes, measure names, total measure costs per home, and quantities installed for some specific measures such as the number of CFLs, faucet aerators, and low flow showerheads. However, the program database did not track quantities of the different types of insulation installed (*e.g.*, sq. feet of ceiling, wall, floor, and pipe insulation). Measure quantity is necessary in cases for calculating reported energy savings estimates and is also helpful for assessing measure-level cost-effectiveness. For this analysis, reported savings are based off Pacific Power's annual report information and are calculated at the program level.

◆ **Primary Heating Fuel Flag**

The primary heating fuel for each customer was tracked in the Pacific Power program database. The fuel type can be entered in the database as a specific electric or as a non-electric heat-type (i.e., all electric heat pump, electric baseboard, electric ceiling cable, electric forced air, electric portable, electric wall heater, and non-electric).

◆ **Measure Tracking**

Measures installed were matched with annual numbers reported by Pacific Power. The measures installed in 2011 and 2012 were consistent with information provided in the annual reports.

Program Participation and Reported Savings

Smith & Lehmann Consulting reviewed program data and annual reports to determine average annual savings, participation levels, and the distribution of measures installed over the program years 2011-2012. Table 3 displays the average savings and participation levels over the evaluation period, as well as for each program year.

Average savings per participant reported by Pacific Power were used as a benchmark to check the results of the billing analysis and to calculate the realization rate for the total evaluation period, 2011-2012.

Table 3. Annual Reported (Ex-Ante) Savings and Participant Levels

Program Year	Participation	Reported at Site Energy Savings (kWh)	Average Savings per Participant* (kWh)
2011	133	244,720	1,840
2012	112	206,080	1,840
Total	245	450,800	1,840

*Average savings per participant were derived from Pacific Power’s program database and matched those reported in Pacific Power’s annual reports for 2011 and 2012.

Annual participation and reported program savings were calculated using Pacific Power’s program database and annual report information. Frequencies of the measures installed are tracked for each participant in Pacific Power’s program accounting database. Table 4 reports the frequency of homes receiving different measures, as reported in Pacific Power’s program accounting database. Note that the frequency reflects the number of homes that received a specific type of measure and not the total number of individual measures installed. Approximately 99% of the 245 homes are electrically heated and received installations consisting of some type of insulation, CFLs, and repair measures.

Table 4. Frequencies of Measure Installations 2011-2012

Measure Type	2011	2012	Grand Total
Total Homes Served	133	112	245
Caulk and Weather Strip Windows	2	5	7
Caulk and Weather Strip Doors	91	60	151
Infiltration	124	107	231
Pipe Insulation	118	106	224
CFLs	127	105	232
Custom Lighting Fixtures	0	1	1
Windows- double glass replacements	3	0	3
Doors- thermal door replacement	6	0	6
Ceiling Insulation	82	67	149
Attic Ventilation	73	45	118
Floor Insulation	114	97	211
Thermostat	27	14	41
Duct sealing and insulation	78	58	136
Water heater repair (and replacement)	5	12	17
Faucet Aerators	85	81	166
Dehumidifier	0	1	1
Wall Insulation	44	36	80
Refrigerator Replacement	19	13	32
Low Flow Shower Head	87	66	153
Ground Cover	77	93	170
Repairs	52	52	104

Energy Savings Analysis

Smith & Lehmann Consulting analyzed monthly billing data, provided by Pacific Power, for all residential customers from December 2009 through January 2014, which included LIW program participants over the 2011-2014 program years. This timeframe included the evaluation period, 2011-2012, as well as the most recent program years 2013-2014, which were utilized as comparison cases. Methods for the analysis included:

◆ Data Screening

To ensure a clean and reliable dataset for the billing analysis, the evaluation team screened the billing data for treatment group and comparison group usage. First, the evaluation team summarized monthly kWh usage and the respective number of billing days per usage-month for each account. These periods were then adjusted to represent usage per calendar month to prevent bias if more or fewer days occurred in each usage-month determined by the meter-read dates. Treatment and comparison group sites were then removed from analysis if any of the following criteria applied:

- Duplicate cases (duplicate site-ID, total kWh, and meter-read date)
- Fewer than 11 months of data were available in each year

- Total annual pre- or post-consumption of less than 1,000 kWh; total annual pre- or post-consumption more than 50,000 kWh

These criteria are commonly used in billing analyses and were selected to ensure sufficient data were available. This process also helps to reduce the risk of including sites where significant changes occurred outside of weatherization that could affect energy consumption. After application of the above criteria, 242 participants remained in the analysis from the original population of 245 participants. The number of participants available for analysis was further limited by requiring case level data match between the baseline and post year. These participants were used as the treatment group in this analysis.

◆ Comparison Group Selection

Smith & Lehmann Consulting used a quasi-experimental research design, which consisted of comparing the change in pre- to post-energy consumption between participants and a comparison group of eligible nonparticipants, who are assumed to be eligible for the program but did not yet participate. The comparison group in this case was selected from weatherization participants who entered the program during 2013-2014, post-evaluation timeframe. By effectively accounting for non-program related factors effecting energy use during the pre- to the post-program periods, Smith & Lehmann Consulting can provide an estimate of “net” impacts of the program.

The comparison group population was limited to participant zip codes to ensure comparability of the housing stock and environmental conditions between both samples. The final nonparticipant comparison group consisted of 187 participants. Average daily treatment group consumption in the baseline year was 51 kWh and average daily comparison group consumption was 48 kWh. Through this method and the proximity of these consumption estimates, we maximized comparability between the comparison group and the treatment group.

Once the screened treatment group of 242 participants and matching comparison groups were selected, accounts were matched back to billing data to obtain final, screened, monthly modeling billing data.

Energy Savings Analysis Results

The analytic approach used a CSA model. The final CSA regression model specification below was used to estimate energy savings from insulation measures:

$$ADC_{it} = \alpha + B1ANNUALPRE_i + B2POST_t + B3PARTPOST_{it} + B4CDD_{it} + B5HDD_{it} + \epsilon_{it}$$

Where for customer (i) and month (t):

- ADC_{it} = average daily kWh consumption
- $ANNUALPRE_i$ = the total annual pre- period kWh usage.
- $POST_t$ = indicator variable that is 1 in the post- period for both the treatment and comparison groups, 0 otherwise.
- $PARTPOST_{it}$ = indicator variable that is 1 in the post- period for the treatment group, 0 otherwise.

- HDD_{it} = average daily heating degree-days (base 65)
- CDD_{it} = average daily cooling degree-days (base 65)

The key coefficient determining average program savings was B3. This coefficient represents the average daily savings per program participant, after accounting for nonparticipant trends. The inclusion of the ANNUALPRE variable was used to ensure level of energy use among participants and nonparticipants had no undue influence over the final savings estimate, resulting in a more robust model.

The model was run on each individual program year, as well as on the evaluation timeframe 2011-2012. The model was also run separately for the different housing types: Single-Family Dwelling (SD), Mobile Home (MH), and Apartment Complex (AC). Results indicated no significant difference in evaluated energy savings for SD and MH cases; however, analysis of AC cases demonstrated no detectable energy savings. This is to be expected, as apartments typically receive fewer measures (on average) than SD or MH cases. An analysis of measure-specific savings would be needed to predict meaningful AC savings estimates. To increase the accuracy of the CSA model, treatment and comparison cases were further restricted to include only SD and MH cases. Apartment-specific analysis and results are discussed separately in the next section.

Table 5 summarizes overall adjusted net kWh model savings results for the program. The table compares average expected savings with the average per participant modeled savings to obtain an adjusted net realization rate of 120% for the evaluation timeframe 2011-2012. The relative precision at the 90% confidence level for the total program savings estimate, 2011-2012, was 3.01%.⁶

Results for individual program years are less stable due to a smaller number of cases in each year (relative precision is better for larger samples). The two-year modeled estimate of savings is constructed by assigning each case's pre-weatherization annual energy use to a modelled base-year and each post-weatherization annual energy use to a common post-year, and running a regression analysis on the total dataset. This result is reported with associated relative precision in Table 5.

Table 5. Model Adjusted Net Savings and Realization Rate Summary (kWh/year)

Program Year	Reported Savings per Participant	Modeled Net Savings per Participant	Net Realization Rate	Relative Precision at 90% Conf. Level
Total (2011-2012)	1,840	2,214	120%	3.01%

⁶ A common measure of model reliability is the relative precision of an estimate. In calculating relative precision of an estimate (B3 in the equation above), a normal distribution is assumed. Knowing the shape of the theoretical distribution of estimates permits us to use the appropriate z-value from the normal curve. For a 90% confidence interval, the z-value is 1.645. Relative precision is calculated by multiplying the z-value from the normal distribution by the standard error of the regression coefficient developed from the regression analysis and dividing by the value developed for the regression coefficient (here B3) from the regression analysis.

Energy Savings Analysis: Apartment Results

Smith & Lehmann Consulting conducted a separate savings analysis for apartment cases. Apartments made up 22.6% of homes completed in 2011 (30 cases out of 133), but only 7.2% for homes completed in 2012. Insufficient comparison data were available on apartments weatherized during 2013-2014. Therefore, comparison cases were drawn from customers (living in apartments) who qualified for Pacific Power's Low-Income Schedule 17 rate. A CSA regression analysis indicated no detectible savings for Apartment Complex (AC) cases under this type of billing analysis.

Units in multifamily buildings (apartments and condominiums) can be most effectively addressed by whole-building weatherization, which would involve treating the individual dwelling units, as in the current program, but also treating building systems. This could perhaps be designed as a unified whole building treatment with the individual unit savings credited to weatherization and the building system upgrades allocated to a commercial sector energy conservation program.

Smith & Lehmann Consulting recommends in the next round of evaluation, Pacific Power should separately analyze energy savings to determine deemed savings specifically attributed to the weatherization of apartment units. Smith & Lehmann Consulting's analysis of apartment complex (AC) cases discovered no detectible savings under a typical billing analysis. To obtain more accurate results of AC-specific savings, Smith & Lehmann Consulting recommends the use of an engineering analysis of savings on an individual measure or per-unit basis. To accomplish this, Smith & Lehmann Consulting also recommends Pacific Power track the specific quantities of measures installed in all apartments weatherized in the future (e.g., sq. feet of insulation). This will ensure sufficient data to perform an engineering analysis of evaluated measure-specific savings.

Payments and Arrearages

Monthly energy bills and payment histories were used to quantify program impacts on payment patterns and customer arrearages. Changes between pre- and post-periods were compared between treatment and comparison groups to measure the net effects of Pacific Power's weatherization program on participant payment patterns.

Methodology

Pacific Power provided monthly payment data for the low-income customer sample from December 2009 to January 2015. The sample included all treatment and comparison group participants. As discussed previously, the comparison group in this case was selected from weatherization participants whom entered the program during 2013-2014 post-evaluation timeframe. Pacific Power payment datasets included the following information:

- ◆ Payment transaction date (monthly)
- ◆ Actual billed amount
- ◆ Actual paid amount

- ◆ Source of payment (direct customer payment, customer assistance payment, and collections actions)
- ◆ Arrearage amount (customer's monthly unpaid ending account balance)

In this analysis, two specific measurements were analyzed:⁷

1. Total payment amounts made by individuals during the pre- and post-periods
2. Proportion of payments to amount billed during the pre- and post-periods

◆ Data Screening

To ensure a clean and reliable dataset, Smith & Lehmann Consulting screened treatment and comparison group payment data. First, the comparison group population was matched to treatment zip codes to ensure comparability of samples. The next step was to summarize payment data and the total number of billing days for the pre- and post- periods for each account (treatment and comparison) weatherized from 2011-2014. Pre- and post-period payment information was summed on an annual basis for each site. Treatment and comparison group sites were removed from the analysis if any of the following conditions applied:

- Removal of sites with more than 400 or less than 330 days in the pre- and post-periods.
- Removal of sites with fewer than 11 bills or more than 13 bills in the pre- and post-periods.
- Removal of sites where total payment amount exceeded 150% of billed amount in either the pre- or post-periods.

These criteria were employed to ensure sufficient data and to reduce chances of including sites where extraneous changes affected payments. The combined application of these three screening rules also removed any remaining extreme values from the treatment and comparison datasets. After applying the screening criteria, 85 treatment group participants and 81 comparison group participants remained from the original counts of 181 and 223, respectively, for the combined (2011 & 2012) analysis.

Payment Analysis Results

Payment Amounts

Table 6 shows the change in payment amounts from the pre-weatherization calendar year to the post-weatherization calendar year and summarizes data for weatherization years 2011 and 2012. The first

⁷ Arrearage is also analyzed (in the next section of the report, *Change in Arrearages*). Analysis of average number of payments per year was also considered, however, since some low-income customers make several small partial payments during parts of the year while others make regular payments in-full and still others come on and off the system, the interpretation of "number of payments" is ambiguous. Therefore, the analysis is limited to dollars, which are a more direct indicator of payment performance.

three columns in the table report on treatment homes and the second three columns report on comparison homes. The model was constructed as if all weatherization took place in a single year. Results shown in this Table 6 can be characterized as follows:

- ◆ Participant bills in the treatment group are generally slightly lower than bills for nonparticipants in the comparison group. The first row of Table 6 shows that treatment group bills are, on average, lower than comparison group bills in both the baseline year (\$1,405 for treatment group divided by \$1,446 for comparison group = 97%) and post-year (\$1,382 for treatment group divided by \$1,427 for comparison group = 97%).
- ◆ Annual bills decreased more for the treatment group than for the comparison group. As shown in Table 6, bills went down for the treatment group by an average of \$23 or about 1.6% and for the comparison by an average of \$19 or about 1.3% for a net decrease of \$4 (first row, tenth column).⁸ This means the average bill decrease for the treatment group was \$4 more than for the comparison group. This pattern is expected because weatherization can also serve as a general buffer for other bill increases because it reduces required energy use.
- ◆ Customer payments increased, on average, for both treatment and comparison groups. The second row in Table 6 shows customer payments went up for both groups, but increased significantly for the treatment group. The treatment group paid, on average, \$149 or about 14.6% more in the post-year than in the baseline year. The comparison group paid on average \$38 more or 3.2%. Overall, the comparison group paid a net of \$111 more than the treatment group (row two, column ten).
- ◆ As noted above, the average annual treatment group bill decrease was \$4 more than the average annual decrease in comparison group bills. The other part of bill payment is external agency payment. The amount of external agency payment declined (by \$209 or 52.4%) for treatment group, but remained statistically similar (\$1 increase) for the comparison group. This results in a net difference of \$210, which is statistically significant at the 0.001 level.

Putting these results together, both the treatment and comparison groups received slightly smaller bills in post-year than in the baseline year; both groups paid more; and the treatment group received significantly lower external agency payments. In each of these comparisons, the treatment group performed better than the comparison group. Overall, treatment group external agency payment assistance dropped by a net of \$210, which can be assumed remains within general payment assistance funding available for other customers.

⁸ Bills and payments are only approximately related. They do not match exactly due to timing of meter reads and bill dates and the beginning and end of each year. In addition, shifting balances forward (arrearage) for many low-income customers also means that bills and payments do not match.

Table 6. Payment Amounts Summary 2011-2012

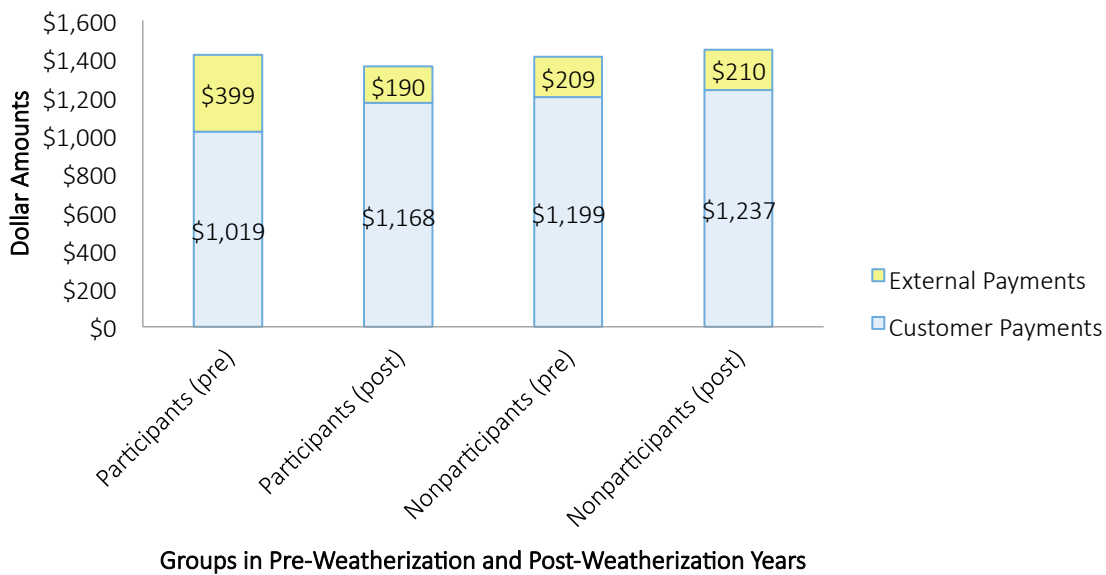
Annual Payment Type	Treatment Group				Comparison Group				Net Difference Amount
	Pre-	Post-	Change	% Change	Pre-	Post-	Change	% Change	
Billed Amount	\$1,405	\$1,382	-\$23	-1.64%	\$1,446	\$1,427	-\$19	-1.31%	-\$4
Customer Payment	\$1,019	\$1,168	\$149*	14.62%	\$1,199	\$1,237	\$38	3.17%	\$111
External Payment	\$399	\$190	-\$209**	-52.38%	\$209	\$210	\$1	0.48%	-\$210**

*Significant at the 0.01 level

** Significant at the 0.001 level

Figure 1 below depicts the change in the yearly customer payments compared to the amount of external agency payment assistance between the pre- and post-years for participants and nonparticipants. This figure is based on a two-year summary in which each year is calculated separately and results are then modeled in the form of a single year.

Figure 1. Payment Summary 2010-2012



The values associated with Figure 1 are provided in Table 6 above. The treatment group made 72% of the total annual payment amount in the pre-weatherization year and 86% of the total annual payment amount in the post-weatherization year. The comparison group paid about 85% of the total annual payment amount in the pre-weatherization year and about 85% in the post-weatherization year. This indicates that by participating in the program, clients are able to pay a larger portion of their annual payment amount (approximately 10% more).

Change in Arrearages

Arrearage is that portion of a customer’s bill they do not pay in a given month, or the unpaid ending balance. Table 7 shows the program impact on customer arrearage amounts.

Table 7. Arrearage Summary 2011-2012 Weatherization

	Treatment Group				Comparison Group				Net Difference
	Pre-	Post-	Change	% Change	Pre-	Post-	Change	% Change	Change
Average Arrearage	-\$10.12	\$11.82	\$21.94*	216.8%	\$25.55	\$35.94	\$10.39	40.7%	\$11.54

*Significant at the 0.024 level

The average customer arrearage represents their ending or outstanding balance amount averaged across a 12-month period. The arrearage value also takes into account the existing arrearage for each customer prior to the pre- and post- periods. Across the 2011-2012 program years, the treatment group average monthly balance forward amount increased about 216.8% (from -\$10.12 to \$11.82), while the comparison group average monthly balance forward amount increased only 40.7%. The treatment group increase was statistically significant at the 0.024 level, but the comparison group increase was not statistically significant. The net difference between the two groups was an \$11.54 increase in the arrearage of participants versus nonparticipants and this change was not statistically significant.

ECONOMIC BENEFITS ASSESSMENT

Pacific Power's Low-Income Weatherization program has a direct and indirect effect on the flow of money through the regional economy and thus creates participant and regional economic NEBs. In this section, Smith & Lehmann Consulting analyzed the associated economic NEBs using the Regional Input-Output Modeling System (RIMS-II). RIMS-II is maintained by the U.S. Department of Commerce, Bureau of Economic Analysis and has served as a useful tool in economic impact studies by investors, planners, and government agencies.

RIMS-II analysis captures the underlying economic relationships characterizing the final-demand region. The final-demand region, in this case, is represented by the four Washington counties of Columbia, Garfield, Walla Walla, and Yakima. In the absence of the weatherization program, the residential sector spends their income on energy and other goods, and receives income from all industries (including the utility) as earnings. When the program is implemented, some spending (both public and private) is diverted to the program tariff and some residential spending on energy routes back to households through program energy savings. The RIMS-II model accounts for this baseline scenario when calculating program effects; all effects presented are net of what would have occurred in the program's absence.

RIMS-II economic impacts can be expressed in terms of output (sales), value added (gross domestic product), earnings, or employment (full- and part-time jobs) on all industries and on individual industries in the local economy. For the purpose of assessing economic NEBs, Smith & Lehmann Consulting focused on the impact the program had on the output of the region's economy.

Model Inputs

Table 8 provides a summary of the four model input categories used in the economic impact analysis; program spending, program costs, participant energy savings, and Pacific Power revenue loss. More detail on RIMS-II economic assumptions will follow this section. Program spending includes total spending within the region on all program aspects, including administrative costs, marketing, labor, and materials, as well as State Matchmaker contributions. Evaluation, utility administration, and program development expenditures are not included as local spending, as these funds typically flow directly out of state. Smith & Lehman Consulting further excluded marketing from the calculation of the final-demand change, as the industry assumed in the analysis is construction (treatment of residential dwellings) and these expenditures would not be spent on contracting weatherization services. Program costs include tariff collections across all ratepayers, including collections for Pacific Power evaluation expenditures. Tariff collections are assigned to residential and commercial ratepayers groups in relative proportion to their share of electricity load.⁹

⁹ Ratepayer sector shares are based on actual electricity load by sector in 2009.

Table 8. Inputs for RIMS-II Economic Impact Model

Input Category	Description	Amount
Program Spending Categories	Agency Administration	\$ 125,292
	Agency Weatherization*	\$ 896,211
	Matchmaker Contributions**	\$ 741,174
Program Costs	Costs to Ratepayers: tariff collections	\$ 898,232
Energy Savings for Participants	Present value of participants avoided energy costs	\$ 765,017
Revenue Loss for Pacific Power	Reduction in Pacific Power revenue	\$ (765,017)

*Agency Weatherization represents Pacific Power's direct reimbursement for measures installed.

**Matchmaker contributions were provided as a total contribution spanning 2011-2012; however, when adjustments were made to convert spending to 2010 dollars, Smith & Lehmann Consulting assumed that Matchmaker contributions had originated as 2012 dollars.

RIMS-II Methodology

The most recent release of RIMS-II I-O Model is constructed from baseline county-level 2010 data. Program spending occurred between March 2011 and February 2013; therefore, when possible, all values have been converted to 2010 dollars using the Consumer Price Index, published by the Bureau of Labor Statistics. Smith & Lehmann Consulting first converted the impacts of the program to 2010 dollars and then aggregated these values over the timeframe of the evaluation to include 2011-2012 program year impacts. Therefore, the economic impact analysis will be performed as if all the weatherization occurred in a single year.

RIMS-II software produces Type I and Type II multipliers. Type I multipliers assess the direct and indirect impacts of a change in industry final-demand. To assess the direct, indirect, and induced effects of the weatherization program, Smith & Lehmann Consulting used Type II multipliers. Type II multipliers not only account for the inter-industry effect (sum of direct and indirect effects), but they also account for the induced impact of a final-demand change. The induced impact relates to the spending of workers whose earnings are affected by a final-demand change. In applying RIMS-II Type II multipliers, the final-demand change is calculated based off of program spending that enters the region due to the program implementation, program costs to ratepayers, as well as the benefits of energy-savings, and Pacific Power's loss in revenue. Smith & Lehmann Consulting utilized Pacific Power program costs and weatherization spending information (Table 8) to develop the final-demand change.

RIMS-II I-O Framework Assumptions

The Input-Output (I-O) framework underlying RIMS-II model imposes six assumptions that should be considered when conducting an economic impact study.¹⁰

◆ Backward linkages

RIMS-II is a backward-linkage model. In a backward-linkage model, an increase in demand for

¹⁰ RIMS II: An Essential Tool for regional developers and planners, Regional Input-Output Modeling System.2012. *United States Department of Commerce, Bureau of Economic Analysis*

output results in an increase in the demand for inputs. Therefore, RIMS-II considers only the impacts related to the production of output.

◆ **Fixed purchase patterns**

I-O models assume that industries do not change the relative mix of inputs used to produce output. They also assume that industries must double their inputs to double their output.

◆ **Industry homogeneity**

RIMS-II assumes that all businesses in an industry use the same production process. This assumption raises the same concern of aggregation bias in all I-O models with less industry detail. I-O models with more robust industry detail mitigate the potential aggregation bias.

◆ **No supply constraints**

All I-O models are referred to as “fixed price” models because they assume no price adjustment in response to supply constraints. In other words, businesses can use as many inputs as needed without facing higher prices.

◆ **No regional feedback**

RIMS-II is a single region I-O model. It ignores any feedback that might exist among regions. It is unclear how the results of an economic impact study would be affected by regional feedback without knowing the details of how a region is economically related to other regions. Smith & Lehmann reduced the impact of possible feedback effects by choosing a study region that is large enough to encompass subgrantee agencies and most of the interrelated industries. Agencies confirmed that some weatherization crews were contracted from outside the region (or State). Funding for weatherization measures installed by crews that were contracted from outside the region was removed from the impact analysis.

◆ **No time dimension**

The length of time that it takes for the total impact of an initial change in economic activity to be completely realized is unclear because time is not explicitly included in I-O models. The actual adjustment period varies and is dependent on the initial change in economic activity and the industry structure that is unique to each region.

The initial change in economic activity should be permanent or at least persistent enough to fully work through the economy. The impact of weatherization on a home is permanent in the sense that the effects of the program measures installed will persist over time, and funding for the program is also planned for an extended period of time.

There are also assumptions in the model related to regional supply conditions that need to be considered when conducting an economic impact study. RIMS-II multipliers are based on national I-O relationships that are adjusted to account for local supply constraints that occur when local industries purchase intermediate inputs from outside the region. These purchases are often called “leakages” because they represent money that no longer circulated in the local economy. RIMS-II accounts for these leakages by considering each industry’s concentration in the region relative to its concentration in

the nation. If additional leakages are known to occur, it is best to remove their related impacts so as not to over-estimate program purchases within the region.

RIMS-II Results

RIMS-II results for Pacific Power’s territory are presented in a summary below, showing program impacts on employment, labor income, total value added, and output in the region (Table 9).¹¹ Each impact is a total of the direct, indirect, and induced effects. This assessment provides the present value of impacts generated over the lives of measures installed by the program and not just impacts arising from weatherization implementation. The measure of the impact on output will be used as a direct NEB in the assessment of program cost-effectiveness.

Table 9. Economic Impacts Summary for Pacific Power’s Washington Territory 2011-2012

Impact Type	Employment (Job-Years)	Labor Income	Value Added	Output
Total Effect	7.7	\$358,057	\$327,597	\$607,012

The model’s estimated impacts can be compared to spending to help contextualize program impacts. Dividing output in Table 9 by total local spending (\$1,762,677) estimates each dollar of program spending on weatherization resulted in \$0.34 of total output in the region.

¹¹ **Employment** is presented in units of job-years. One job-year equals 12 months of full-time or part-time employment for one person. **Labor income** includes all employment income (wages and benefits) as well as proprietors’ income. **Value added** is the difference between gross output (income plus inventory change) and intermediate inputs (goods and services imported or bought from other industries). The value added includes employee compensation, tax payments, and gross operating surplus. **Output** estimates production in producer prices. In manufacturing, this equals sales, plus the change in inventory. In retail and wholesale industries, this equals the gross margin, not gross sales.

ASSESSMENT OF NON-ENERGY BENEFITS

Pacific Power’s Low-Income Weatherization program in Washington has a mission to improve energy efficiency by reducing both the electricity requirements and increase the penetration of weatherization and electric efficiency measures in residential dwellings either owned or rented by qualifying low-income customers. This portion of the impact evaluation assesses non-energy impacts as additional inputs to calculating program cost-effectiveness.

Energy saving improvements and installation are provided at no cost to the low-income households. USDOE and USDHHS fund and coordinate the federal government contribution to this program.

NEBs of low-income programs are those benefits outside of energy savings that create positive change within the homes of participants and surrounding communities. Utility-specific NEBs are those positive changes that directly effect and can be quantified by the utility, which in this case is Pacific Power. Additional and quantifiable NEBs accruing to Pacific Power included reductions in external assistance payments. The direct cost of repairs is also included as a participant NEB and is quantified as a cost-offset to the program. Pacific Power internally tracks the cost-offset and reported repair NEBs at \$61,634 for the combined 2011 and 2012 program years based on internal TrackSmart data. Smith & Lehmann Consulting relied on payment information for the assessment of remaining utility NEBs.

From the perspective of the average treatment group household, there is a meaningful drop in assistance payments the year after weatherization (Table 10). Treatment group external agency payment assistance dropped by a net of \$210, which can be assumed remains within general payment assistance funding available for other customers. Smith & Lehmann Consulting concludes it would be reasonable to accept the net drop in payment assistance as a payment benefit from this part of the analysis.

Table 10. Payment Assistance Amounts Summary 2011-2012

External Payment	Treatment Group				Comparison Group				Net Difference
	Pre-	Post-	Change	%	Pre-	Post-	Change	%	
2011	\$401	\$267	-\$134*	-33.4%	\$213	\$155	-\$58	-27.2%	-\$76
2012	\$397	\$139	-\$258**	-64.9%	\$205	\$254	\$49**	23.9%	-\$307
Total	\$399	\$190	-\$209**	-52.38%	\$209	\$210	\$1	0.48%	-\$210**

*Significant at the 0.05 level

** Significant at the 0.001 level

The evaluation team concludes a one-time per participant NEB of \$210 be applied to the analysis of program cost-effectiveness. This will be in addition to the NEBs attributed to aggregated repairs and economic impacts (results of RIMS-II analysis). Table 11 provides an overview of the total NEBs attributed to Pacific Power’s WAP (2011-2012).

Table 11. Washington Low Income Weatherization Program NEBs Summary 2011-2012

Non-Energy Benefits	2011 Impact	2012 Impact	2011-2012 Impact
External Payment Reduction	\$ 27,930	\$ 23,520	\$ 51,450
Home Repair Costs	\$ 29,775	\$ 31,859	\$ 61,634
Economic Impact	\$329,521	\$277,491	\$ 607,012
Total	\$387,226	\$332,870	\$720,096

External payment reduction benefits (per year) were estimated by multiplying per participant value of \$210 by the number of weatherization participants each year. Pacific Power tracked home repair costs internally, and estimates were taken from the Company's TrackSmart database. Economic NEBs were estimated for each of the program years, 2011 and 2012, by dividing the total number of participants (245) for the timeframe 2011-2012 into the total impact (\$607,012). This resulted in \$2,477.60 per participant NEB, which was then multiplied by the number of participants for each program year.

PROCESS EVALUATION

Pacific Power’s contract for weatherization services is held by three weatherization agencies: BMAC, NCAC, and OIC. All agencies implement the program in Pacific Power’s service territory with administrative oversight from WADOC.

BMAC, NCAC, and OIC are the most important entities in this system because the agencies directly deliver the weatherization services to residential low-income customers and WADOC provides administrative oversight and quality control. WADOC is also the link upwards to USDOE and USDHHS, which provide basic funding and guidance. From a utility perspective, coordination of utility support for low-income weatherization with WAP is a *best practice* because the substantial federal and state contributions are viewed as leverage.¹² Washington was awarded \$370,000 of additional USDOE funding based on leveraging over the 2011 and 2012 program years.

Agencies coordinate by providing weatherization specialists and crews to deliver the direct services. Agencies leverage funding from Pacific Power, USDOE, USDHHS, Matchmaker Program and other sources to achieve comprehensive weatherization of the homes of low-income customers. The Matchmaker Program was created in 1987 and currently consists of State capital funds distributed on a two-year cycle. Washington communities receive State Matchmaker funding when they provide a dollar-for-dollar match. This allows agencies to leverage resources from Pacific Power and other sources to increase available funding for low-income weatherization projects.

Program Measures

Pacific Power’s weatherization program focuses on the installation of permanent energy efficient materials and is intended to maximize the efficient use of residential electricity by customers who meet income guidelines.¹³ Measures are categorized as either major or supplemental. Major measures are defined by the Pacific Power tariff to include ceiling insulation, wall insulation and floor insulation, and are applicable in dwellings with permanently installed operable electric space heating systems. Supplemental measures related to heating (e.g., attic ventilation and weather stripping) can only be installed in homes with an electric heating system. Additional measures targeting other electrical end uses and measures not related to heating can be installed in all homes. Some measures are considered “always cost effective,” are not dependent on audit results and can be installed in homes that receive certain measures. For example, if a home receives ceiling insulation it can also receive attic ventilation.

Program Operations

Agencies employ energy auditors to evaluate a home’s energy performance based on certain efficiency indicators. The auditor uses Targeted Retrofit Energy Analysis Tool (TREAT), a USDOE approved energy

¹² Coordinating utility and public program low-income weatherization program efforts can provide the most cost-effective low-income weatherization programs. Hill, Lawrence J. & Marilyn A. Brown, “Estimating the Cost Effectiveness of Coordinated DSM Programs.” *Evaluation Review*, Vol. 19, No. 2, April 1995, Pp. 181-196.

¹³ Pacific Power & Light Company Schedule No. 114, Residential Energy Efficiency Rider- Optional for Qualifying Low Income Customers, July 1, 2013.

audit software, identifying energy-saving opportunities and determining the energy-saving measures to install in each home. All agencies follow USDOE WAP guidelines for installation, which require measures that are not considered “always cost effective” to achieve a Savings-to-Investment Ratio (SIR) of 1.0 or greater when funded by USDOE or Pacific Power sources. Agencies are also permitted to install (typically in every home) certain measures that have been predetermined, by WADOC, as energy saving “priorities.” This Priority List of measures is updated and approved by USDOE every two years.

Auditors address the health and safety of the home, for example, by adjusting for proper ventilation (e.g., duct sealing and insulation repairs), providing other necessary health and safety improvements, and by completing certain home repairs that are necessary to install the weatherization measures. Repair work is simply a practical reality – a necessary activity when working with the low-income portion of the state housing stock. It extends the life of the housing stock and keeps homes habitable. This part of the work effort contributes to project costs but generally not directly to the energy savings goals of each weatherization project. In severe cases, such as very old homes, the repair costs may be too great and may result in not treating a home. This case is termed a “deferral.”

After completing work on a home, the agencies submit invoices and documentation to Pacific Power directly and to USDOE through WADOC. Pacific Power pays a rebate of 50% of the installed cost of all eligible energy efficient measures and supplemental measures, as required by the Pacific Power & Light Schedule No. 114. If Matchmaker Program participating agencies exhaust all State Matchmaker funds, Pacific Power is required to fund 100% of costs associated with the installation of program measures. Pacific Power also pays a reimbursement for administrative costs based on 15% of Pacific Power’s rebate on installed measures. The annual Pacific Power funding cap for all program components will not exceed \$1,000,000 per calendar year; however, agencies have yet to reach the funding cap. Measures most frequently installed include: infiltration, pipe insulation, and lighting (CFLs). Pacific Power reimbursements related to repairs are limited to 15% of the annual cost of total jobs performed by each agency.

Methodology

For the process evaluation, data collection consisted of telephone surveys of a sample of program participants, a discussion with Pacific Power’s Weatherization Program Manager, a telephone interview with the Section Manager of WADOC, and telephone interviews with the Directors of all three weatherization agencies in Washington.

◆ Client Survey

For the participant (treatment group) surveys, Smith & Lehmann Consulting sampled Washington residents who received WAP services for which Pacific Power provided full or partial payment. The purpose of this telephone survey was to obtain data documenting and aiding in measurement of customer satisfaction, verification of program services, and opinions on various program issues and perceived improvements.

◆ **Sample Selection**

The evaluation team completed 54 participant telephone surveys from August – September 2014, achieving 10% precision and 90% confidence. The client survey sample was randomly obtained from homes with measures installed in the most recent program year, 2012. The limitation to the most recent program year was taken to reduce recall concerns, thereby improving the reliability of the data. Sampling was completed with replacement.

Clients who received services in 2011 were expected to have greater recall bias than those who received services in 2012. This recall bias is typically exacerbated among the elderly, who usually constitute at least one-third of low-income energy program recipients. There is a slight risk that the clients who received services in 2012 will not be fully representative of the clients who received services in 2011. However, this risk is mitigated by the reduced recall bias when sampling is restricted to measures installed in 2012.

◆ **Stakeholder Interviews**

Stakeholder interviews were conducted to provide qualitative data documenting processes, funding sources, and issues related to Washington’s WAP. These interviews addressed evaluation questions regarding program participation and wait listing. Program managers were selected from each of the following agencies, as well as with the Section Manager of WADOC:

- BMAC
- NCAC
- OIC

Process Evaluation Findings

Participant Survey

The client survey achieved 54 completed participant surveys and two incompletes out of 62 clients reached, yielding a 92% completion rate. Table 12 reports the target and achieved survey samples as compared to the total population. Five respondents refused to participate or were not home at the time the interviewer called. Out of the 117 phone numbers called, 43 were invalid, disconnected or the wrong number. This is typical due to the more transient nature of the low-income population, the general shift away from landline phones with a fixed phone number to cellular phones, and more frequent changes of phone numbers. The client survey protocol can be found in the Appendix of this report.

Smith & Lehmann Consulting exhausted the initial call list of 2012 clients, but after receiving updated phone numbers for some clients, the survey completion quota was reached.

Table 12. Target and Achieved Survey Samples for Washington’s Participant Survey

Total 2011 & 2012 Population	Viable Population	Target Completes	Desired Precision at 90% Conf.	Achieved Completes	Achieved Precision at 90% Conf.
117	61	54	10%	54	10%

Survey response rates and cooperation rates were calculated according to the American Association for Public Opinion Research (AAPOR) standard definitions. For the purpose of this evaluation Smith & Lehmann Consulting calculated Response Rates (RR) following RR1 and RR2 AAPOR calculations¹⁴ (Table 13). These response rates consider all customers attempted, whether or not they could be reached. RR1 is the minimum response rate, while RR2 counts partial interviews as respondents. Cooperation Rates (COOP) represent the proportion of all cases interviewed based on all eligible customers who could be contacted. These are household-level cooperation rates based on all households that could be contacted.¹⁵ COOP1 is the minimum cooperation rate, while COOP2 counts partial interviews as respondents.

Table 13. AAPOR Response and Cooperation Rates

RR1	RR2	COOP1	COOP2
46.15%	47.86%	88.52%	91.8%

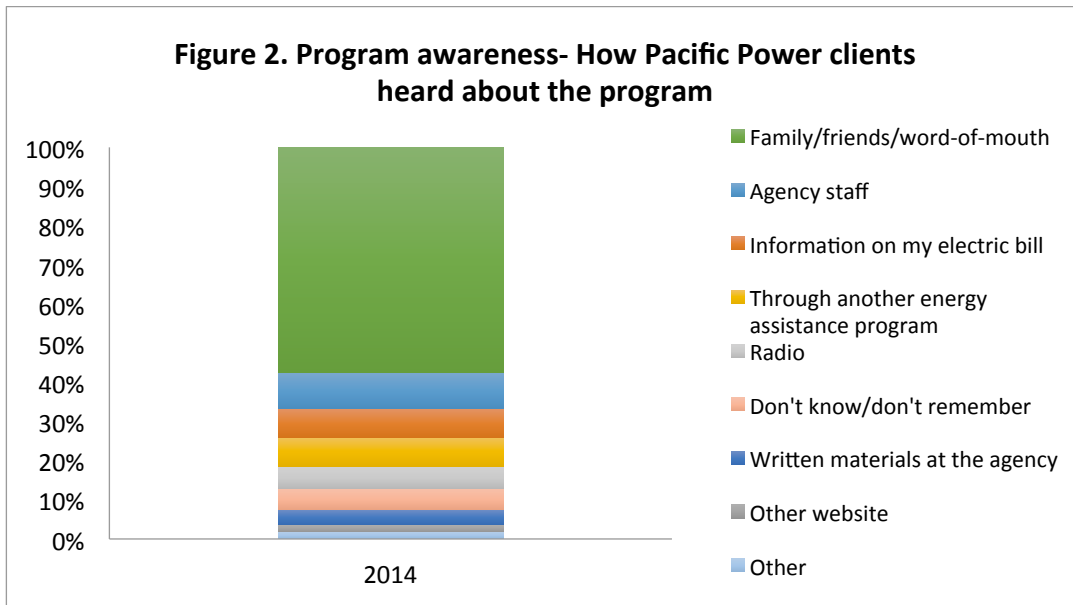
Program Awareness

Interviewers asked participants how they heard about the program (Figure 2). Over half of participants, or 31 out of 54 (57%) said that they heard about the program from family, friends, or word-of-mouth. Five participants indicated that they heard about the program from agency staff while four participants heard about the program directly from Pacific Power information on their electricity bill.

While 57% of participants heard about the program from family and friends, there was less awareness of the program’s funding source: 50% (27 out of 54) of participants had no knowledge of funding sources and 15% (8 out of 54) indicated they simply did not know or remember. Ten participants (or 19%) identified Pacific Power or the “power company” as the funding source while other participants responded with the agency that provided the services to their home (13% or 7 out of 54).

¹⁴ American Association for Public Opinion Research provided calculations for Response Rates (RR1 and RR2) and Cooperation Rates (COOP1 and COOP2). The American Association for Public Opinion Research. 2011. *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys*. 7th edition. AAPOR. Pg. 44.

¹⁵ These are excellent Cooperation Rates and probably reflect the extensive nature of the weatherization work performed in many of the weatherized homes.



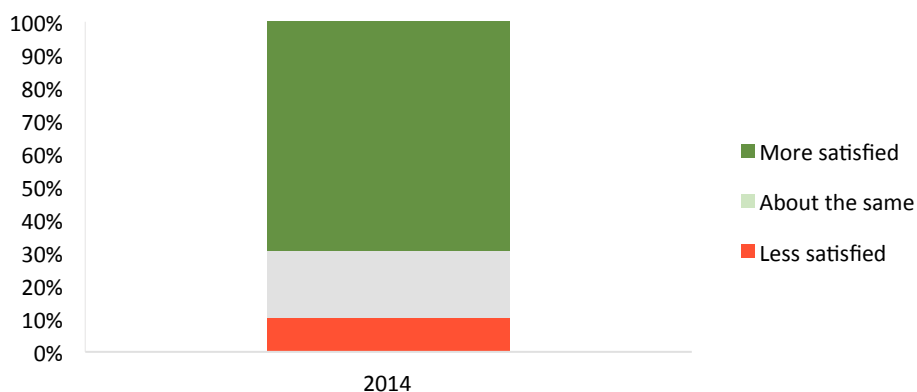
Installation Verification

Most participants verified that they received the services listed in Pacific Power’s records (96% or 52 out of 54). One participant indicated they did not receive light bulbs and another said they did not remember receiving light bulbs; however, they did receive other weatherization services and phone interviews were continued. When a home has been weatherized, typically a particular individual will have conducted the primary interaction with the weatherization agency. This person may or may not have been available for the phone survey; however, considerable effort was made by Smith & Lehmann Consulting to screen participants for accuracy of responses and level of engagement in the program/survey.

Measure Satisfaction

Clients were asked about their satisfaction with the lighting in their home after receiving the new light bulbs from the agency. Figure 3 demonstrates about two-thirds of participants were more satisfied with their new lighting (69% or 34 out of 49), while 20% (10 out of 49) said the lighting was about the same. For Figure 3, the color green indicates a positive result, red as negative, and light gray as neutral.

Figure 3. Client Satisfaction with Light Bulbs



Light Bulbs

Forty-nine percent of participants indicated that agency staff installed light bulbs directly into their fixtures (25 out of 51). Eight participants (16%) said that they have replaced some of their light bulbs, averaging about four bulbs each. Of those who replaced light bulbs, four participants (50%) reported installing new CFLs, two (25%) replaced the CFLs with traditional incandescent, one (13%) replaced with LED light bulbs, and one participant (13%) did not remember what they used as a replacement. The majority of participants who replaced bulbs indicated that they did so because the CFLs provided by the agencies burned out (50% or 4 out of 8 who replaced CFLs). This result is typical as most bulbs are eventually replaced when burned-out and not for other non-necessity reasons. Despite considerable efforts to minimize recall bias of participants, concerns remained within the evaluation team in regards to the accuracy of survey responses owing to the time gap between bulb installation and survey participation. Smith & Lehmann Consulting was unable to verify whether the bulbs that failed were those installed by the agencies. Bulb failures could be due to a quality problem with the bulbs supplied by the agencies or they could have been bulbs purchased and installed by the client.

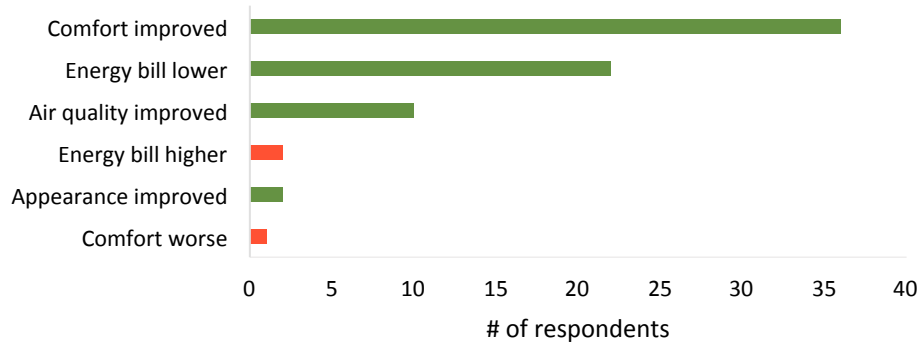
Participants were also asked whether they have purchased and installed any additional energy-efficient light bulbs after receiving the CFLs from the agency. Over half (58% or 29 out of 50) indicated that they did purchase and install additional light bulbs. Of this group, 26 participants indicated that they purchased CFLs (90%), while one (3%) purchased LEDs, one (3%) purchased halogens, and one (3%) purchased incandescent light bulbs. This may indicate a change in behavior due to exposure and education of the program. However, stocking practices in stores have changed dramatically and may be the prime causal factor. More research on customer behavior would be needed to confidently report a significant change.

Energy Information

After weatherization was completed, 47 participants (87%) voluntarily indicated that they noticed changes in their home. A majority (73%) reported improved comfort (i.e. cooler in the summer, warmer in the winter) (Figure 4). Twenty-two participants (47%) indicated their energy bill is more affordable after the completion of weatherization. Again, green in Figure 4 indicates a positive result, red as negative and light gray as neutral. A small number of participants indicated negative outcomes to

participating in the program. For example, two participants (4%) indicated their energy bill was actually less affordable and one (2%) indicated their comfort worsened.

Figure 4. Self-reported changes in clients' homes after weatherization measures completed

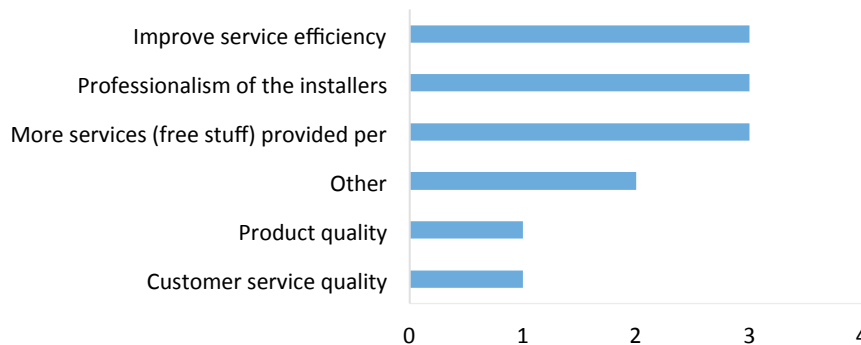


Participants were asked their opinions on energy usage and efficiency. When asked whether it was important or unimportant to save energy by reducing usage in the home, 94% of participants believed it was very important to save energy. Additionally, most participants (78%) strongly agreed that most other people have things that could be done to improve the energy efficiency of their home.

Program Delivery and Satisfaction

All clients (100%) would recommend the weatherization program to friends and family. Ten clients (19%) believed that there could be improvements to the program. Most of these participants indicated a variety of improvements ranging from improving service efficiency (i.e. high amount of initial paperwork, time to receive services, changing income qualifications), professionalism of installers, and providing more free services per home (Figure 5). As mentioned before, recall bias has likely skewed survey results and it is difficult to determine the actual level of program satisfaction. Even with many participants living in electric heated homes, they may still be receiving other non-electric weatherization measures. In a coordinated program with federal, electric and natural gas funding, it is difficult to determine the degree to which participants are satisfied with Pacific Power’s LIW program, specifically.

Figure 5. Customer suggested program improvements



Stakeholder and Agency Interviews

Representatives from all Washington agencies were interviewed for this evaluation. Agency interviews followed a common protocol, while the interview with the Section Manager of WADOC followed a similar, yet shortened, pattern of questions. The agency interview protocol can be found in the Appendix of this report. Interviews addressed the following topics, but allowed for conversation to flow in different directions when other subjects of interest arose.

◆ Program Consistency

All agency administrators agreed the program's primary goals are to save energy and help reduce clients' utility bills. Due to the regulatory structure in Washington, all agencies operate under WADOC, which is the agency responsible for overseeing statewide WAP operations, compliance, monitoring, and allocating low-income weatherization funding. WADOC reports directly to USDOE, serving as the link between the federal government and weatherization agencies. This structure is meant to streamline processes and align agency practices across the State.

For example, in 2011, WADOC launched a new statewide data tracking system, Weatherization Information Data System (WIDS), which tracks job-level information accounting for both program costs and energy-savings. Most agencies utilize this database for all jobs processed through USDOE; however, it is not a mandatory practice.

◆ Link Between WAP and LIHEAP

Washington agencies are partnering with the Low Income Home Energy Assistance Program (LIHEAP), administered by the WADOC to bring in clients and streamline their qualification process.¹⁶ During the 2011 program year, most Washington weatherization clients were deemed eligible by first being screened through LIHEAP income eligibility guidelines, which are set at 125% of the Federal Poverty Level (FPL). In 2012, WADOC revised the low-income weatherization guidelines, making it standard practice for all clients to be screened through LIHEAP income eligibility process.

LIHEAP in Washington qualifies participants based on a total household income level at or below 125% of FPL, while federal USDOE guidelines for weatherization allow for household income to be at or below 200% of FPL. Pacific Power & Light Company's Schedule 114 defines low-income as "households qualifying under the federal low-income guidelines and certified for eligibility according to agency procedure." Under *Provisions of Service*, Schedule 114 also states that an Agency must qualify residential customers for assistance using the Federal Low Income Guidelines. WADOC, however, included specific language in the *Weatherization Manual for Managing the Low-Income Weatherization Program*, revised July 2012, stating "local agencies

¹⁶ State of Washington Department of Commerce, Low-Income Home Energy Assistance Program. Found at <http://www.commerce.wa.gov/Services/individualassistance/Low-Income-Home-Energy-Assistance-Program/Pages/default.aspx>

must follow the income eligibility guidelines for the Washington State Energy Assistance Program/Low-Income Home Energy Assistance Program (LIHEAP) to determine types of eligible income, how to document income, and other eligibility rules.” The Washington State Low-Income Weatherization Income Eligibility Guidelines allow for the service of homes up to 200% FPL; however, by running intake for weatherization through LIHEAP those served are limited to 125% FPL.¹⁷

Two of the agencies also accept walk-ins and receive referrals from other local service agencies and community events. One agency reported roughly 15% of clients serviced between 2010 and 2011 program years were documented above 125% of FPL. This lends some explanation to the difficulties agencies face in finding eligible participants. However, using LIHEAP qualification as proof of eligibility also reduces program costs considerably and allows for easier access to other types of statewide programs, as participants can qualify for multiple services under LIHEAP processes.

◆ **Impact and Adequacy of Pacific Power Funding**

Agencies reported that Pacific Power funding supplemented other funding sources and allowed for more homes to be weatherized per year. Pacific Power funding is capped at \$1,000,000 per program year; however, agencies have never spent the maximum amount. Pacific Power’s Weatherization Program Manager indicated previous efforts had been made to assist the agencies in targeting potential qualified customers.

Smith & Lehmann Consulting recommends that Pacific Power continue collaborating with agencies in an effort to service more Pacific Power homes. Smith & Lehmann Consulting also recommends the other agencies join NCAC in their effort to collaborate with local community health and asthma clinics, as well as the Health Home Program in an effort to reach out to potential priority clients.

◆ **Impact of American Recovery and Reinvestment Act**

An enormous effort was made in Washington to plan accordingly and ramp-up processes for the American Recovery and Reinvestment Act (ARRA) funding that inflated the program from 2010-2012. All agencies report increasing the number of Pacific Power homes weatherized during this time; however, due to prioritized spending of ARRA dollars, most of these homes did not receive Pacific Power funding and were only reported to WADOC. BMAC also reported having success with maintaining staff levels throughout ARRA, as well as a steady production of weatherized Pacific Power homes.

All agencies indicated that with the introduction of ARRA, the requirements that came with the funding ultimately affected program delivery. With ARRA came stricter administrative procedures, implementation requirements, and training protocols. Agencies reported meeting

¹⁷ Washington State Low-Income Weatherization Program – Income Eligibility Guidelines, 2015.

prevailing wage requirements, required by ARRA, presented the greatest initial burden.¹⁸ Now that ARRA funding has been expended, agencies are left incurring the cost of stricter procedures and lengthy protocols. For example, one agency Director stated that filling all the necessary affidavits through the State for gaining access to the client's home and to closeout a job have added an average of 45-60 days to processing times depending on the level of complexity in the job. In addition to increased administrative costs, agencies reported losing up to half the number of contractors available to subcontract weatherization projects due to the additional procedures, affidavits, and certifications required of outside contractors. Remaining contractors have increased their costs to incorporate the extra administrative procedures.

To counter this effect, some agencies, which did not have the prior capacity, hired internal crews to compete with outside subcontractors and accomplish weatherizing more homes. This adaptation of flexibility was an unexpected improvement coming out of ARRA and allowed for agencies to mitigate the effect of additional costs on program performance.

◆ **Provision of Energy Education**

WADOC requires agencies to provide energy education in the home, but each agency approaches delivery of energy education differently; however, all agencies provided participants with copies of Pacific Power's *Bright Ideas* booklet.

OIC reported reviewing energy education materials with residents during the income eligibility appointment. BMAC reported completion of energy education by the auditor in the home. Their training focuses primarily on behavioral changes aimed at reducing the client's energy burden. The auditor also reviews specifics of the measures installed to ensure efficient use and maximum energy savings. NCAC reported reviewing Pacific Power's *Bright Ideas* booklet with clients in the home as well as hosting a weekly energy class on-location at the NCAC office.

◆ **Prioritization and Processing**

All agencies are following a priority points system, which is set by WADOC to follow USDOE guidelines. Points are assigned to weatherization participants in typical need-base categories, such as elderly, disabled, and presence of children in the home. WADOC recently updated Section 1.1 of the State *Weatherization Manual for Managing the Low-Income Weatherization Program*, which determines the priority for delivering services, to target high-energy users and households with energy burden greater than 8% of gross income. The updated priority guidelines went into effect July 2013 and utilize LIHEAP Annual Backup Heat Cost Chart to calculate client's Energy User Median Level and determine their relative priority for weatherization before applying the typical need-based screens.

¹⁸ Washington State Department of Labor & Industries, Special Information for ARRA Public Works Weatherization Projects. Found at <http://www.lni.wa.gov/TradesLicensing/PrevWage/Weatherization/default.asp>

It is standard practice in Washington for agencies to receive a comprehensive list from LIHEAP at the start of each program year of eligible participants in their respective counties. NCAC also promotes walk-ins and receives referrals from other agencies, such as local health care organizations and the Department of Social Services. Agencies contact potential participants to arrange a time to review eligibility for weatherization of their home. This initial process may include a review of ownership documents, income statements, and other materials required for qualification.

Once eligibility is determined, agencies set a schedule for the auditor to conduct a pre-assessment. If the home passes the pre-assessment, the agency sends out a certified auditor to conduct a complete home audit. The State of Washington requires Building Performance Institute (BPI) certification for all auditors. The auditor is responsible for collecting information on the home and recommending weatherization and repair measures to be installed through the program. WADOC has developed a pre-approved list of measures, based on USDOE protocol, to allow agencies to install specific measures without conducting individualized, cost-effectiveness tests or using audit software. Agencies currently use the Targeted Retrofit Energy Analysis Tool (TREAT) to determine all other measures appropriate for installation.

Upon completing the home audit, agencies schedule either outside contractors or internal crews to perform the work and discuss plans with the homeowner to install identified measures. BMAC and NCAC both report maintaining internal crews as well as subcontracting out installations. This allows for flexibility of production and ensures that current process times average approximately three to four months for complete weatherization of eligible participants. During the 2011-2012 timeframe, the wait for weatherization was much longer (average one year) due to larger wait-lists incurred with additional ARRA funding.

OIC and NCAC report not needing to maintain wait-lists because dedicated staff members are able to call through the entire list of eligible participants each year. This produces a list of pre-qualified customers, which move through the process of weatherization. OIC reports completing most of the homes on the list each year and only occasionally needing to re-certify a participant due to expiring income qualifications. NCAC, an agency almost exclusively serving the Pacific Power service territory, reports not needing to maintain a wait-list simply because they do not run out of available funds to weatherize eligible participants. BMAC reports maintaining a wait-list of approximately 25-50 participants; however, their timeframe for weatherization remains similar to the other two agencies.

◆ **Deferrals and Home Repairs Policy**

During the pre-assessment process, the auditor may issue a “deferral notice” if the homeowner needs to address any repairs in the home before continuing with the audit process. Agencies report on average 50-65% of applicants are determined “deferrals,” and of those potential participants only 10% complete the repairs necessary to receiving weatherization services. Due to the financial state of many low-income households, clients are routinely forced to choose

between competing needs while facing a limited budget; therefore, they are making a conscious decision not to fix their home. Pacific Power & Light Company Schedule No. 114 and the State of Washington mandates Pacific Power reimburse 50% of the installed cost of repairs, but only if they are necessary to make the installation of energy efficient measures. Total reimbursement on repairs available to the agencies is limited to 15% of the annual reimbursement (total fund spent) on energy efficient measures received. Despite this allowance, agencies report increasing repair costs as a major program delivery obstacle and the main reason homes are “deferred” from receiving services. Agencies report an average deferral-rate between 50%-65% of all clients that apply to the program. While some of these clients will return to the program, many will not be able to afford the repairs necessary to move forward with weatherizing the home. In an effort to mitigate this effect, agencies are collaborating with the State attempting to utilize Matchmaker funds to establish a home repair program outside of typical weatherization funding.

Despite this allowance for repairs, Pacific Power reports agency rebates for repairs at approximately 6% of total funds spent in both 2011 and 2012 program years. Smith & Lehmann Consulting recommends Pacific Power initiate a discussion with WA WAP agencies aimed at increasing the percentage of total rebates claimed for repairs. Accomplishing this will allow agencies to service more of the homes they interact with, thus increasing the efficiency of funding already utilized by the program.

◆ **Invoicing and Payments**

In order to receive payments, Washington agencies submit invoices directly to Pacific Power for each individual job. Agencies receive payments from Pacific Power based on their monthly invoices. Agencies do not report any issues in receiving payments from Pacific Power and WADOC is not involved with the invoicing or payment process.

◆ **Reporting and Monitoring**

Agency reporting occurs in conjunction with invoicing. Agencies are required to submit a one-page form to Pacific Power for each completed home. Agencies submit a cover invoice along with the form for each completed home, which includes:

- Customer name and address (and owner’s name and address in case of rental)
- Account number
- Home occupant (owner versus renter)
- Dwelling type (single-family, multifamily, manufactured home)
- Measures installed
- Material, labor, and total cost per measure
- Pacific Power rebate for each measure
- Agency administrative fee billed to Pacific Power
- Total reimbursement requested
- kWh savings estimated for total job

- Total cost of all measures

As the grantee for federal funding, WADOC reviews and submits reports to USDOE. These reports are submitted quarterly and annually for USDOE and annually for LIHEAP. Reports submitted to USDOE include the following:

- Number of completions
- Number of leveraged units
- Funding spent
- British Thermal Units (BTUs) saved
- Housing types
- Household and individual demographics

The State of Washington's program inspection and monitoring process requires 100% of completed units must be inspected at the agency level. WADOC is also required to inspect a minimum of 5% of completed units annually for compliance, regardless of federal funding source. New regulations, after federal assessment of ARRA, will require all homes weatherized after July 1, 2015 to be inspected by a Quality Control Specialist. Pacific Power also has an internal inspector review 10% of completed homes.

◆ **Program Achievements and Lessons Learned**

Both WADOC and the agencies noted that successful completion of ARRA was the greatest challenge and achievement experienced over the 2011-2012 program years. All agencies reported that while production of weatherized homes doubled, the program continued to operate smoothly from 2011-2012. The most notable change during the evaluation period was the closeout of ARRA support; however, this resulted in minimal layoffs of program employees. Despite management and funding challenges, the weatherization program in Washington continues to serve a large number of homes, while improving its process, outreach, and operations.

Process Evaluation Conclusions

Pacific Power's decision to coordinate its weatherization efforts with Washington's subgrantee agencies provides leverage to each utility dollar and should be continued. Coordination with the Washington WAP is a best practice, and despite management and funding challenges, the weatherization program in Washington continues to improve its process, outreach, and operations.

◆ **Aligning WAP with LIHEAP**

The partnership between LIHEAP payment assistance and WAP is beneficial to both programs. LIHEAP certification streamlines the application process and WAP helps clients to decrease their energy burden by weatherizing their home. This decreases not only the energy burden to the

client but also the burden placed on LIHEAP to help the client over future heating seasons. Using LIHEAP qualification as proof of eligibility also reduces program costs considerably and allows for easier access to statewide programs, as clients can qualify for multiple services under LIHEAP processes. However, by aligning these two programs, WADOC is limiting program participation to 125% of FPL. The Washington State Low-Income Weatherization Income Eligibility Guidelines allow for the service of homes up to 200% FPL; however, by running intake for weatherization through LIHEAP those served are limited to 125% FPL.¹⁹

Process Evaluation Recommendations

◆ Pacific Power Recognition

Client survey results indicate 19% of participants remember or recognize that Pacific Power contributed to the weatherization work they received. Pacific Power should consider whether it is important that customers recognize Pacific Power's contribution to the weatherization services received. If so, Pacific Power should continue to provide a branded item concurrently with weatherization services to increase customer recognition.

◆ Outreach to Potential Clients

Smith & Lehmann Consulting recommends that Pacific Power continue to collaborate with agencies in an effort to find solutions for increasing the number of Pacific Power households served, and develop deeper levels of energy savings. Smith & Lehmann Consulting also recommends the other agencies join NCAC in their effort to collaborate with local community health and asthma clinics, as well as the Health Home Program to reach out to potential priority clients.

◆ Home Repair Policy

Despite the allowance for home repairs of 15% of the total annual funds spent on weatherization, Pacific Power reports agency rebates for repairs at approximately 6% of total funds spent in both 2011 and 2012 program years. Smith & Lehmann Consulting recommends Pacific Power initiate a discussion with WA WAP agencies aimed at increasing the percentage of total rebates claimed for repairs. Accomplishing this will allow agencies to service more of the homes they interact with, thus increasing the efficiency of funding already utilized by the program.

¹⁹ Washington State Low-Income Weatherization Program – Income Eligibility Guidelines

COST EFFECTIVENESS ANALYSIS

The impact evaluation produced the energy impacts and inputs used to calculate program cost-effectiveness.

Cost-effectiveness was assessed using five different perspectives. Smith & Lehmann Consulting provided inputs to the cost-effectiveness calculations to Cadmus, who performed the calculations of the Benefit/Cost Ratio and Levelized Cost for each of the program years and for the total evaluation period.

Cost Tests

Cost-Benefit analysis was conducted by Cadmus using the five specified tests: PacifiCorp Total Resource Cost (PTRC) test, Total Resource Cost (TRC) test, Utility Cost Test (UCT), Ratepayer Impact Measure (RIM), and the Participant Cost Test (PCT). The inputs were provided by Smith & Lehmann Consulting to evaluate cost-effectiveness.

Cost-effectiveness perspectives of the five tests include:

- ◆ **PTRC:** This test incorporates program costs and benefits from the perspectives of both Pacific Power and Pacific Power customers combined. Benefit measures include the present value of avoided energy, capacity costs, and line losses, plus a 10% adder to represent non-qualified benefits. Cost measures include both the costs to the participant and the utility. Cost-effectiveness analyses also included quantifiable NEBs (i.e., reductions in external agency assistance payments, home repair costs, and regional economic impacts).
- ◆ **TRC:** This test approaches program costs and benefits from the perspectives of both Pacific Power and Pacific Power customers combined. Benefit measures include the present value of avoided energy, capacity costs, and line losses. Cost measures include both the costs to the participant and the utility. In this case, the cost to the participant is zero. Utility costs are all program costs including all administration, implementation, and incentive costs associated with funding the program. Cost-effectiveness analyses also included quantifiable NEBs (i.e., reductions in external agency assistance payments, home repair costs, and regional economic impacts).
- ◆ **UCT:** This test approaches costs and benefits from Pacific Power's perspective. Benefits included avoided energy and capacity costs as well as line losses. Costs included all administration, implementation, and incentives costs associated with funding the program.
- ◆ **RIM:** This test measures what happens to customer bills or rates due to changes in utility revenues and operating costs caused by the program. Rates or bills will go up to cover lost revenues. This test indicates the direction and magnitude of the expected change in customer bills or rate levels. Benefits include all avoided energy and capacity costs, as well as line losses. Costs included all Pacific Power program costs as well as lost revenues.

- ◆ **PCT:** This test approaches costs and benefits from the participant’s perspective. In this case, the cost to the participant is zero. While benefits would include bill reductions, the result of the test would be undefined due to zero costs. Therefore, the result of the PCT was determined “Not Applicable.”

Table 14. Benefits and Costs Included in Various Tests

Test	Benefits	Costs
PTRC	Present value of avoided energy and capacity costs with 10% adder for non-quantified benefits plus selected NEBs	Program costs including administration and marketing
TRC	Present value of avoided energy and capacity costs plus selected NEBs	Program costs including administration and marketing
UCT	Present value of avoided energy and capacity costs	Program costs including administration and marketing; and incentive costs
RIM	Present value of avoided energy and capacity costs	Program costs including administration and marketing; plus the present value of lost revenues
PCT	Present value of bill savings	Participant share of measure costs (zero)

Note 1: The present value of avoided energy and capacity costs includes avoided line losses from reduced energy use by program participants.
Note 2: Federal and state coordinated contributions to project costs are treated as external to the calculation.
Note 3: Any avoided capital and/or operating cost resulting from measures are included as a participant benefit.

Assumptions

Cost-effectiveness for 2011 and 2012 was tested using the 2011 IRP 35% east residential whole house load factor decrement. Tables 15 and 16 include a breakdown of the agency and utility costs, as well as the discount rate, line loss, inflation rate, and residential energy rate. Table 17 lists the annual energy savings for each program year, and Table 18 provides an estimate of the dollar amounts included in the assessment of NEBs. The discount rate was provided by Pacific Power as reported in Washington Annual Reports for each of the program years: 2011, and 2012. The Annual Reports also provided the line loss and program cost inputs.

Table 15. WA Low-Income Weatherization Financial Inputs

Parameter	2011 Value	2012 Value
Discount Rate	7.17%	7.17%
Residential Line Loss	8.87%	9.67%
Residential Energy Rate (\$/kWh)	\$0.083	\$0.0863
Inflation Rate	1.80%	1.80%

Table 16. WA Low-Income Weatherization Program Costs

Program	Utility Admin	Agency Admin.	Incentives	Total Utility Costs
Low Income Weatherization 2011	\$15,721	\$60,186	\$431,125	\$507,032
Low Income Weatherization 2012	\$35,560	\$70,057	\$500,491	\$606,108

Table 17. WA Low-Income Weatherization Annual Savings*

Program	Evaluated KWh Savings	Net-to-Gross Percentage	Net KWh Savings	Measure Life
Low Income Weatherization 2011	305,300	100%	305,300	30
Low Income Weatherization 2012	301,735	100%	301,735	30
Low Income Weatherization 2011-2012	542,452	100%	542,452	30

* The 2011-2012 were developed through a stand-alone regression analysis and do not reflect the sum of the 2011 and 2012 program years.

Table 18. WA Low-Income Weatherization Non-Energy Benefits

Non-Energy Benefits	2011 Impact	2012 Impact	2011-2012 Impact
External Payment Reduction	\$27,930	\$23,520	\$51,450
Home Repair Costs	\$29,775	\$31,859	\$61,634
Economic Impact	\$329,521	\$277,491	\$607,012
Total	\$387,226	\$332,870	\$720,096

Claimed energy savings were drawn from the evaluated kWh savings portion of this analysis. The TRC and PTRC included NEBs associated with repair costs, reductions in agency assistance payments, and regional economic impacts (Table 18). Cost-effectiveness analysis incorporated an average Measure Life of 30 for each of the different program years. Table 19 provides a comparative summary of the benefit/cost ratios from all five test perspectives by year and for the evaluation timeframe 2011-2012.

Table 19. WA Low-Income Weatherization Benefit/Cost Ratios

Measure	PTRC	TRC	UCT	RIM	PCT
Low Income Weatherization 2011	1.75	1.66	0.95	0.56	N/A
Low Income Weatherization 2012	1.40	1.32	0.81	0.50	N/A
Low Income Weatherization 2011-2012	1.47	1.39	0.79	0.49	N/A

Cost-Effectiveness Results

Tables 20 presents the results of program cost-effectiveness tests for the evaluation period 2011-2012. The PTRC includes a 10% conservation adder, as well as selected participant and utility NEBs (i.e., reductions in external agency assistance payments, home repair costs, and regional economic impacts). The overall 2011-2012 portfolio was found to be cost-effective from the perspectives of PTRC and TRC. The 2011-2012 program was not cost-effective from the perspective of the UCT and RIM test.

Table 20. 2011-2012 Low-Income Weatherization – Cost-Effectiveness including Non-Energy Benefits

Cost-Effectiveness Test	Levelized \$/kWh	Costs*	Benefits*	Net Benefits	Benefit/Cost Ratio**
PacifiCorp Total Resource Cost Test (PTRC)	\$0.1432	\$1,072,589	\$1,576,515	\$503,926	1.470
Total Resource Cost Test (TRC) No Adder	\$0.1432	\$1,072,589	\$1,494,279	\$421,690	1.393
Utility Cost Test (UCT)	\$0.1432	\$1,072,589	\$846,330	(\$226,259)	0.789
Ratepayer Impact Measure (RIM) Test		\$1,715,359	\$846,330	(\$869,030)	0.493
Participant Cost Test (PCT)		\$0	\$1,600,404	\$1,600,404	N/A
Discounted Participant Payback (years)					N/A
Lifecycle Revenue Impact (\$/KWh)					\$0.00001044

*Smith & Lehmann provided evaluated costs and benefits necessary to calculating cost-effectiveness

**Cadmus is responsible for results of the cost-effectiveness summary

CONCLUSIONS

This evaluation demonstrates that Pacific Power's coordination of its weatherization efforts with the Washington agencies and with USDOE and USDHHS is cost-effective from the perspectives of PTRC and TRC. The overall program was not cost-effective from the perspective of the UCT and RIM test. The RIM test result is not unusual since RIM test normally shows a less than cost effective result for energy saving programs. The UCT does not consider NEBs, which ultimately resulted in the failure of program cost effectiveness from this particular test perspective. Coordination of this kind is a utility best practice because it provides significant leverage for every utility dollar.

The partnership between LIHEAP payment assistance and the Low Income Weatherization program is beneficial to both programs: LIHEAP certification streamlines the application process and LIW helps clients to decrease their energy burden by weatherizing their home. This decreases not only the energy burden to the client but also the burden placed on LIHEAP to help the client over future heating seasons. However, by aligning these two programs, WADOC is limiting program participation to 125% of FPL. The Washington State Low-Income Weatherization Income Eligibility Guidelines allow for the service of homes up to 200% FPL; however, by running intake for weatherization through LIHEAP those served are limited to 125% FPL.²⁰ Overall, this evaluation demonstrates that the program is operating as planned within the design parameters outlined in Pacific Power & Light Company Schedule No. 114, State of Washington.

RECOMMENDATIONS

- ◆ If agencies continue to serve apartments and/or condominiums in multifamily buildings, Pacific Power should separately analyze energy savings to determine deemed savings specifically attributed to the weatherization of apartment units. Smith & Lehmann Consulting's analysis of apartment complex (AC) cases discovered no detectable savings under a typical billing analysis. To obtain more accurate results of AC-specific savings, Smith & Lehmann Consulting recommends the use of an engineering analysis of savings on an individual measure or per-unit basis. To accomplish this, Smith & Lehmann Consulting also recommends Pacific Power track the specific quantities of measures installed in all apartments weatherized in the future (e.g., sq. feet of insulation). This will ensure sufficient data to perform an engineering analysis of evaluated measure-specific savings.

If agencies continue to serve apartments and/or condominiums, Pacific Power should discuss existing commercial DSM program with agencies, and also consider developing an option for full building upgrades. For example, individual dwelling units could continue to be served through the current program while common area and building systems could be covered under an

²⁰ Washington State Low-Income Weatherization Program – Income Eligibility Guidelines

alternative Demand Side Management (DSM) program with energy savings allocated separately to the weatherization program and to a commercial building program.

- ◆ Pacific Power should continue to collaborate with agencies in an effort to find solutions to service more Pacific Power homes, and develop deeper levels of energy savings. Smith & Lehmann Consulting also recommends the other agencies join NCAC in their effort to collaborate with local community health and asthma clinics, as well as the Health Home Program reach out to potential priority clients.
- ◆ Brand Pacific Power's weatherization program. Client survey results indicate 19% of participants remember or recognize that Pacific Power contributed to the weatherization work they received. Pacific Power should consider whether it is important that customers recognize Pacific Power's contribution to the weatherization services received. If so, Pacific Power should continue to provide a branded item concurrently with weatherization services to increase customer recognition.
- ◆ Agencies indicated increasing repair costs, typical of most low-income cases, as a major barrier in the delivery of program services. Agencies report an average deferral-rate between 50%-65% of all clients that apply to the program, and report availability of funds to cover repairs as the main reason homes are "deferred" from receiving services. While some of these clients will return to the program, many will not be able to afford the repairs necessary to move forward with weatherizing the home. In an effort to mitigate this effect, agencies are collaborating with the State attempting to utilize Matchmaker funds to establish a home repair program outside of typical weatherization funding.

Pacific Power reimbursements related to home repairs are limited to 15% of the annual cost of total jobs performed (i.e., funds spent) by each agency.²¹ Despite this allowance for repairs, Pacific Power reports agency rebates for repairs at approximately 6% of total funds spent in both 2011 and 2012 program years. Smith & Lehmann Consulting recommends Pacific Power initiate a discussion with WA WAP agencies aimed at increasing the percentage of total rebates claimed for repairs. Accomplishing this will allow agencies to service more of the homes they interact with, thus increasing the efficiency of funding already utilized by the program.

²¹ Pacific Power & Light Company Schedule No. 114, Residential Energy Efficiency Rider- Optional for Qualifying Low Income Customers, July 1, 2013.

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- ◆ RIMS II: An Essential Tool for regional developers and planners, Regional Input-Output Modeling System.2012. *United States Department of Commerce, Bureau of Economic Analysis*

APPENDIX: Interview Protocols

Client Survey (Spanish Language Capacity)

Participants: Washington residents who received Weatherization Assistance Program (WAP) services for which Pacific Power (PP) provided full or partial payment.

Purpose: To provide qualitative data documenting and aiding in measurement of cost-effectiveness, customer satisfaction, verification of program services, and opinions on various program issues and perceived improvements.

Introductory Protocol

*Hello, my name is [FIRST AND LAST NAME] from Smith & Lehmann Consulting and I am calling on behalf of Pacific Power. We are talking with people who received energy-saving services from **(The Agency)** over the past few years.*

Agency Selection: *[It will be indicated which agency the participant applied through]*

- Blue Mountain Action Council (BMAC), Walla Walla (Walla Walla, Garfield and Columbia counties)
- Opportunities Industrialization Center of Washington (OIC), Yakima (Upper Yakima County)
- Yakima Valley Farm Workers Clinic/Northwest Community Action Center (NCAC), Toppenish (Lower Yakima County)

May I speak with _____, or the person who remembers receiving energy efficiency services through [insert Agency]? This is a short survey and will take approximately 5 minutes.

- Agreed to participate
- Refused to participate
- Refused, person not home

[Background]

The survey is voluntary. You may decline to answer any of the questions, and may terminate the survey at any time. If you have questions regarding this survey, I can provide you with contact information for someone at Rocky Mountain Power [provide contact information if Respondent requests it]:

Shawn Grant, Project Manager

P: 801-220-4196

E: Shawn.Grant@rockymountainpower-pacificpower.net

Potential Research Questions:

1. Our records indicate that you have participated in **(The Agency's)** weatherization/energy efficiency program, is this correct? [Note: use "weatherization", "energy efficiency", or "services" throughout, whichever the client understands better]
 - Yes
 - No [CONTINUE TO QUESTION 2]
 - Don't know/don't remember
 - Refused

2. Do you remember receiving [insert service received by customer]? [This will be provided].
 - Yes
 - No [PROBE WITH SUPPLEMENTAL SCRIPT]
 - Supplement: Our records indicate that your home received [insert service] from [Agency]. Do you remember someone coming to your home in [month of service] 2012 and [insert service received].
 - [If Yes:] SKIP to Q3
 - [If NO:] Is there someone else in your home who remembers this?
 - [If Yes:] May I speak with that person? [If yes, continue interview with other person]
 - [If No:] [Skip to interview termination script][Do not count this as completed interview]
 - Don't know/don't remember
 - Refused
3. Are you still living in the same home where you received the services?
 - Yes
 - No
 - Don't know/don't remember
 - Refused
4. How did you hear about this program/services provided by [Agency]? [DO NOT READ THROUGH LIST]
 - Agency staff
 - Information on my electric bill
 - Pacific Power website
 - Other website [SPECIFY]
 - Through another energy assistance program
 - Written materials at (Agency)
 - Family/friends/word-of-mouth
 - Pacific Power representative
 - Other [SPECIFY]
 - Don't know/remember
 - Refused
5. When you applied for this program, did you find it easy, difficult, or in-between?
 - Easy
 - Difficult
 - In-between
 - Don't know/remember
 - Refused
6. How long did you wait to receive weatherization/energy efficiency services [Clarify: from the time you applied for the program until service delivery]? [Don't read choices if a timeframe is volunteered]
 - Less than one month

- At least one month but less than three months
 - At least three months but less than six months
 - At least six months but less than a year
 - More than a year
 - Don't know/remember
 - Refused
7. [Ask question if light bulbs in record] Our records indicate that you received several new energy-efficient light bulbs. Did the agency staff install these directly into your fixtures?
- Yes, the new light bulbs were installed directly into the light fixture. [SKIP TO QUESTION 9]
 - No, the agency staff left the light bulbs for me to install. [CONTINUE TO QUESTION 8]
 - No, I didn't receive any new light bulbs.
 - Don't know/don't remember
 - Refused
8. Did you install these energy-efficient light bulbs?
- Yes
 - No [SKIP TO QUESTION 13]
 - Don't know/remember
 - Refused
9. Did you replace any of the new energy-efficient light bulbs with different ones? [For interviewer: did Client remove any of the CFL light bulbs that were installed by the Agency, or any of the CFL light bulbs from the agency that he/she installed his/herself?]
- Yes
 - No [SKIP TO QUESTION 13]
 - Don't know/remember [SKIP TO QUESTION 13]
 - Refused [SKIP TO QUESTION 13]
10. How many energy-efficient light bulbs did you replace?
Record Number:
11. What type of bulb did you replace it with? [DO NOT READ THROUGH LIST – PROBE TO IDENTIFY TYPE OF LIGHT BULB]
- Incandescent
 - Halogen (looks like old type but isn't)
 - Energy-saving (CFL) (the curly expensive type)
 - Energy-saving (LED)
 - Other: [SPECIFY]
 - Don't know/remember
12. Why did you replace it/them?
- Not bright enough
 - Bulb(s) failed
 - Didn't like the quality
 - Other: [SPECIFY]

- Don't know/remember

Data Entry Point (for Interviewer):

How confident are you that the respondent answered questions 8-12 to the best of their ability?

- 1 = very concerned
- 2 = somewhat concerned
- 3 = neither concerned or confident
- 4 = somewhat confident
- 5 = very confident

13. [Ask specifically based on records] Since the [Agency] performed this work in your home, are you more satisfied or less satisfied with the lighting in your home compared to the old bulbs? [SKIP QUESTION IF DON'T REMEMBER RECEIVING LIGHT BULBS OR SAYS THEY DIDN'T RECEIVE LIGHT BULBS]

- More satisfied
- About the same
- Less satisfied
- Don't know/remember
- Refused

14. Now I have some questions about the impact of weatherization on your home. Did you notice any changes in your home after the Weatherization was completed? [PROMPT: change in comfort, change in appearance, change in air quality, change in energy bill] [IF Yes: could you tell me what changed?]

[DO NOT READ OPTIONS – CHECK ALL THAT APPLY]

- No change noticed
- Comfort improved
- Comfort worse
- Appearance worse
- Appearance improved
- Appearance worse
- Air quality improved
- Air quality worse
- Energy bill lower
- Energy bill higher
- Other [SPECIFY]

15. Since the [Agency] performed this work in your home, do you believe that your electric bill is more affordable or less affordable? [Do not ask if volunteered in #14, just choose answer]

- More affordable
- About the same
- Less affordable
- Don't know/remember
- Refused

16. Since the [Agency] performed this work in your home, is the temperature of your home more comfortable or less comfortable? [Do not ask if volunteered in #14, just choose answer]
- More comfortable
 - About the same level of comfort
 - Less comfortable
 - Don't know/remember
 - Refused
17. I would like to ask you if you agree or disagree with the following statement: Do you think it is important or unimportant to save energy by reducing the energy usage in the home? Do you think it is very [important/unimportant] or somewhat [important/unimportant]?
- Agree (strongly/somewhat)
 - Disagree (strongly/somewhat)
 - Neither agree nor disagree
 - Don't know/remember
 - Refused
18. I would like to ask you if you agree or disagree with the following statement: Most people probably have things that could be done to improve the energy efficiency of their home. Do you strongly [agree/disagree] or somewhat [agree/disagree]?
- Agree (strongly/somewhat)
 - Disagree (strongly/somewhat)
 - Neither agree nor disagree
 - Don't know/remember
 - Refused
19. When the [Agency] performed this work on your home, were the agency staff courteous, and respectful towards you, your family, and your home?
- Yes
 - No
 - Don't know/remember
 - Refused
20. Did the work crew work carefully to protect your home, or was there damage to your home from the work crew?
- Home protected
 - Home damaged
 - Don't know/remember
 - Refused
21. Was there any work left uncompleted, or that was not fully completed?
- Yes [SPECIFY]
 - No
 - Don't know/remember
 - Refused

22. Would you recommend this weatherization/energy assistance program to family and friends?

- Yes
- No
- Don't know
- Refused

23. Is there anything about the program that needs to be improved?

- Yes
- No [SKIP TO QUESTION 25]
- Don't know [SKIP TO QUESTION 25]
- Refused [SKIP TO QUESTION 25]

24. [If yes to 23] In what ways do you think the program can be improved? (Check all that apply)

- Customer Service Quality
- Product Quality
- Professionalism of the Installers
- Level of services provided
- More services (free stuff) provided per home

25. What type of residence do you live in?

- Single family home
- Duplex
- Condominium
- Mobile or Manufactured Home
- Apartment
- Refused
- Other [SPECIFY]

26. Do you own or rent your residence?

- Own
- Rent
- Don't know
- Refused

27. Do you have an air conditioner in your home?

- Yes
- No [SKIP TO QUESTION 29]
- Don't know
- Refused

28. [If yes to 27] Is it a swamp cooler, window AC unit, or central AC?

- Swamp Cooler
- Window AC [SPECIFY UNITS]
- Central AC
- Other [SPECIFY]
- Don't know

- Refused

29. Do you know which organization provided the funding for the [Insert: measure received: CFLs, new refrigerator]?

- Yes, Rocky Mountain Power or “power company”
- Yes, Agency [SPECIFY]
- Yes, Other [SPECIFY]
- No
- Don’t know/remember
- Refused

That is the end of our survey. We would like to thank you for taking your time to participate; your responses are very valuable to our process.

Have a wonderful rest of your day, goodbye.

Data Entry Point (for Interviewer):

Last 5 digits of phone number:

How well did the respondent understand the questions? (Did the respondent need you to repeat a lot of questions, seem confused by the questions, or give answers that didn’t seem like they really answered the question, or were the answers linked well to the questions?)

- 1 = respondent misunderstood the questions
- 2 = respondent somewhat misunderstood the questions
- 3 = respondent neither misunderstood or understood
- 4 = respondent somewhat understood the questions
- 5 = respondent understood the questions well

How confident are you that the respondent answered the questions to the best of their ability? (i.e. was respondent rushing through the interview and not appearing to think very much about their responses, or do you think the respondent was trying to answer as accurately as possible?)

- 1 = very concerned
- 2 = somewhat concerned
- 3 = neither concerned or confident
- 4 = somewhat confident
- 5 = very confident

How confident was the respondent in recalling events accurately? (i.e. did respondent seem confused, have trouble with memory, seem to be “guessing” with responses, or did respondent seem to recall events fairly easily?)

- 1 = very concerned with respondent’s memory of event
- 2 = somewhat concerned with respondent’s memory of events
- 3 = neither concerned or confident
- 4 = somewhat confident in respondent’s recall
- 5 = very confident in respondent’s recall

Agency Interview Protocols

Participants: Program managers will be selected from Blue Mountain Action Council (BMAC), Walla Walla, WA, Opportunities Industrialization Center of Washington (OIC), Yakima, WA, and Yakima Valley Farm Workers Clinic/Northwest Community Action Center (NCAC), Toppenish, WA. The Program manager of Washington Department of Community, Trade and Economic Development will be contacted and informed of the process, as a courtesy, prior to the interview start-date.

Purpose: To provide qualitative data documenting processes, funding sources, and issues related to Pacific Power's Washington Weatherization Assistance Program. These interviews will address Pacific Power's evaluation questions regarding program participation and wait listing.

Introductory Protocol

Thank you for speaking with me today. I am from [Smith & Lehmann Consulting or H. Gil Peach & Associates] and am working with Pacific Power (a division of PacifiCorp), to find out more about how Weatherization Assistance Programs (WAPs) operate in Washington. Our evaluation focuses on the 2011 and 2012 program years. The purpose of our evaluation is to measure the cost-effectiveness and energy impacts of the program, as well as assess program operations.

You were recommended as someone who plays an important role in administering WAP services provided by [Agency]. I have some questions that should take about 20 minutes to answer, is this still a good time to talk?

Do you mind if I record our call? This is just for note taking purposes; I will not share the recording or your individual answers with anyone outside of the project. None of the comments you share today will be attributed to you as an individual. They may, instead, be attributed to your organization.

Do you have any questions before we begin?

Potential Research Questions:

1. Please tell us your title and role in the weatherization program?
2. What were [your Agency's] biggest accomplishments during each of the program years: 2011 and 2012?
3. What were the major challenges [your Agency's] faced in each year: 2011 and 2012?
4. Were any significant changes made to the WAP during each of the program years: 2011 and 2012?
5. Does your agency use a priority list in determining who gets services? If yes, how are priorities determined? (i.e. is there a point system, what is it, who is prioritized?)
6. Does [your Agency] have any data sources with participant income or poverty level information?
 - What is the format of this data – excel, paper records?
 - Can we get copies of electronic files?
 - Would those files include the customer ID for Pacific Power?
7. Please explain how your weatherization participant wait list is compiled. At what point in the process is a household moved to the wait list?
 - When they first call in.
 - After they are qualified by telephone or by interview
 - After the home is audited and found to be eligible

- Other: _____
8. How many customers are now on your wait list?
 9. How many Pacific Power customers are currently on the waiting list?
 10. How far out in time does your wait list go (in other words, if you were to weatherize all of the homes currently on your wait list, about when would the last home be finished?
Year: _____ Month: _____
 11. Does your agency have a time goal for weatherizing a home, once it is on the wait list?
 12. Is this time target usually met?
 13. What Building Weatherization Report (BWR) information is reported, and is this information accessible?
 14. How can we determine which houses that receive their electricity from Pacific Power were funded by other sources (ex: ARRA funding)?
 - Is this information available electronically for each Pacific Power customer?
 - If not, how are the records of weatherization services maintained, and how could we access this information?
 15. Where Savings to Investment Ratios (SIR Ratios) are being relied upon, are they reflecting total cost of each measure no matter which funding source or combination of funding sources are used, or are they calculated according to the USDOE approved optional discounted method (which permit the agency to disregard the non-federal portion of costs)?
 16. What kinds of barriers limit participation in the program? [If any]
 17. How is the [Agency] addressing any program participation barriers?
 - What challenges has the [Agency] faced with these strategies to address barriers?
 - What strategies have worked?
 18. What are some of the reasons for walkaways?
 19. How are walkaways among potential weatherization clients addressed by the [Agency]?
 20. What are the problems from the perspective of the [Agency] and how might these be solved?