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PacifiCorp

Final Washington Low Income Weatherization Program Evaluation for Program Years 2013 - 2015

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Table of Acronyms

Acronyms	Meaning
ARRA	American Recovery and Reinvestment Act
BMAC	Blue Mountain Action Council
CDD	Cooling Degree Days
CFL	Compact Fluorescent Light Bulb
CSA	Conditional Savings Analysis
HDD	Heating Degree Days
kWh	Kilowatt-hour
LIHEAP	Low Income Home Energy Assistance Program
NEI	Non-Energy Impact
NCAC	Northwest Community Action Center
NOAA	National Oceanic and Atmospheric Administration
OIC	Opportunities Industrialization Center of Washington
PCT	Participant Cost Test
PTRC	PacifiCorp Total Resource Cost Test
QCI	Quality Certification Inspector
RIM	Ratepayer Impact Measure Test
RIMS-II	Regional Input-Output Modeling System
SIR	Savings-to-Investment Ratio
TRC	Total Resource Cost
UCT	Utility Cost Test
USDHHS	United States Department of Health & Human Services
USDOE, DOE	United States Department of Energy
WADOC	Washington State Department of Commerce
WAP	Weatherization Assistance Program

1. Executive Summary

Opinion Dynamics presents its evaluation findings for the Pacific Power Low Income Weatherization Program (referred to as the “Program” throughout this report) in operation in the state of Washington during the 2013 through 2015 program years. We performed both an impact and process evaluation and results from these are presented in the report. Additionally, we conducted a payment analysis, an arrearage analysis, and an economic impacts assessment to estimate non-energy impacts. Last, we include cost-effectiveness test results using several approaches. Navigant Consulting performed the cost-effectiveness tests.

Three Washington non-profit agencies known for serving low income communities implement the Program: Opportunities Industrialization Center of Washington (OIC) in Yakima, Yakima Valley Farm Workers Clinic/Northwest Community Action Center (NCAC) in Toppenish, and Blue Mountain Action Council (BMAC) in Walla Walla. These agencies provide energy efficiency services targeted towards weatherization to existing single family (including manufactured) and multi-family homes, so long as the multi-family property is at least 66% occupied by low-income tenants. “Low Income” qualifications are based on 200% of federal poverty guidelines or 60% of the state median Income, whichever is greater. Participants receive energy efficiency measures at no cost to them.

Opinion Dynamics conducted this evaluation of the Program on behalf of the utility for the 2013 through 2015 program years. The evaluation objectives were to: (1) document and measure effects of the Program (energy and non-energy); and (2) identify areas of potential improvement. To quantify energy benefits, we conducted an impact evaluation using a billing analysis with a comparison group to estimate the ex-post net annual energy savings attributable to the Program. To quantify non-energy impacts, such as reduced costs and external payments, we conducted a payment analysis of the treatment and comparison groups. We also completed an economic impacts assessment using the Regional Input-Output Modeling System (RIMS-II), developed by the U.S. Bureau of Economic Analysis. The energy benefits and non-energy impacts were used as inputs to cost-effectiveness tests conducted by Navigant Consulting and provided in Section 6 of this report. Last, we conducted a process evaluation based on a program materials review, in-depth interviews with agency staff, and participant responses to a telephone survey. The telephone survey asked about participant satisfaction with the Program and implementing agencies, program barriers and bottlenecks, best practices, and any opportunities for improvement.

1.1.1 Impact Results

We conducted a billing analysis to estimate the electric savings by applying a Conditional Savings Analysis (CSA) model to estimate weather-normalized, Program-induced energy (kWh) savings based on differences between participant and comparison group consumption data. The result shows that the average annual net energy savings per participant for the 2013-2015 program years is 1,122 kWh. In Table 1, we present the ex-post net savings for each program year and in total. Overall, the Program achieved 69% of its ex-ante gross savings for the evaluation period.

This estimate is lower than the energy savings estimated for the Program in the previous evaluation. Lower savings can result from a variety of factors such as the mix of measures installed, as well as characteristics of the participants who participated in the Program. Program tracking data shows that no windows were replaced during the 2013-2015 program years, but a total of 3 homes received double-paned window replacements during the 2011-2012 program years. Additionally, more refrigerators, thermal doors, and water heaters were replaced in the previous evaluation period. We do note, however, that more participants received insulation, attic ventilation, and CFLs during 2013-2015 than had during the 2011-2012 program years. Measure mix

may therefore be a partial explanation for the difference in net energy savings per participant between the evaluation periods.

Table 1. Ex-Ante Gross and Ex-Post Net Energy Savings (kWh)

Program Year	Participation	Ex-Ante Gross Energy Savings (kWh)	Ex-post Net Energy Savings (kWh)	Realization Rate
2013	139	255,760	155,958	61%
2014	107	156,456	120,054	77%
2015	98	144,648	109,956	76%
Total	344	556,864	385,968	69%

The net savings may reflect both measure savings and behavior changes, given that many participants took recommended actions to save energy beyond the measures installed. Four in five participants recall receiving tips on how to save energy from the implementation staff, and of those, about 85% reported taking actions based on the recommendations they received. The Program is installing deep energy savings measures that will likely provide persistent savings since many of the measures have a long effective useful life, such as insulation. Further, most participants will reap these savings over a long period since most of them (85%) own their homes.

The Program's decision to add LEDs in 2016 is a solid one given the current lighting market conditions, i.e. Energy Independence and Security Act of 2007 (EISA) legislation has mostly removed incandescent bulbs from store shelves and CFLs are more prevalent in homes. Forty percent of survey respondents reported the use of CFLs before Program participation, thus showing a move towards this bulb type as a baseline. However, half the survey respondents who received CFLs through the Program removed at least some of them. Most participants noted that bulbs were removed because they burned out. The Program's decision to move from CFLs to LEDs will likely reduce the removal rate due to bulb burnouts since LEDs last far longer than CFLs before burning out.

1.1.2 Non-Energy Impact Analyses

To estimate some of the non-energy impacts of the Program, we compared the change in external assistance payments and arrearages for program participants and a comparison group. External assistance payments are provided by the low income non-profit agencies and go towards helping low income customers pay their Pacific Power electric bills. We also conducted an economic impact assessment of the Program in operation for the 2013 through 2015 program years. The non-energy impacts of the Program are used to estimate the Program's cost-effectiveness for the evaluation period.

Table 2 presents the annual change in external assistance payments annually and overall for the evaluation period. For the program participants, external payment assistance per participant decreased by \$155 (over 40%). For the control group on the other hand, the external payment assistance increased by \$77 (a 50% increase) over the evaluation period. The difference in these amounts is \$232 and is used as one of the non-energy impacts in the cost effectiveness analysis.

Table 2. External Assistance Payment Summary for Participant and Comparison Groups

Payment Type	Participant Group				Comparison Group				Net Difference
	Pre	Post	Change	% Change	Pre	Post	Change	% Change	Amount
2013	\$ 404	\$ 226	\$ (178)	-44%	\$ 137	\$ 132	\$ (5)	-3%	\$ 174
2014	\$ 305	\$ 174	\$ (131)	-43%	\$ 120	\$ 204	\$ 85	71%	\$ 216
2015	\$ 351	\$ 196	\$ (155)	-44%	\$ 213	\$ 366	\$ 152	71%	\$ 308
Total	\$ 353	\$ 198	\$ (155)	-44%	\$ 157	\$ 234	\$ 77	49%	\$ 232

We also examined the change in arrearages. To estimate this non-energy impact, we calculated the change in arrearage payments for Program participants and compared this to the change in arrearage payments for the comparison group. Table 3 presents the findings from this analysis. We find that arrearages increased for the participant group while they decreased for the comparison group for the evaluation period. While this result is counterintuitive, there are explanations for why this may occur. If the participants increased the number of residents in the home, changed the way the use non-weatherization related measures, and/or made structural changes, energy use by this group could increase and therefore lead to increased arrearages. The net difference is negative \$28, which is an additional non-energy impact used in the cost-effectiveness analysis. There is no net Program benefit since no reduction in participant group monthly arrearages paid on behalf of the participants was observed.

Table 3. Arrearage Summary for Participant and Comparison Groups

	Participant Group Arrearage				Comparison Group Arrearage				Net Difference
	Pre	Post	Change	% Change	Pre	Post	Change	% Change	Amount
Monthly Arrearage	\$2	\$12	\$11	687%	\$18	\$1	(\$18)	-95%	(\$28)

Last, we conducted an economic impact assessment of the Program in operation for the 2013 through 2015 program years. The economic impact results serve as one set of non-energy impacts used to evaluate the cost-effectiveness of the Program. We used the Regional Input Output Modeling System II (RIMS-II), maintained by the U.S. Department of Commerce, Bureau of Economic Analysis, to generate the results. RIMS-II captures the underlying economic relationships that characterize the final-demand region. In this case, the final-demand region is represented by the counties included in Pacific Power's service territory.

The results from this analysis are expressed in changes in employment (in job-years), labor income earned, value added, and output in the region. Each impact represents the sum of direct, indirect, and induced effects due to the Program. The impacts are expressed as the present value of the impacts generated over the lives of installed measures and not just the impacts from the implementation of weatherization in 2015. The measure of the Program's impact on output (i.e., the last column of Table 4) serves as a net-energy benefit and an input to the cost-effectiveness analysis.

Table 4. Economic Impacts Summary for Pacific Power Washington's LIWP for PY2013-2015

Impact Type	Employment (Job-Years)	Labor Income	Value Added	Output
Total Effect	30.3	\$1,536,199	\$2,098,613	\$3,814,536

To contextualize the results, the model’s estimated impacts can be compared to spending. Dividing the output in Table 4 by the total local spending (\$5,049,217 in 2015 dollars) estimates that each dollar of program spending on weatherization resulted in \$0.76 of additional total output in the region.

1.1.3 Cost Effectiveness Results

Navigant completed cost-effectiveness tests of the Program using various approaches: the PacifiCorp Total Resource Cost (PTRC) test, Total Resource Cost (TRC) test, Utility Cost (UCT) test, Ratepayer Impact Measure (RIM).Opinion Dynamics and PacifiCorp provided the inputs to Navigant for their calculations. The Participant Cost Test (PCT) was considered “not applicable” because customers have no participation costs and benefit/cost ratios were not calculated using this approach. The annual and evaluation period benefit/cost ratios are presented in Table 5 and show that the Low Income Weatherization Program is considered cost-effective based on the PTRC and TRC tests.

Table 5. Benefit/Cost Ratios - Low Income Weatherization, Including Non-Energy Impacts

Program Year	PTRC	TRC	UCT	RIM	PCT
2013	2.89	2.63	0.29	0.22	n/a
2014	2.27	2.06	0.26	0.2	n/a
2015	1.62	1.48	0.15	0.12	n/a
2013-2015	2.22	2.01	0.23	0.18	n/a

1.1.4 Process Results

The process evaluation examined Program operations from multiple perspectives. Pacific Power and its implementers have worked together for several years to deliver the Program. Over this time, they have developed expertise in implementing the Program despite its complex funding mechanisms. Combining the funds from Pacific Power with those from government organizations allows the Program to reach more utility participants and demonstrates a best practice in low income energy efficiency program delivery.¹ It is customary practice for utilities to work with community action agencies to bring their energy efficiency programs to low income households since these organizations generally have well-established relationships with them already.

Amongst Pacific Power participants, 52% received OIC services, 33% received NCAC services and 15% received services from BMAC. The agencies can serve most participants that qualify relatively quickly; most often within three months of applying. Close to 70% of the surveyed participants reported wait times of less than 3 months. OIC and NCAC do not maintain waitlists but instead randomize participant names they receive and serve as many households as they can each year. In the following year, these agencies begin the process again. BMAC historically maintains a waitlist of approximately 20 to 30 participants, most of whom are Pacific Power customers. Regardless of agency, all prioritize households with disabled, elderly, and younger (under 18) residents in the home.

¹ Kushler, Martin, York, Dan and Witte, Patti, “Meeting Essential Needs: The Results of a National Search for Exemplary Utility-Funded Low-Income Energy Efficiency Programs”, ACEEE Report Number U053, September 2005.

From the agency perspective, the program is operating smoothly with high levels of participant satisfaction, quick turnaround times for services, and improved comfort. However, there are two key issues impacting participation rates and program administrative costs. The first issue is a structural barrier that is very common in low income weatherization programs across the country. Sometimes, the Program cannot install energy efficiency measures because other structural or safety issues in the home need to be addressed first and are not covered by the Program. The second issue was a change in regulations faced by the agencies during the evaluation period. In 2014, the national standards replaced state standards resulting in subsequent training and certification for many personnel across the weatherization agencies. The changes included the addition of quality control inspectors (QCIs), a national certification for auditors, and additional inspections of completed projects. With these changes came increased training and administration costs that made it more expensive to serve low income participants.

The Program is helping to educate participants on ways to save energy beyond the direct-install measures. While energy education is not a formal part of the Program, agency staff still speak to Program participants about ways to save energy in the home. Coupling energy efficiency education with home audits and measure installation is one way implementation staff can take advantage of their visits to help induce behavioral changes than may further reduce energy costs. It is also considered a best practice of energy efficiency programs designed to serve low income participants.² Four in five survey respondents reported learning about ways to save energy from the agency staff and three in four participants found the energy education to be extremely helpful.

The Program is also going beyond energy and cost benefits by improving the health, comfort and aesthetics of the homes. In the telephone survey, we asked program participants if the air quality, appearance, and comfort were better, the same, or worse after they participated in the program. Seventy percent of respondents reported an improvement in comfort, 63% in air quality, and 46% in home appearance. Fewer than 5% reported that these home characteristics were worse since participation. Additionally, 63% of participants indicated the weatherization staff discussed ways to improve health and safety in the home.

The Program is meeting participant needs very well. Participant experience with the Program was very positive. Approximately three-quarters of surveyed participants reported that they were “completely satisfied” with the Program and 93% would recommend the program to others; these findings are consistent with previous program evaluation results.³

Pacific Power tried to increase awareness about its sponsorship of the Program with additional efforts in 2015. However, the agencies are generally credited for the funding more than Pacific Power. Only 5% of surveyed participants identified Pacific Power as a funding source. This proportion did not change even when we looked at program participants from 2015 compared to 2014.

1.1.5 Recommendations

Based on the evaluation results, we recommend the following:

² Ibid.

³ Smith & Lehmann Consulting and H. Gil Peach & Associates, *Washington Low-Income Weatherization Program Evaluation Report for Program Years 2011-2012*, Prepared for Pacific Power and Light Company. August 17, 2015, page 30.

- Pacific Power is adhering to best practices by delivering the Program through community-based agencies. OIC, NCAC, and BMAC have served as Program implementers on behalf of Pacific Power for years. It is a common practice for utilities to work with community action agencies to bring their energy efficiency programs to low income households since these organizations generally have well-established relationships with them already. Additionally, these agencies are knowledgeable about using funding from utilities in combination with government funding to expand the reach of programs. The implementing agencies demonstrate their understanding of program processes, requirements and funding mechanisms. Leveraging these types of agencies is a best practice in low income weatherization programs. **Pacific Power should continue to use the same Program implementers moving forward.**
- Pacific Power has tried to increase awareness about its funding of the Program, given that the utility provides at least 50% of the costs of measures installed in participants' homes. Most participants cannot recall who funds the Program and those that do often associate it with the agencies instead of the utility. In 2015, Pacific Power started to send letters and magnets to participants to thank participants for participating and to increase awareness of the utilities' role in the Program. However, no change in recognizing the utility as a funding source could be seen in the survey responses from participants who participated in 2014 versus 2015. **If it is a priority for Pacific Power to make sure it is recognized for its sponsorship of the Program, Pacific Power might also consider branding the agency staff who conduct the audits and installation services by wearing shirts with the Pacific Power name and logo.**
- Though the Program has been well received, it has had declining participation since 2013. The decline in participation could be due to several factors, including changes in regulations, increased costs of Program implementation, the end of funding available through the American Reinvestment and Recovery Act of 2009 (ARRA), and/or market penetration amongst the eligible population. **We recommend that Pacific Power take a historical look at participation amongst its low income population that likely has electric heat to determine how much of the market has been penetrated thus far. This exercise could also help to identify and target households that have not participated yet.**
- The weatherization agencies reported challenges with Program implementation due to the more stringent regulations to which they must adhere as it relates to program implemented using government funds, such as quality control inspections of all projects. Smaller agencies, such as BMAC, noted difficulties in meeting the new regulations because of its smaller staff size. The agencies indicated that new regulation and standards are driving up administration and operating costs, increasing project timeframes (thus reducing the number of projects per year), and decreasing the cost effectiveness of the services they provide. **We recommend Pacific Power inquire with the implementing agencies, particularly with BMAC, to assess whether they need assistance in providing training for QCIs or auditors to ease the added costs of regulatory compliance.**
- Finally, the Program is struggling with an issue commonly found in low income weatherization programs throughout the country, i.e. overcoming the structural barriers to installing weatherization measures. These structural barriers are an issue impeding participation and cost-effectiveness. Agencies reported that they defer participants who need to address safety issues such as faulty wiring, leaky roofs, and safe access to parts of the home prior to weatherization. This issue is a quandary to most utilities who need to allocate funds directly to energy saving improvements for cost-effectiveness standards, instead of structural and safety improvements that do not directly lead to energy savings. While other funding sources can help, it often is not enough. For most utilities, this remains an unsolvable dilemma. However, one electric cooperative in Arkansas advocated for a new tariff in the state that allowed for an innovative financing solution that directly solved this issue. The Pay-As-You-

Save model, allows the utility to fund both structural and energy improvements and provides immediate net savings for the participant. The participant does not incur a debt obligation while the utility benefits from a low risk path to cost recovery through a charge on the bill that is less than the estimated savings from the upgrades. **We recommend that Pacific Power staff explore this innovating financing tariff that allowed a utility to address both structural and energy improvements through its low income weatherization program at no cost to the participant.** More information on this innovative tariff and how it operates can be found in the documents in Appendix B.

2. Introduction

Pacific Power’s Low Income Weatherization Program (the “Program”) provides energy efficiency measures to eligible residential participants through a partnership with three local weatherization agencies in Washington: Opportunities Industrialization Center of Washington (OIC)⁴ in Yakima, Yakima Valley Farm Workers Clinic/Northwest Community Action Center (NCAC)⁵ in Toppenish, and Blue Mountain Action Council (BMAC)⁶ in Walla Walla. Partnering with agencies that historically serve Washington’s low income communities provides Pacific Power with streamlined access to the participants targeted by this program.

Pacific Power provides rebates to the implementing agencies by covering 50% of the cost of services while funds from the Washington state Matchmaker Program⁷ are available. When Matchmaker Program funds are depleted, the utility covers 100% of the cost of eligible measures and services. All measures installed under the Program must also be eligible under the Matchmaker program and importantly, reimbursements to the agencies are calculated after property owner contributions are deducted. Agencies are also reimbursed for administrative costs based on 15% of the Pacific Power rebate on installed measures.

To cover any remaining program costs, the implementing agencies leverage federal government funding from the United States Department of Energy (USDOE) and the United States Department of Health and Human Services (USDHHS). The Washington Department of Commerce, Community Services and Housing Division (WADOC) administers the federal funding to the agencies. WADOC also provides administrative oversight of the weatherization services the agencies provide.

Leveraging utility, state and federal funding sources allows the agencies to provide comprehensive weatherization services to more low income households than they may have otherwise. Other exemplary utility-funded low income energy efficiency programs also bring together multiple funding sources and implement programs through social service agencies. We show the sources of funding and roles of oversight and implementation of Pacific Power’s Program in Figure 1.

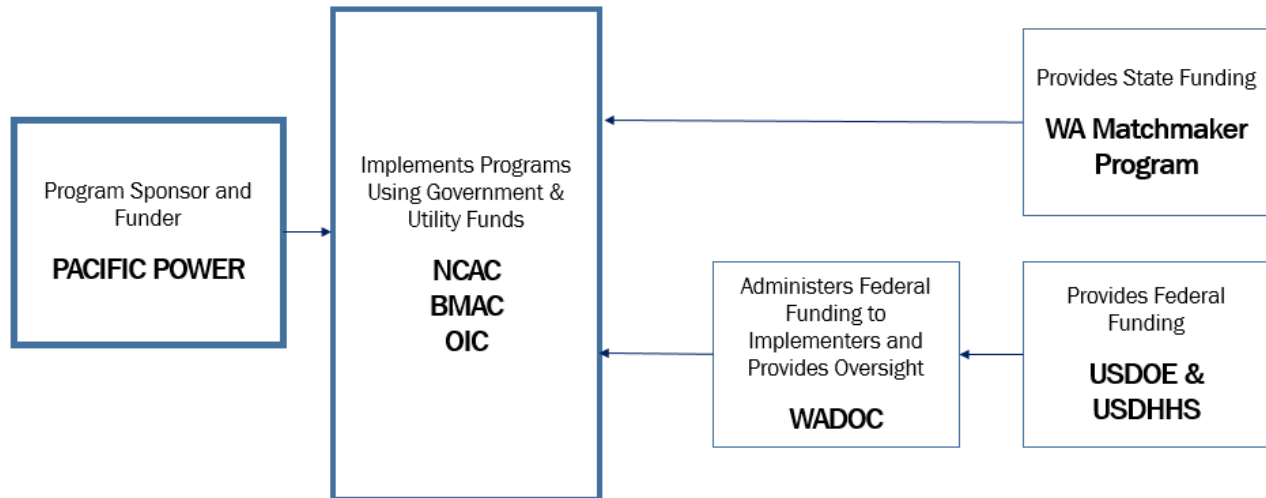
⁴ OIC serves Yakima County – North of Union Gap.

⁵ NCAC serves Yakima County – South of Union Gap.

⁶ BMAC serves Columbia, Garfield, and Walla Walla counties.

⁷ The Matchmaker Program increases resources for low income home weatherization by leveraging local matching dollars and resources from utilities, rental owners and other sources. It provides a dollar for dollar match up to a state budget amount, to help increase the reach of low income weatherization programs operated by local agencies and utilities.

Figure 1. Funding and Oversight for Pacific Power’s Low Income Weatherization Program



2.1.1 Program Implementation

Program implementation involves the following steps, which are detailed in the 2015 Washington Annual Report on Conservation Acquisition⁸:

- income verification based on Washington Department of Commerce guidelines⁹ to ensure that participants qualify for program participation,
- energy audit using a U.S. Department of Energy approved tool to determine eligible measures that are cost effective to install,
- installation of measures that have a Savings Investment Ratio of 1.0 or greater,
- post-inspections of all projects, and
- billing notification to Pacific Power Company within 90 days of job completion, which includes the measures installed and the associated cost of each project, along with the associated invoice.

The Program is available to income eligible residential customers in existing single family (including manufactured) and multi-family homes in all territory served by Pacific Power in the state of Washington. Duplexes and fourplexes are eligible if low income tenants occupy one-half of the property. Other multi-family

⁸ http://www.pacificcorp.com/content/dam/pacificcorp/doc/Energy_Sources/Demand_Side_Management/2016/2015_WA_Annual_Report.pdf

⁹ The Washington Department of Commerce Weatherization Manual, Policies and Procedures and Supporting Documents, Section 1.2.1 describe the current income eligibility guidelines in detail. The Department of Commerce provides annual updates of the federal poverty guidelines to the implementing agencies.

units are eligible if at least 66% of the units are occupied by low income qualifying tenants. “Low income” qualifications follow Federal low income guidelines and eligibility is based on 200% of federal poverty guidelines or 60% of State Median Income (SMI), whichever is greater.¹⁰

Agencies directly install measures for participants based on heating fuel-type and need. Measures vary by household, are classified as either “major” or “supplemental.” Major measures include floor, wall, and ceiling insulation and supplemental measures include, but are not limited, to, weather stripping, attic ventilation, and timed thermostat installation. Major measures and a portion of supplemental measures are only available where an electric heating system heats at least 51% of the home.

2.1.2 Evaluation Objectives

Below we list the objectives of our evaluation of the Pacific Power Program and we include in parentheses the evaluation type in which the objective is covered:

- Document and measure effects of the Program (impact and process)
- Verify measure installation and savings (impact)
- Review Program operations (process)
- Document all other funding used by agencies to provide no-charge services to participants (process)
- Quantify non-energy benefits through payment analysis (non-energy impact analyses)
- Provide data to support Program cost effectiveness assessments (non-energy impact analyses)
- Identify areas of potential improvement (impact and process)
- Document compliance with regulatory requirements (process)
- Survey participants and agency staff (process)

In the remainder of the report, we include a description of the data collection and methodologies used to conduct the study, a presentation of the impact evaluation, the findings from the process evaluation, the external payment analysis, arrearage analysis, economic impact assessment, and cost effectiveness results.

¹⁰ Note that the maximum eligibility for LIHEAP funding is 60% SMI.

3. Data Sources

In this section, we present the data sources used in this evaluation.

3.1 Program tracking data

We requested and received Program tracking data for program years 2013 through 2016 to support both impact and process evaluation. These data are tracked at the measure level therefore program participants who received more than one measure or treatment are listed multiple times. Our examination of the data revealed that Pacific Power changed its Program tracking system after 2013, therefore the same set of variables provided in the 2014-2016 program tracking data were not provided in the 2013 data. Regardless, we received all necessary data fields to conduct both the impact and process evaluation components of the study.

We received the following key variables in the 2013 Program tracking data:

- Participant name, address, and phone number
- Project name (embedded within this is the implementing agency that provided services)
- Project ID
- Utility premise ID
- Bill account number
- Heating source
- Cost recovery date
- Agency invoice date
- Measure installed
- Estimated kWh/year savings per weatherized home
- Direct install costs
- Measure costs

The Program tracking data system used for 2014 participants and beyond differed from the system used in 2013. We received more variables per record, which was at the measure level. We received the following key variables in the 2014-2016 Program tracking data:

- Participant name, address, and phone number
- Project name (embedded within this is the implementing agency that provided services)
- Project ID
- Primary utility number (participant identifier)

- Bill account number
- Cost recovery date
- Project creation date
- Project last update date
- Measure category, type, sub-type, and name
- Estimated kWh/year savings per weatherized home
- Direct install costs
- Measure costs

The Program tracking data systems did not include kWh/year savings at the measure level and assumed the same average savings per home. Because we conducted a billing analysis for the impact evaluation, the kWh/year savings at the measure or participant level were not needed.

Note that while we did not evaluate the 2016 program year, we requested these data for the billing analysis as well as the payment analysis. We used future Program participants as a comparison group where participants of the Program were matched to them based on zip code and average daily consumption.

We used the Program tracking data to identify program participants and the measures they had installed to develop the participant telephone survey sample. During the survey, we asked respondents to verify their participation.

3.2 Participant consumption data

We received participant consumption data from January 2012 through November 2016 for participants who participated in the Program during the 2013 through 2016 program years. The 2012 consumption data allowed us to establish baseline energy usage for those participants who participated in the Program during the 2013 through 2015 evaluation years and for the comparison group. These data included monthly kWh usage and one of a few different participant identifiers (e.g., bill account number or a primary utility number) thereby allowing us to relate the consumption data to Program tracking data.

3.3 Monthly billing and payment records

The payment analysis relied on monthly energy bills, participant payment records, and participant assistance payments amongst participants and the comparison group. Key participant payment data we received included the following variables for program participants:

- Participant identifier
- Participant billed amount
- Date of billed amount (generally billed monthly)
- Payment amount

- Payment date
- Payment status
- Participant assistance payment amount
- Participant assistance payment date
- Payment assistance agency

3.4 Inputs for RIMS-II Model

To use the RIMS-II model for our economic impact assessment of the Program, we requested and received the following data:

- Program Spending subcategorized by:
 - agency administration costs,
 - agency weatherization costs, and
 - state and federal government contributions, including Matchmaker funds
- Program Costs, specifically the cost to ratepayers
- Energy savings for participants through the Program¹¹, and
- Revenue loss for Pacific Power due to the Program.¹²

All data were provided by Pacific Power except for state and federal contributions to the Program. This information was provided to us by each of the weatherization agencies.

3.5 Agency Interviews and Participant Survey Data

Primary data collection activities included in-depth interviews with staff members at the three weatherization agencies: Opportunities Industrialization Center of Washington (OIC), Yakima Valley Farm Workers Clinic/Northwest Community Action Center (NCAC), and Blue Mountain Action Council (BMAC). We also conducted a participant telephone survey. The agency interviews helped inform our review of Program operations, compliance with regulatory requirements, as well as major accomplishments and challenges related to Program implementation. We used information gathered through the participant telephone survey to verify the installation of measures, estimate lighting in-service rates, and inform process related Program findings.

¹¹ Energy savings for participants are quantified as net benefits from the PCT and the present value of this is converted to 2015 dollars using the Consumer Price Index published by the U.S. Bureau of Labor Statistics

¹² Revenue loss occurs when participants receive energy efficiency measures and they purchase less energy, which the utility experiences as lost revenue over the installed measures' lifetimes. This is modeled as the negative value of the full present value of participants' energy savings.

4. Impact Evaluation

A total of 344 customers participated in the Program over the 2013 through 2015 years. In the participant telephone survey, we asked respondents whether they recalled someone coming to their home to provide weatherization services and perform energy efficiency upgrades. Virtually all survey respondents (n=40 out of 41 surveyed) confirmed their participation.¹³ One respondent refused to provide an answer but responded to all relevant remaining questions in the survey. Given this, we assume 100% of survey respondents did confirm their participation. A list of the various measures installed from the most common, infiltration, to the least common, thermal doors, is presented in Table 6 below. Other common measures include compact fluorescent light bulbs, floor insulation, water pipe insulation, caulk/weather-stripping, and ground cover.

Table 6. Washington Participation Counts and Measures for Program Years 2013 to 2015

Measures	2013	2014	2015	Total	Percent
Participation – Total # of Homes	139	107	98	344	100%
Infiltration	131	107	95	333	97%
Compact Fluorescent Light Bulbs	131	105	85	321	93%
Floor Insulation	128	99	85	312	91%
Water Pipe Insulation and Sealing	120	74	76	270	78%
Caulk/Weather-stripping	100	81	68	249	72%
Ground Cover	98	74	71	243	71%
Faucet Aerators	99	81	55	235	68%
Showerheads	81	85	55	221	64%
Ceiling Insulation	77	67	39	183	53%
Duct Insulation	70	50	54	174	51%
Attic Ventilation	48	41	63	152	44%
Repairs	47	44	34	125	36%
Wall Insulation	35	31	15	81	24%
Timed Thermostat	24	28	14	66	19%
Fluorescent Light Fixture	5	19	16	40	12%
Replacement Refrigerators	10	8	5	23	7%
Water Heater Replacement	5	2	4	11	3%
Thermal Doors	2	0	1	3	1%

4.1 Methodology

We conducted a billing analysis to estimate the electric energy savings. Our methodology compares pre- and post-participation energy usage, using future participants as a comparison group. This is called a Variation-in-Adoption method, and it is one of the recommended methods to use when it is not possible to do a randomized

¹³ Participant telephone survey sample only included participants from 2014 and 2015 to help mitigate recall bias.

control test.¹⁴ Since this is a three-year study, pre-participation usage for 2014 and 2015 participants serves as a comparison for 2013 participants. Likewise, pre-participation usage for 2015 participants serves as a comparison for 2014 participants. To get a comparison for 2015 participants, we include pre-participation usage for 2016 participants in the model.

We used comparison group matching to ensure that our comparison group was as similar as possible to participants. For each participant in 2013-2015, we compared their pre-participation monthly bills to the corresponding monthly bills for each possible comparison group match (using only pre-participation data for the control group participant, also). We then took the difference in kWh usage for each matched monthly pair and squared it. We developed a score equal to the sum of squared differences across all available months of pre-participation data for each possible participant-comparison group match. Pairs with the lowest scores indicate the best comparison group match for each participant based on similar electric usage patterns and levels. We used these scores, in combination with other geographic data, to build and test different comparison group specifications within the modeling process.

After selecting the comparison group, we built a Conditional Savings Analysis (CSA) model to estimate weather-normalized, program-induced energy (kWh) savings based on differences in participant and comparison group data. We identified Program-induced energy savings by combining participant tracking data with participant consumption data to classify pre- and post-participation periods for each individual participant based on the month their measures were installed.

Next, we weather normalized the model by including variables that account for changing weather conditions from year to year. We used zip codes for each participant to locate the nearest National Oceanic and Atmospheric Administration (NOAA) weather station with consistently valid hourly data and identified three valid stations for Washington participants.¹⁵ We next converted the hourly data into the monthly Heating Degree Day¹⁶ and Cooling Degree Day¹⁷ data needed for analysis of monthly consumption. Last, we included a monthly index in the model to provide information on time trends that appear across all participants, both participants and comparison participants.

To automatically account for all unknowns that vary by participant (such as square footage, etc.), we used the

¹⁴ SEE Action, "Evaluation, Measurement, and Verification (EM&V) of Residential Behavior-Based Energy Efficiency Programs: Issues and Recommendations", DOE/EE-0734, May 2012, p. 17.

¹⁵ The nearest NOAA weather station with reliable hourly data was found without paying attention to what state the weather station was located in. That means the nearest station for a Washington participant was not necessarily in Washington. There were three weather stations matched to Washington participants in this study:

Eastern Oregon Regional Airport, aka Pendleton Municipal, Pendleton, OR 97801
Walla Walla Regional Airport, Walla Walla, WA 99362
Yakima Air Terminal, Yakima, WA 98903

For occasional occurrences of missing hourly data within a weather station series, we replaced the missing data with an average of temperatures from the other weather stations with reliable data. The data from the other stations is weighted based on 1/squared distance between the two stations. Consequently, a station twice as far away receives ¼ of the weight in the calculation of the average.

¹⁶ Heating Degree Day = 65 - Daily Average Temperature; if HDD < 0 then HDD = 0. The HDD is calculated for each day, then summed over the month to get monthly HDD.

¹⁷ Cooling Degree Day = Daily Average Temperature - 65; if CDD < 0 then CDD = 0. The CDD is calculated for each day, then summed over the month to get monthly CDD.

following fixed-effects regression model specification:

$$\begin{aligned}
 ADC_{kt} &= a_k \\
 &+ a_1 Month_t \\
 &+ a_2 HddD_t \\
 &+ a_3 CddD_t \\
 &+ a_4 Post_{kt}
 \end{aligned}$$

Where:

ADC_{kt}	= Average Daily kWh Consumption of participant k during month t
a_k	= Fixed effect of participant k
$Month_t$	= Number of months since January 2012 for month t
$HddD_t$	= Average Heating Degree Days per day during month t
$CddD_t$	= Average Cooling Degree Days per day during month t
$Post_{kt}$	= A 0/1 binary variable equal to 1 for participant k in month t if their LIW measures have already been installed

4.1.1 Description of the Data

To begin our billing analysis, we first prepared the data by matching Program participants to the available billing records. We did so as we felt it important to include billing records only if the same participant was in the same premise for enough time during the study period. This is because many of the measures create savings related to space heating use, which can vary significantly depending on the comfort level preferred by the occupant. For example, if measures are installed in a home and a new occupant moves in shortly after who likes to keep their home warmer, measurement of the true energy savings from the measures would be obscured by behavior changes. Consequently, our billing analysis only includes monthly billing records for participants who resided at the same premise for at least 11 months before and 11 months after the measures were installed. Due to the seasonal nature of savings related to space heat and cooling, we recognize the importance of including as much of a full year of data as possible for reporting average annual savings.

Our review of previous Pacific Power studies for Washington show that savings cannot be estimated for participants in apartments, which occurs when the properties are master-metered. Consequently, we excluded the 61 participants in apartments from the billing analysis. After the exclusion of apartments, we also removed 23 participants because they did not have the requisite 11 months of pre- and post- data. These requirements left 260 participants in the analysis dataset, which is equal to approximately 75% of all participants from 2013-2015.

After identifying Program participants with sufficient valid consumption data, we next identified the best matched comparison participant for each participant. Selecting the top three comparison group matches for each participant using lowest match scores is a good balance between getting a tight match and compensating for cases with a low number of pre-participation month matches. Note that the same comparison group participant is often in the top three matches for more than one participant. Regardless of the number of matches, each comparison group participant is included in the model dataset only once.

Using the top three matches algorithm, we found 780 matches for the 260 participants. There are 290 unique participants within the group of 780 top three matches. Only a subset of these comparison group participants is from the 2016 participant group. Consumption data used for analysis covers 2012 through 2016, to include both pre-participation data for 2013 participants and post-period comparison data for 2015 participants.

4.2 Results

We produced the results presented in Table 7 when we ran the model with 260 participants and the matched comparison group from the top three matches algorithm.

Table 7. Results of the Billing Analysis Model using Top Three Matched Control Group

Variable	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1.81E-15	0.10265	0	1
Month	0.04141	0.01064	3.89	<.0001
HddD	1.971	0.01142	172.61	<.0001
CddD	1.55809	0.03286	47.42	<.0001
Post	-3.07287	0.36282	-8.47	<.0001

Standard Error is a measure of accuracy of the parameter estimate.
 t-Value is used in t-tests and are used to determine the statistical significance of the parameter estimate.
 Pr > |t| presents p-values and are also used to determine the statistical significance of the parameter estimates.

As the parameter estimate on the *Post* variable indicates, we find an average savings of 3.07 kWh per day after Program measures are installed. This translates to 1,122 kWh of savings per year on a weather-normalized annual basis. All coefficients are statistically significant at the 95% confidence level or better and the adjusted R-squared for the model is 0.706.

We built alternative models to test the consistency of the savings estimate from the basic model. Based on the similarities in energy savings estimates across the model specifications, we feel confident in our annual per participant savings estimate of 1,122 kWh per year. Results from these models are in Appendix A.

4.2.1 Ex-Post Net Energy Savings from the Program

In Table 8, we present the annual ex-ante gross and ex-post net energy savings for the Program.¹⁸ The net savings realization rate is 69% for the 2013-2015 evaluation period.

Table 8. Ex-Ante Gross and Ex-Post Net Energy Savings (kWh)

Program Year	Participation	Ex-Ante Gross Energy Savings (kWh)	Ex-Post Net Energy Savings (kWh)	Realization Rate
2013	139	255,760	155,958	61%
2014	107	156,456	120,054	77%
2015	98	144,648	109,956	76%
Total	344	556,864	385,968	69%

¹⁸ We retrieved ex-ante gross energy savings by year from Pacific Power’s Washington Annual Report on Conservation Acquisition for the years 2013 through 2015.

4.2.2 Analysis of Program's Net Ex-Post Savings Estimate

The net savings estimate per participant, 1,122 kWh, is approximately 51% of the previous evaluation period (2011 through 2012) and 25% of the evaluation prior to that (2009 through 2010). Lower savings can result from a variety of factors such as the mix of measures installed, as well as characteristics of the participants who participated in the Program. Program tracking data shows that more refrigerators, thermal doors, and water heaters were replaced in the previous evaluation period (2011-2012) than in this evaluation period (2013-2015). We do note, however, that more participants received insulation, attic ventilation, and CFLs during 2013-2015 than had during the 2011-2012 program years. Measure mix may therefore be a partial explanation for the difference in net energy savings per participant between the evaluation periods.

Another contributing factor is occupancy changes. Approximately 7% of survey respondents indicated that someone in the household retired or became unemployed, 12% had additional people move into the home and 10% of the households were expecting to add a new child since the measures were installed. These increases in home occupancy may have increased the hours of use for heating and water heating which could then decrease energy savings.

5. Analyses of Non-Energy Impacts

We conducted an external payment analysis, an assessment of changes in arrearages, and an economic impact analysis to estimate non-energy impacts of the Program. We compared changes to external assistance payments and customer arrearages between Program participants and a comparison group over the evaluation period. Additionally, we examined the monetary impact of the Program on the region's economy. The non-energy impacts of these analyses serve as non-energy inputs to calculate cost-effectiveness for the Program.

5.1 Payment and Arrearage Analyses

5.1.1 Methodology

In addition to the payment data described in the Data Sources section (Section 3), additional data used in the analysis came from the Program tracking data. We merged on the cost recovery date, which allowed us to determine the pre- and post- periods based on when the participant received the energy efficient measures.¹⁹ With these data, we calculated the difference in external payments and customer arrearages made during pre- and post-periods between Program participants. We define the pre-period as the year prior to the cost recovery date and the post-period as the year after the cost recovery date. For the comparison group, we estimated the average cost recovery date for all participants and used it for every household in the comparison group.

Opinion Dynamics first reviewed the participant and comparison group external assistance payment and arrearage data provided by Pacific Power. External assistance payments are provided by the low income non-

¹⁹ We intended to use the variable "measure effective date" but the program tracking data for participants in 2013 did not include this variable. To remain consistent in our treatment of participants we relied on the "cost recovery date", which was available for all participants. The difference between the two date fields was, on average, one and a half months, so we felt it would be close enough to the date that measures were installed in participants' homes. Cost recovery date is used as a proxy for measure installation date throughout the payment analysis.

profit agencies and go towards helping low income customers pay their Pacific Power electric bills. We next summarized the payment and arrearage data and the total number of billing days for the pre- and post-periods for each account from one year prior to participation through one year post-participation, based on the cost recovery date. We removed participant and comparison group sites from our analysis if any of the following conditions applied:

- Sites with less than 12 months of external payment and arrearage data in the pre- or post-periods.
- Sites where the average payment amount exceeded 100% of the average billed amount in either the pre- or post-period.

After applying the screening criteria, we were left with 263 participants and 71 comparison group participants out of the original counts of 345 participants and 80 comparison group participants for the external payment analysis. For the arrearage analysis, we were left with 301 participants and 89 comparison group participants.

5.1.2 Results

Table 9 below presents the annual change in assistance payments annually and overall for the evaluation period. For the program participants, external payment assistance per participant decreased by \$155 (over 40%). For the control group on the other hand, the external payment assistance increased during the time period of evaluation by \$77 (a 50% increase). The difference in these amounts is \$232 and is used as one of the non-energy impacts in the cost effectiveness analysis.

Table 9. External Payment Assistance Amounts Summary for Participants and Comparison Group

Payment Type	Participant Group				Comparison Group				Net Difference
	Pre	Post	Change	% Change	Pre	Post	Change	% Change	Amount
2013	\$ 404	\$ 226	\$ (178)	-44%	\$ 137	\$ 132	\$ (5)	-3%	\$ 174
2014	\$ 305	\$ 174	\$ (131)	-43%	\$ 120	\$ 204	\$ 85	71%	\$ 216
2015	\$ 351	\$ 196	\$ (155)	-44%	\$ 213	\$ 366	\$ 152	71%	\$ 308
Total	\$ 353	\$ 198	\$ (155)	-44%	\$ 157	\$ 234	\$ 77	49%	\$ 232

In addition to conducting an external assistance payments analysis, we examined the change in arrearages. An arrearage is the unpaid ending monthly balance on a customer’s bill. To estimate this non-energy impact, we calculated the change in arrearages for Program participants and compared this to the change in arrearages for the comparison group. Table 10 presents the findings from this analysis. The average monthly arrearage for the participant group increased by \$11 while it decreased by \$18 for the comparison group. While this result is counterintuitive, there are explanations for why this may occur. If the participants increased the number of residents in the home, changed the way the use non-weatherization related measures, and/or made structural changes, energy use by this group could increase and therefore lead to increased arrearages. The net difference is negative \$28, which is used as another non-energy impact in the cost-effectiveness analysis. There is no net Program benefit since no reduction in participant group monthly arrearages paid on behalf of the participants was observed.

Table 10. Arrearage Summary for Participant and Comparison Groups

	Participant Group Arrearage				Comparison Group Arrearage				Net Difference
	Pre	Post	Change	% Change	Pre	Post	Change	% Change	Amount
Monthly Arrearage	\$2	\$12	\$11	687%	\$18	\$1	(\$18)	-95%	(\$28)

5.2 Economic Impact Assessment

We conducted an economic impact assessment of the Program in operation for the 2013 through 2015 program years. The economic impact results serve as one set of non-energy impacts used to evaluate the cost-effectiveness of the Program, as presented in Section 7. Below we describe the modeling tool, inputs, and results.

5.2.1 Methodology

We used the Regional Input Output Modeling System II (RIMS-II), maintained by the U.S. Department of Commerce, Bureau of Economic Analysis, to generate these results. RIMS-II captures the underlying economic relationships that characterize the final-demand region. In this case, the final-demand region is represented by the counties included in Pacific Power's service territory. Without the Program, the residential sector spends their income on energy and other goods and services, while also receiving income from various sectors as earnings. With the Program in operation, a portion of both public and residential spending diverts to the program tariff while a portion of residential spending used previously for energy returns to the households from energy savings. The RIMS-II model accounts for the baseline scenario when calculating the economic effects of the Program. All effects are net of what would have happened had the Program not been in operation.

Using the RIMS-II model, we provide the economic impacts of the Program in terms of output (sales), value added (gross domestic product), employment (full- and part-time jobs), and earnings on all industries in the local economy.

Table 11 presents a summary of the four model input categories used to estimate the economic impacts of the Program: program spending, program costs, participant energy savings, and revenue loss for Pacific Power due to the energy savings experience by program participants. Program costs include several subcategories including agency administration costs, costs of weatherization, contributions of state and federal funds used in support of weatherization, and the cost of the program to ratepayers, represented by tariff collections. Note that the values in the table represent the total amount of benefits or costs accrued over multiple years. To account for this, we converted all values to 2015 dollars using the Consumer Price Index published by the U.S. Bureau of Labor Statistics and conducted the economic impact analysis as if all program activity occurred in a single year.

The present value of energy savings experienced by program participants represents the program spending that diverts back to the local economy and is equal to the revenue loss to Pacific Power as less energy is used by these residents.

Table 11. Inputs for RIMS-II Economic Impact Model

Input Category	Description	Amount	Sector
Program Spending Categories	Agency Administration ¹	\$92,013	Construction
	Agency Weatherization ²	\$1,902,532	Construction
	State/Federal Government Contributions	\$3,054,671	Construction
Program Costs	Costs to Ratepayers: tariff collections ³	\$2,311,972	Household
Energy Savings for Participants	Present Value of participants' avoided energy costs ⁴	\$2,490,745	Household
Revenue Loss for Pacific Power	Reduction in Pacific Power Revenue ⁵	(\$2,490,745)	Utilities

NOTES:

¹Agency Administration refers to the weatherization agency's costs to administer the program including labor costs

²Agency Weatherization represents Pacific Power's direct reimbursement for measures installed

³These represent the program costs covered by the tariffs collected from ratepayers.

⁴Energy savings for participants are quantified as net benefits from the PCT

⁵Revenue loss occurs when participants receive energy efficiency measures and they purchase less energy, which the utility experiences as lost revenue over the installed measures' lifetimes. This is modeled as the full present value of participants' energy savings

5.2.2 Results

We present the RIMS-II results in Table 12. The results are expressed in changes in employment (in job-years), labor income earned, value added, and output in the region. Each impact represents the sum of direct, indirect, and induced effects due to the Program. The impacts are expressed as the present value of the impacts generated over the lives of installed measures and not just the impacts from the implementation of weatherization in the first year. The measure of the Program's impact on output serves as an NEI and an input to the cost-effectiveness analysis.

Table 12. Economic Impacts Summary for Pacific Power Washington's LIWP for PY2013-2015

Impact Type	Employment (Job-Years)	Labor Income	Value Added	Output
Total Effect	30.3	\$1,536,199	\$2,098,613	\$3,814,536

To contextualize the results, the model's estimated impacts can be compared to spending. Dividing the output in Table 12 by the total local spending (\$5,049,217 in 2015 dollars) estimates that each dollar of program spending on weatherization resulted in \$0.76 of total output in the region.

6. Cost Effectiveness

This section presents the cost-effectiveness findings for Navigant’s analysis of the Washington Low Income Weatherization Program for program years 2013-2015. Navigant completed cost-effectiveness tests of the Program using various approaches: PacifiCorp Total Resource Cost (PTRC) test, Total Resource Cost (TRC) test, Utility Cost (UTC) test, Ratepayer Impact Measure (RIM) test, and the Participant Cost Test (PCT). Each scenario is analyzed using modeled assumptions provided by PacifiCorp.

All scenarios utilize the following assumptions:

- **Avoided Costs:** Navigant performed a custom analysis of calculating avoided costs by using the *Residential Whole House* decrement cost and the Residential Cooling load shape. The decrements values were populated using the 2013 PacifiCorp Integrated Resource Plan (IRP) for program years 2013-2014 and the 2015 PacifiCorp IRP for program year 2015.
- **Modeling Inputs:** Navigant utilized program level savings provided by Opinion Dynamics and administration costs provided by Pacific Power in the *WA_CostEffectiveness_Inputs.xlsx*.
- **Non-Energy Impacts:** Navigant incorporated select non-energy impacts including changes in payment assistance and arrearages, and economic impacts, which were provided by Opinion Dynamics. The direct cost of home repairs is also included and is quantified as a cost-offset to the program. Home repair costs are provided by Rocky Mountain Power.
- **Benefit/Cost Tests:** Multiple benefit/cost tests are reported including; PacifiCorp Total Resource Cost Test (PTRC), Total Resource Cost Test (TRC), Utility Cost Test (UCT), Rate Impact Test (RIM), and Participant Cost Test (PCT).

The cost-effectiveness inputs are as follows:

Table 13. Low Income Weatherization Program Inputs

Parameter	2013	2014	2015
Discount Rate	6.88%	6.88%	6.66%
Residential Line Loss	9.67%	9.67%	9.67%
Residential Energy Rate (\$/kWh) ¹	\$ 0.0874	\$ 0.0841	\$ 0.0885
Inflation Rate	1.90%	1.90%	1.90%

¹ Future rates determined using a 1.9% annual escalator.

Table 14. Low Income Weatherization Program Annual Program Costs

Program Year	Utility Admin	Admin Program Delivery	Eval, Marketing, Prog Devel.	Incentives	Total Utility Costs	Gross Customer Costs
2013	\$ 32,333	\$ 85,229	\$0	\$ 582,803	\$ 700,365	\$0
2014	\$ 27,992	\$ 84,318	\$0	\$ 586,654	\$ 698,964	\$0
2015	\$ 103,543	\$ 31,002	\$ 3,483	\$ 720,043	\$ 858,071	\$0
2013-2015	\$163,868	\$200,550	\$ 3,483	\$1,889,500	\$ 2,257,400	\$0

Table 15. Low Income Weatherization Program Annual Program Savings

Program Year	Gross kWh Savings	Realization Rate	Adjusted Gross kWh Savings	Net to Gross Ratio	Net kWh Savings	Measure Life
2013	255,760	61%	155,958	100%	155,958	30
2014	156,456	77%	120,054	100%	120,054	37
2015	144,648	76%	109,956	100%	109,956	37
2013-2015	556,864	69%	385,968	100%	385,968	34

Table 16. Low Income Weatherization Program Non-Energy Impacts

Program Year	Payment Assistance	Arrearage	Home Repair Cost	Economic Benefit	Total Non-Energy Impacts
2013	\$32,297	(\$47,136)	\$62,458	\$1,541,339	\$1,588,958
2014	\$24,861	(\$36,284)	\$48,080	\$1,186,498	\$1,223,155
2015	\$22,770	(\$33,232)	\$29,753	\$1,086,699	\$1,105,990
2013-2015	\$79,929	(\$116,652)	\$140,291	\$3,814,536	\$3,918,103

Table 17. Non-Energy Benefit Adjustments

Non-Energy Impact	Perspective Adjusted
Payment Assistance	PTRC, TRC
Arrearage	PTRC, TRC, UCT, RIM
Health and Safety	PTRC, TRC
Economic Impact	PTRC, TRC

The benefit/cost ratios for each of the cost-effectiveness tests are presented in Table 18.

Table 18. Benefit/Cost Ratios - Low Income Weatherization

Program Year	PTRC	TRC	UCT	RIM	PCT
2013	2.89	2.63	0.29	0.22	n/a
2014	2.27	2.06	0.26	0.20	n/a
2015	1.62	1.48	0.15	0.12	n/a
2013-2015	2.22	2.01	0.23	0.18	n/a

Table 19 provides the cost-effectiveness results for the combination of program years 2013 through 2015.

Table 19. LIW Program Level Cost-Effectiveness Results – PY2013-2015

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.3577	\$2,257,400	\$5,000,932	\$2,743,531	2.22
Total Resource Cost Test (TRC) No Adder	\$0.3577	\$2,257,400	\$4,546,301	\$2,288,901	2.01
Utility Cost Test (UCT)	\$0.3577	\$2,257,400	\$511,546	(\$1,745,854)	0.23
Rate Impact Test (RIM)		\$2,858,645	\$511,546	(\$2,347,100)	0.18
Participant Cost Test (PCT)		\$0	\$2,490,745	\$2,490,745	n/a
Lifecycle Revenue Impacts (\$/kWh)					\$ 0.0000172474
Discounted Participant Payback (years)					n/a

Table 20, Table 21, and Table 22 provide the cost-effectiveness results for each individual program year.

Table 20. LIW Program Level Cost-Effectiveness Results – PY2013

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.2915	\$700,365	\$2,023,303	\$1,322,938	2.89
Total Resource Cost Test (TRC) No Adder	\$0.2915	\$700,365	\$1,839,367	\$1,139,001	2.63
Utility Cost Test (UCT)	\$0.2915	\$700,365	\$203,273	(\$497,092)	0.29
Rate Impact Test (RIM)		\$932,484	\$203,273	(\$729,210)	0.22
Participant Cost Test (PCT)		\$0	\$814,921	\$814,921	n/a
Lifecycle Revenue Impacts (\$/kWh)					\$ 0.0000060473
Discounted Participant Payback (years)					n/a

Table 21. LIW Program Level Cost-Effectiveness Results – PY2014

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.3475	\$698,964	\$1,585,221	\$886,257	2.27
Total Resource Cost Test (TRC) No Adder	\$0.3475	\$698,964	\$1,441,110	\$742,146	2.06
Utility Cost Test (UCT)	\$0.3475	\$698,964	\$181,670	(\$517,294)	0.26
Rate Impact Test (RIM)		\$886,929	\$181,670	(\$705,259)	0.2
Participant Cost Test (PCT)		\$0	\$774,619	\$774,619	n/a
Lifecycle Revenue Impacts (\$/kWh)					\$ 0.0000047298
Discounted Participant Payback (years)					n/a

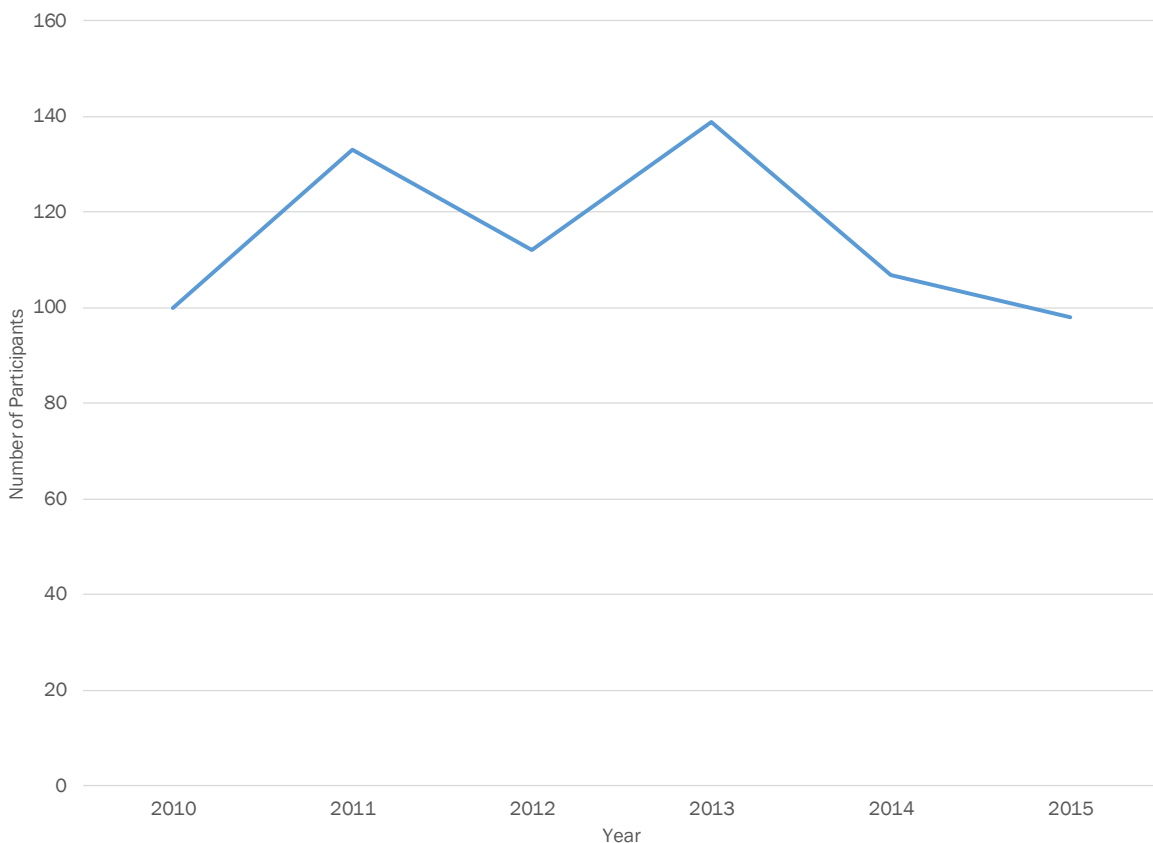
Table 22. LIW Program Level Cost-Effectiveness Results – PY2015

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.4524	\$858,071	\$1,392,408	\$534,337	1.62
Total Resource Cost Test (TRC) No Adder	\$0.4524	\$858,071	\$1,265,825	\$407,754	1.48
Utility Cost Test (UCT)	\$0.4524	\$858,071	\$126,603	(\$731,468)	0.15
Rate Impact Test (RIM)		\$1,039,233	\$126,603	(\$912,630)	0.12
Participant Cost Test (PCT)		\$0	\$901,205	\$901,205	n/a
Lifecycle Revenue Impacts (\$/kWh)					\$ 0.0000061087
Discounted Participant Payback (years)					n/a

7. Process Evaluation

Notably, the Program’s participation reached a peak in 2013 but has been declining over the current evaluation period (see Figure 2). Based on feedback from the Program manager, the decline is at least partially due to the discontinuation of ARRA funding that benefitted the Program in previous years. Without the additional funding, the same numbers of participants cannot be served. It is uncertain if the number of participants has reduced because ARRA funding is no longer available, because fewer participants are signing up to participate in the Program, or for some other reason, such as changes in regulations. Regardless, the number of participants served by the program during this evaluation period is smaller than it has been in previous years. In this process evaluation, we examined the Program’s operations from the perspective of the agencies and participants.

Figure 2. Number of Program Participants from 2010 - 2015



7.1 Agency perspective

We conducted a total of three agency interviews in December 2016. We spoke with a representative from OIC, another from NCAC, and last, with a staff member from BMAC to gain a deeper understanding of the Program’s operations and any key areas of improvement. We present each agency’s perspective in the subsections below. Notably, 52% of Program participants received OIC services, 33% received NCAC services, and 15% received BMAC services.

7.1.1 Opportunities Industrialization Center of Washington (OIC)

OIC serves many Pacific Power participants and successfully uses all available Program funds it receives from the utility. OIC maintains six contracts with a variety of funding sources, allowing them to leverage funds when it provides energy efficiency services to Pacific Power low income customers. OIC services between 85-100 homes per year with its available funds. In addition to Pacific Power's Program, OIC funnels participants through other energy assistance programs, such as the Low Income Energy Assistance Program (LIHEAP) funded by the U.S. Department of Health and Human Services (USDHHS).

OIC does not maintain a cumulative waitlist, but instead works from a participant list that is reset each year. Once participants receive low income weatherization services, OIC removes them from its list. The agency prioritizes homes with elderly or disabled residents, with children under 18, and with a high-energy burden. The list contains approximately 2,500 participants, but half are eliminated due to ineligibility or because they have been served in the past. OIC calls participants in a randomized order from this list until it reaches the number of households it can serve in a year. The agency then removes all names at the end of the year and begins the process again. This system does not provide services on a "first-come, first served" basis.

OIC said its biggest challenge during the evaluation period was adjusting to changes in federal regulations affecting the implementation of low income weatherization programs. In 2014, the national standards replaced state standards resulting in subsequent training and certification for many personnel. The changes included the addition of quality control inspections, a national certification for auditors, and an inspection of completed projects. As OIC stated:

"It has taken everyone a long time to get up to speed on the national standards. There has been a significant loss in personnel that was not able to pass national standards"

OIC also noted a challenge related to serving rental properties. OIC requires landlords to sign a rental home agreement when it provides low income weatherization services to their properties. The agreement prohibits them from raising rents for at least one year after the completion of weatherization services and places conditions on the sale of weatherized properties. If a landlord sells the property, he or she must sell to a low income participant, or be required to pay a portion of the weatherization services costs back to the agency.

As is common with other low income weatherization programs, the agency noted difficulties servicing homes that needed remedial repairs due to safety. To address this problem, OIC helps connect participants with church groups, Housing and Urban Development funds, and other resources that can potentially provide needed repairs before they can provide weatherization services.

7.1.2 Yakima Valley Farm Workers Clinic/Northwest Community Action Center (NCAC)

NCAC services between 50 and 60 participants a year, 90% of which are Pacific Power participants. As is the case with all the implementing agencies, NCAC receives 50% of the costs of services from Pacific Power, with additional state and federal funding sources available to make up the remaining costs of energy efficiency and weatherization services. NCAC mentioned receiving funds from the Energy Matchmaker Fund to cover 50% of the costs of services until the Fund is depleted. The Matchmaker Fund rarely runs out of funds, however NCAC noted that this occurred in 2014. When this happened, Pacific Power paid 100% of remaining weatherization projects.

Like OIC, NCAC does not maintain a waitlist, but rather it renews its list annually. It services as many participants as it can and projects usually take 60 to 90 days from when the home gets audited to when the

project is completed. Various energy and health assistance programs, physicians at low income clinics, and outside agencies refer participants to NCAC for low income weatherization services.

NCAC weatherization staff conveyed no challenges related to Program implementation, but did note that they do have to defer participants that do not meet eligibility requirements or when they need to address maintenance and repair issues such as unsafe wiring, leaky roofs, and plumbing. Once participants remedy these issues, NCAC staff can provide low income weatherization services. Aside from pre-existing maintenance and safety concerns, NCAC staff could think of no additional challenges it faced related to the Program.

7.1.3 Blue Mountain Action Council (BMAC)

BMAC services a smaller number of participants per year compared to OIC and NCAC. Approximately 70% of its participants come to BMAC through a referral service with partner agencies that provide energy assistance. BMAC's wait list is between 20-30 participants and at the time of the interview, 14 of those were from Pacific Power.

Like the other agencies, BMAC has had to deal with deferrals and walkaways due to home repairs participants need to make prior to receiving services through Pacific Power's weatherization program. The staff mentioned an increase in the deferral rate during the 2013-2015 program years.

BMAC faced challenges with program implementation due to new USDOE and WADOC standards. In previous years, it provided services to between 24-30 homes. In 2014, BMAC provided weatherization services to just below 20 homes after regulations changed. Implementation of a quality certification inspector (QCI) caused the most difficulty for BMAC. All projects had to be reviewed by a third-party QCI and auditors and QCIs were required to sign conflict of interest statements prohibiting them from working on the same job. Since BMAC is a small agency, it only employed one auditor who now had to go through QCI certification. Additionally, BMAC had to hire two additional QCI inspectors to avoid conflict of interest issues from arising. BMAC stated that these regulations "took (the) best trained people out of the work force (during the QCI training) which increased the cost of every project." Complying with the new regulations also slowed productivity and affected their weatherization completion counts.

BMAC indicated that new regulation and standards are driving up administration and operating costs, increasing project timeframes, and decreasing the cost effectiveness of the services they provide. The need for subcontractors has increased as the production goals increased, yet it takes time and funds for subcontractors to get trained on new paperwork and processes. The need to get up-to-speed on new federal regulations has caused some subcontractors to be deterred from working for the BMAC entirely.

7.2 Participant perspective

The evaluation team attempted to reach a census of participants who participated in the Program in 2014 and 2015 with a telephone survey. Participants from 2013 were not included to avoid recall bias, given the amount of time that has passed since these participants received weatherization services through the Program. Of the 205 participants who participated in 2014-2015, we had valid phone numbers for 203. A

total of 41 participants completed telephone interviews, yielding a response rate of 28% and cooperation rate of 33%.²⁰ (see Table 23).

Table 23. Washington Participant Telephone Survey

Population Frame	Unique Telephone Numbers	Final Survey Responses	Survey Response Rate	Survey Cooperation Rate
205	203	41	28%	73%

The call center attempted to reach participants multiple times. lists the survey disposition categories.

Table 24. Participant Survey Disposition

Survey Disposition	Sample
Completed	41
Answering machine	50
Disconnected phone	43
Not available callback	14
Language problems	10
No answer	9
Customer said wrong number	9
Initial refusal	8
Not available	6
Non-specific callback/secretary	3
Hard Refusal- Do not call	3
Callback to complete	2
Respondent scheduled appointment	2
Callback to complete	1
Mid-interview termination	1
Computer tone	1
Total	203

We used this survey to collect data about participant household characteristics and Program experience. Based on demographic data provided by the surveyed participants, approximately 56% participants (n=23) reside in single family or manufactured homes and 37% live in mobile homes (n=15). A total of 85% (n=35) own their homes with the remaining 15% renting their residences.

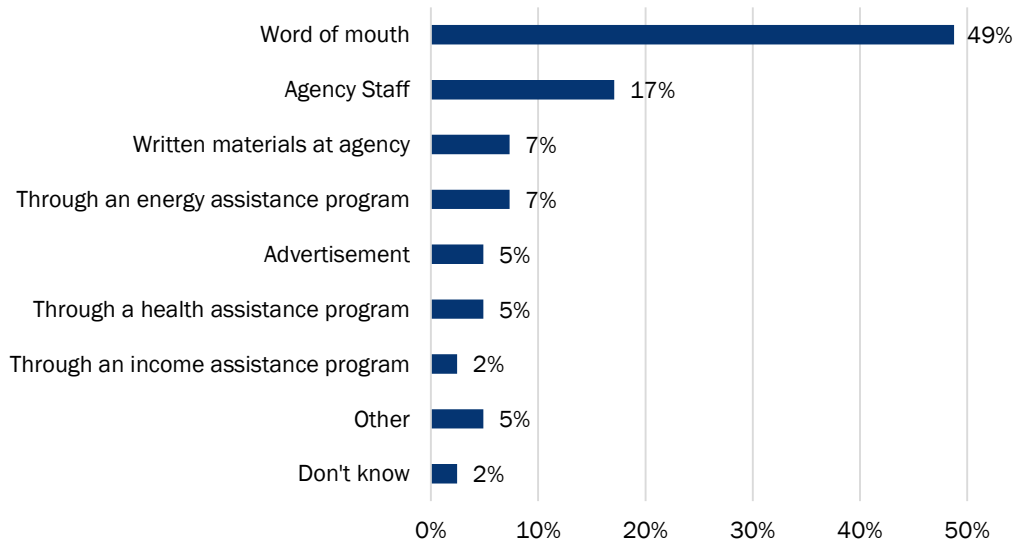
7.2.1 Program Awareness

Participants were asked how they heard about the Program. Figure 3 shows that close to half heard about the Program by word of mouth from family, friends, and neighbors (49%). This source of awareness continues as

²⁰ Response rate is calculated using American Association for Public Opinion Research (AAPOR) Response Rate 3.

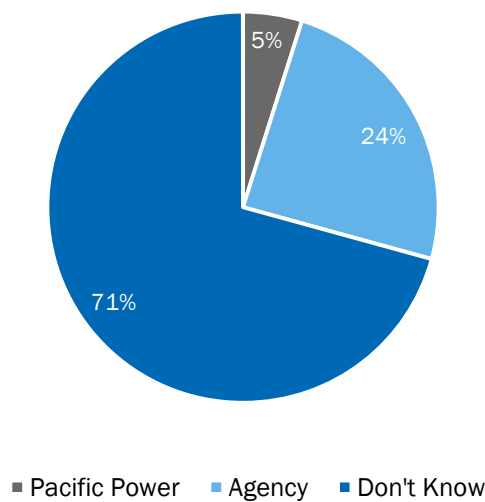
the predominant source for most customers since a similar proportion of participants noted friends, family, and neighbors were the main way they heard about the Program during the previous evaluation period. About one-quarter of participants learned about the Program from agency staff or agency materials.

Figure 3. How Participants Learned of the Program (n=41)



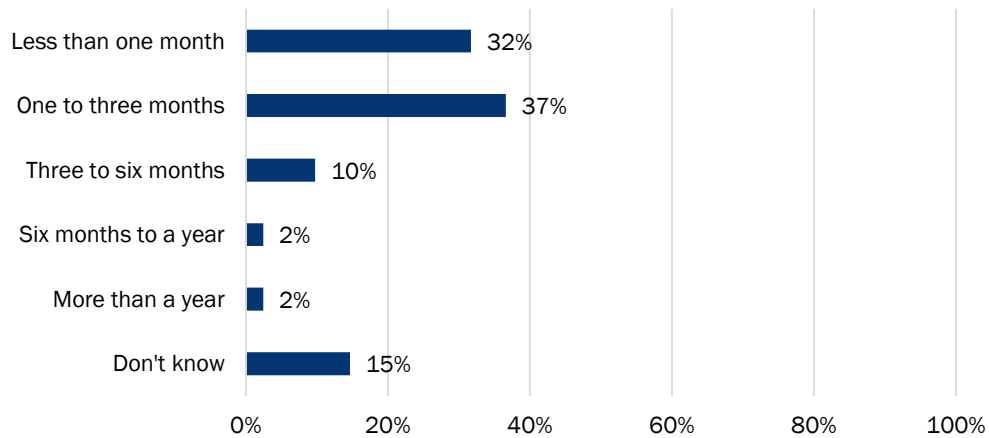
Historically, Pacific Power participants have had difficulty identifying Pacific Power as a funding source of the Program. As Figure 4 shows, 71% of participants could not identify a funding source and those who could often associated the Program with the implementing agency and not Pacific Power. Only 5% identified Pacific Power as a funding source. Beginning in 2015, Pacific Power started to send thank you letters and distribute magnets to participants who received services, however no change in recognizing the utility as a funding source could be seen in the survey responses from participants from 2014 versus 2015.

Figure 4. Participant Awareness of Program Funding Sources (n=41)



Most surveyed participants (69%) reported receiving weatherization services within three months of submitting their application. This finding supports the information shared by the implementing agencies since they do not have participant waiting lists.

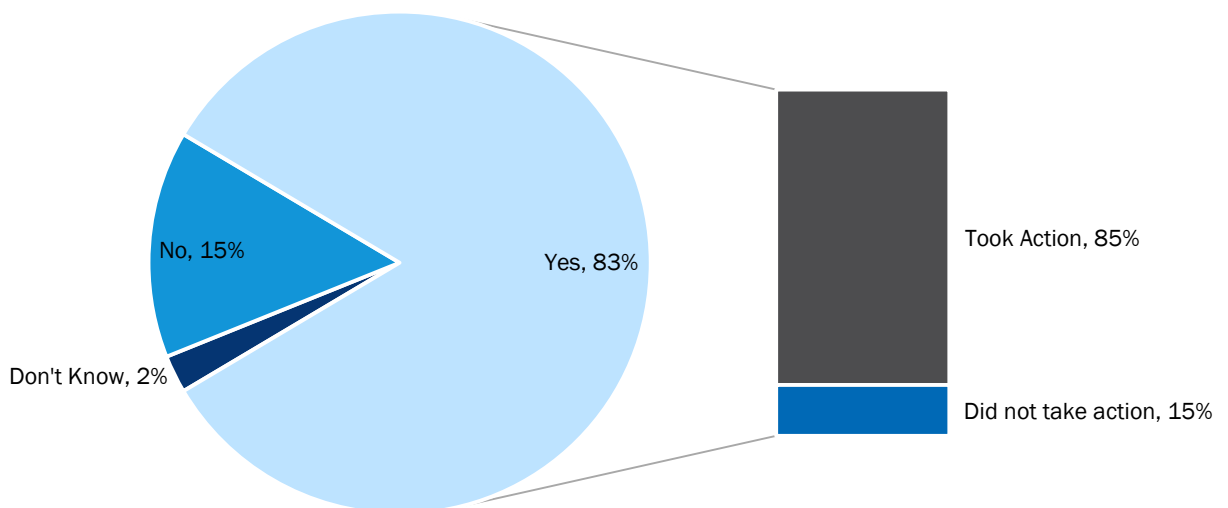
Figure 5. Time between Application Process to Receiving Weatherization Services (n=41)



7.2.2 Energy Education

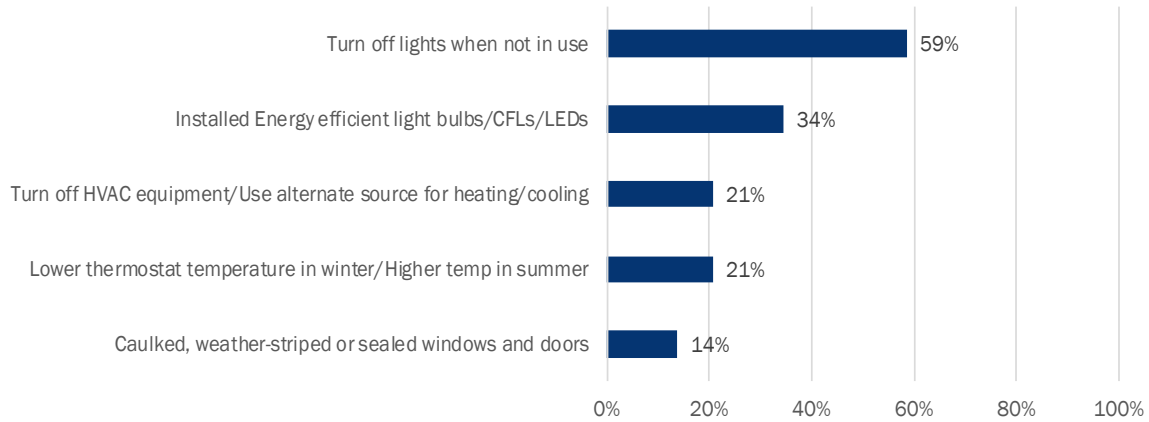
The Program does not offer energy education formally, however, Figure 6 shows four in five survey respondents learned about ways to save energy from the agency staff. Of those, 85%, (n=28 of 34) reported taking some recommended energy saving actions. All participants who had not acted on recommendations received did state that they intended to in the future (n=5 of 34). The opportunity to present energy saving recommendations during audits or measure installations has had a positive impact on program participants.

Figure 6. Weatherization Staff Provided information on Ways to Save Energy in the Home (n=41)



There were 29 participants who reported taking energy saving actions following the information received during the weatherization. Figure 7 lists the top five energy actions taken by participants. The two most common action relate to lighting.

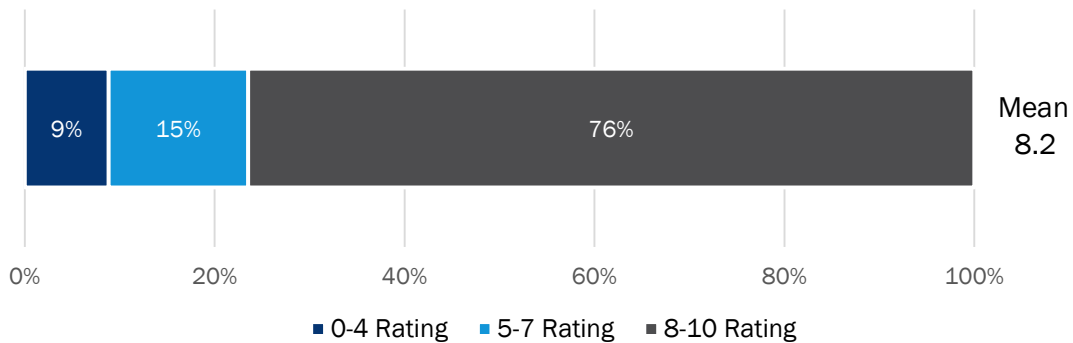
Figure 7. Top Five Energy Actions Taken (n=29)



Note: Percentages do not sum to 100% and contain multiple responses

Participants provided positive feedback on the energy education received informally during agency audits or equipment installations, as 76% participants indicated the education they received was “extremely helpful”(Figure 8).

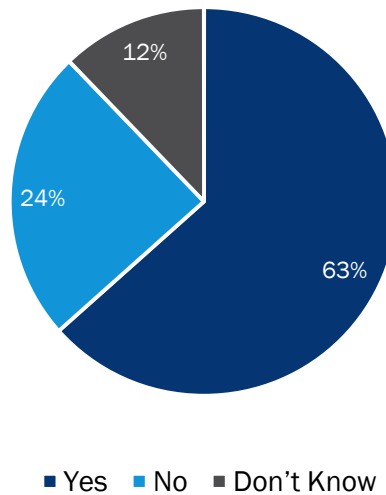
Figure 8. Helpfulness of Energy Education (n=34)



Scale from 0 to 10 where 0 is “Not at All Helpful” and 10 is “Extremely Helpful”

In addition to ways to save energy in the house, 63% of participants indicated the weatherization staff discussed ways to improve health and safety in the home (Figure 9). These results clearly show the additional efforts made by the agencies as they implement the Program to Pacific Power participants.

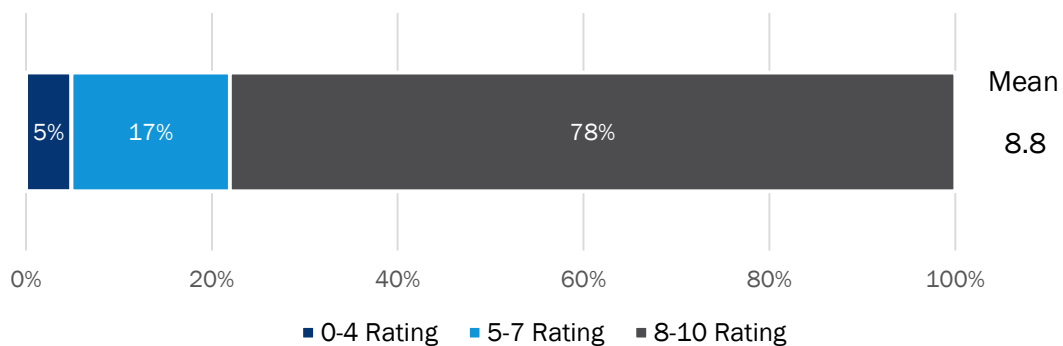
Figure 9. Ways to Improve Health and Safety in the Home (n=41)



7.2.3 Program Delivery and Satisfaction

Participant feedback was positive as three in four participants were “completely satisfied” with the Program (Figure 10). Some of the positive comments received are listed in Table 25. There were nine participants not completely satisfied with the Program (score of 7 or lower) and the reason most cited was related to home damage that occurred when the agency installed measures. We list the verbatim responses as to why these participants were not completely satisfied in Table 25 as well.

Figure 10. Program Satisfaction (n=41)



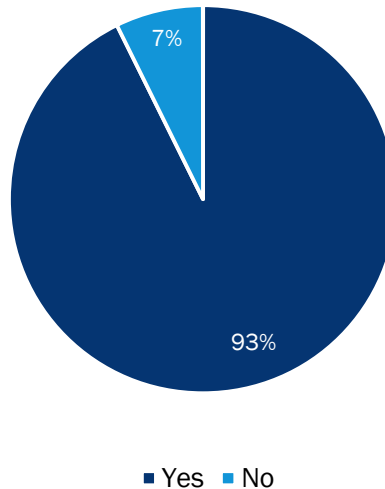
Scale from 0 to 10 where 0 is “Completely Dissatisfied” and 10 is “Completely Satisfied”

Table 25. Program Comments from Surveyed Participants

Sample of Verbatim Responses of Participants who rated Program Satisfaction greater than 7
I saved a lot of money and my house really needed those improvements. I saved a lot.
Did the job efficiently above and beyond.
Because it sealed up a lot of gaps and cut my electricity bill almost in half.
Brighter in home and bill is less and that helps when you have four children.
The head guy that supervised the work was extremely friendly, knowledgeable, and thorough. They did top notch work.
Because the people who came here were nice and courteous.
With everything they did they were extremely efficient.
Because they explained to us how the house worked and they did a lot of good stuff to our house. They also helped us to lower our bill too.
All Verbatim Responses of Participants who rated Program Satisfaction less than or equal to 7
Very informal didn't appreciate it.
Pipes froze and broke.
I would like it if things were better.
The electrician cut into a wall that I had remodeled and later found out that he couldn't put the heater in the hole and didn't fix the hole that he had made. From what I have seen from electricity bill is still the same.
Just the work they conducted.
They cut a hole in the ceiling of the bathroom and didn't patch it very well.
Water pipe broke and I had to crawl under the trailer to fix it and I'm a disabled person.
I didn't see much of a difference.
There are more things they could do that would be more meaningful. They do things that defeat the purpose.

Of these nine respondents, eight saw no change in their electric bill, and one noted their electric bill was higher following the Program. Though they did not say so, these participants may not be completely satisfied because none of them saw a decrease in their monthly electric bills after receiving weatherization services. However, most participants are satisfied with the Program and 93% said they would recommend it to others (Figure 11).

Figure 11. Recommend Program to Family and Friends (n=41)



Reflecting high program satisfaction, just about half of respondents (49% n=20) had no suggestions for improving the Program. Amongst those who did provide suggestions (n=21), participants most often requested more measures such as window and door replacement (n=6), further education outreach (n=5), and insulation (n=3). Table 26 includes some verbatim suggestions from survey respondents.

Table 26. Program Improvement Recommendations from Surveyed Participants

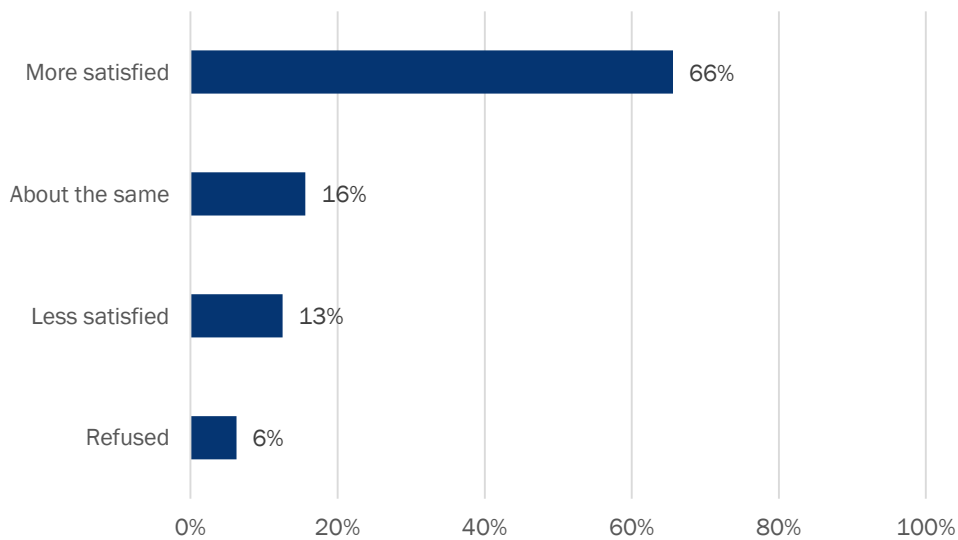
Participant Recommendations for Program Improvements	
Windows	Don't know if window repair could be involved in the program.
	Getting windows done would have been a lot easier and economical for me.
	If they could provide new windows for people, even if the windows are not broken.
	Provide new windows and roofs.
	Some houses need doors or windows, more advertising.
	People may need new windows.
Insulation	If they could have insulated in the walls but they did a great job.
	Perhaps providing insulation for walls.
	Verify pipes were wrapped.
Education and Outreach	Just letting people know more about it.
	Just try and check for the families that might really need the program.
	Talking to people more about how to save energy.

Participants were pleased with the application process, with 78% stating the process was “extremely easy”. Further, all participants were very pleased with the weatherization staff with virtually all (98%) stating “Yes” when asked if the agency staff was courteous and respectful towards them and their family members.

7.2.4 Impact of Program

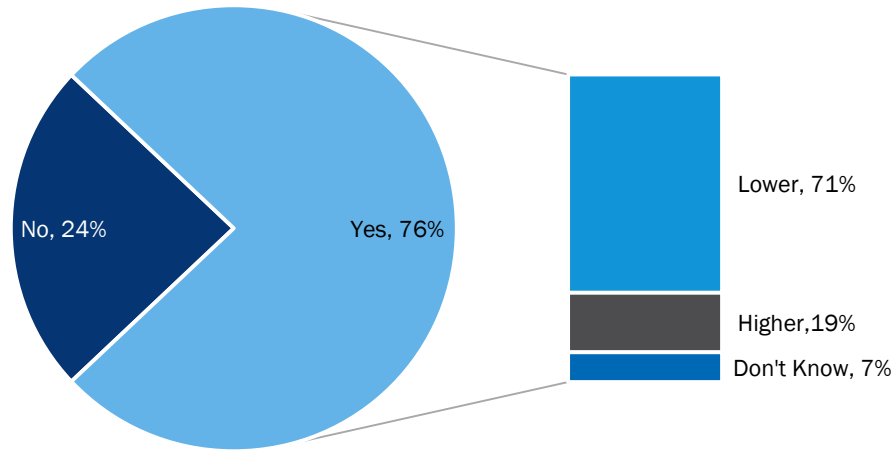
There were 32 who recalled receiving CFL bulbs through the Program. Of those, two-thirds (n=21 out of 32) reported higher levels of satisfaction with the CFLs than their previous lighting as Figure 12 shows. We inquired as to whether the CFLs remained installed in the homes and found that in about half the cases, participants removed at least some of the bulbs installed through the Program. Given this feedback, we fully support Pacific Power’s decision to add LEDs to its list of measures as it should help reduce bulb removals.

Figure 12. Satisfaction with CFLs (n=32)



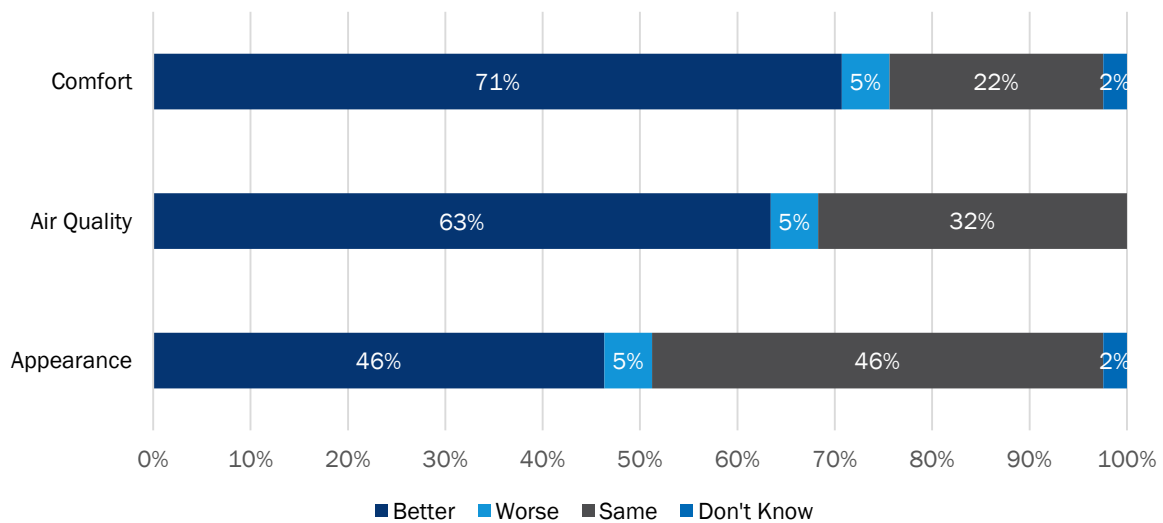
Participants were asked in the survey if they noticed a change in their electric bill after receiving weatherization services and three in four participants reported they did. Of this set of participants, 71% said their bills were lower and just under 20% said their bills rose (see Figure 13).

Figure 13. Change Noticed in Electric Bill (n=41)



We also explore non-energy impacts. In the telephone survey, we asked Program participants if the air quality, appearance, and comfort improved, stayed the same, or got worse after they participated. As Figure 14 shows, 71% of participants reported an improvement in home comfort. Air quality and appearance of the home were better for 63% and 46% of participants as well. This provides further evidence of the positive impact of the Program beyond energy saving benefits.

Figure 14. Impact of Measures on Home Characteristics (n=41)



8. Conclusions and Recommendations

Pacific Power is adhering to best practices by delivering the Program through community-based agencies. OIC, NCAC, and BMAC have served as Program implementers on behalf of Pacific Power for years. It is a common practice for utilities to work with community action agencies to bring their energy efficiency programs to low income households since these organizations generally have well-established relationships with them already. Additionally, these agencies are knowledgeable about using funding from utilities in combination with government funding to expand the reach of programs. The implementing agencies demonstrate their understanding of Program processes, requirements and funding mechanisms. Leveraging these types of agencies is a best practice in low income weatherization programs. **Pacific Power should continue to use the same Program implementers moving forward.**

Participants continue to be highly satisfied with the Program, the application process, energy education, and agency staff. The Program provides energy conservation recommendations that allows it to go beyond measure savings with behavior savings as well. Most participants recall this education, find it extremely helpful and many took some of the recommended actions. This education may be contributing to the energy savings per participant.

Pacific Power has tried to increase awareness about its funding of the program, given that the utility provides at least 50% of the costs of measures installed in participants' homes. Most participants cannot recall who funds the Program and those who do often associate it with the agencies instead of the utility. In 2015, Pacific Power started to send letters and magnets to participants to thank participants for participating and to increase awareness of the utilities' role in the program. However, no change in recognizing the utility as a funding source could be seen in the survey responses from participants who participated in 2014 versus 2015. **If it is a priority for Pacific Power to make sure they are recognized for its sponsorship of the Program, Pacific Power might also consider branding the agency staff who conduct the audits and installation services by wearing shirts with the Pacific Power name and logo.**

Though the Program has been well received, it has had declining participation since 2013. The decline in participation could be due to several factors, including changes in regulations, increased costs of Program implementation, the end of funding available through the American Reinvestment and Recovery Act of 2009 (ARRA), and/or market penetration amongst the eligible population. **We recommend that Pacific Power take a historical look at participation amongst its low income population that likely has electric heat to determine how much of the market has been penetrated thus far. This exercise could also help to identify and target households that have not participated yet.**

The weatherization agencies reported challenges with Program implementation due to the more stringent regulations to which they must adhere, adhere as it relates to program implemented using government funds. The changes included the addition of a quality control inspection, a national certification for auditors, and an inspection of completed projects. Smaller agencies, such as BMAC, noted difficulties in meeting the new regulations because of its smaller staff size. The agencies indicated that new regulation and standards are driving up administration and operating costs, increasing project timeframes (thus reducing the number of projects per year), and decreasing the cost effectiveness of the services they provide. **We recommend Pacific Power inquire with the implementing agencies, particularly with BMAC, to assess whether they need assistance in providing training for QICs or auditors to ease the added costs of regulatory compliance.**

We estimated the ex-post net energy savings equal to 1,122 kWh per participant using a billing analysis. The savings per participant is 55% of what was reported in the previous evaluation period (2011 through 2012) and 75% of the savings estimated for the evaluation period prior to that (2009 to 2010). We believe this lower estimate stems from a difference in the measure mix installed in low income homes, changes in occupancy

of treated homes, and lower persistence of CFLs due to removal. Pacific Power's decision to add LEDs to its list of measures should help reduce the removal rate of bulbs installed through the Program.

Finally, the Program faces an issue commonly found in low income weatherization programs throughout the country, i.e., overcoming the structural barriers to installing weatherization measures. Agencies reported that they defer participants who need to address safety issues prior to weatherization and, as reported in the previous evaluation, the agencies defer 50-65% of applicants. Of these potential participants, only 10% complete the repairs necessary to receive weatherization services from the agencies.²¹ These structural barriers are an issue impeding participation and cost-effectiveness. This issue is a quandary to most utilities who need to allocate funds directly to energy saving improvements for cost-effectiveness standards, instead of structural and safety improvements that do not directly lead to energy savings. While other funding sources can help, it often is not enough. For most utilities, this remains an unsolvable dilemma. However, one electric cooperative in Arkansas advocated for a new tariff in the state that allowed for an innovative financing solution that directly solved this issue. The Pay-As-You-Save model, allows the utility to fund both structural and energy improvements and provides immediate net savings for the participant. The participant does not incur a debt obligation while the utility benefits from a low risk path to cost recovery through a charge on the bill that is less than the estimated savings from the upgrades. **We recommend that Pacific Power staff explore this innovating financing tariff that allowed a utility to address both structural and energy improvements through its low income weatherization program at no cost to the participant. More information on this innovate tariff and how it operates can be found in the documents in Appendix B.**

²¹ Smith & Lehmann Consulting and H. Gil Peach & Associates, *Washington Low-Income Weatherization Program Evaluation Report for Program Years 2011-2012*, Prepared for Pacific Power and Light Company. August 17, 2015, page 34.

Appendix A: Alternative Model Specifications

We built alternative models to test the consistency of the savings estimate from the basic model. We built our first set of alternative models to look at the impact of using different algorithms for selecting the matched comparison group. Comparison Group Alternative 1 took the one best match for each participant rather than the top three matches. Comparison Group Alternative 2 continued to use the top three matches, but only selected the match if the weather station area was the same for both the participant and the match. We show very little variation in estimated savings using these alternative comparison groups, so we have confidence in the results developed using the base model. We show very little variation in estimated savings using the alternative models, as shown in Table 27.

Table 27. Model Results for Different Comparison Group Specifications

Model	Post Variable Coefficient	Annual kWh Savings
Basic Model	-3.0787	1,122
Control Group Alternative 1	-2.89356	1,056
Control Group Alternative 1	-3.0391	1,109

We built another set of alternative models to explore the impact of weather on the model results. While we did weather-normalize the basic model by including HDD and CDD factors, our review of the data shows that there was a significant difference in weather conditions between the pre- and the post- periods during the study timeframe. We demonstrate this by calculating the percentage differences in the pre- and post-period average annual heating and cooling degree days, as Table 28 shows.

Table 28. Difference in Weather Temperatures in Pre- and Post-Period

Variable	Pre-Period	Post-Period	Percent Difference
Average Annual HDD	5,428	4,475	-18%
Average Annual CDD	869	1,077	24%

It is possible that the warmer winters and cooler summers that occurred after installation of measures is affecting the impact estimates beyond what the basic weather-normalization model can account for.

We tested an alternative model to see if they could do a better job of identifying Program-induced savings during this time of increasing temperatures. We present the results of the alternative weather-normalization model in Table 29 below. Weather Alternative 1 added separate variables related specifically to the HDD and CDD conditions during the post-period (Post*HddD and Post*CddD). Theoretically, this creates weather-normalized savings estimates based on the weather that occurred during the post-period.

Table 29. Comparison of Model Results for Different Weather Specifications

Model	Month Variable Coefficient	Base Annual kWh Savings (based on Post Coefficient)	HDD Annual kWh Savings (based on Post*HddD Coefficient)	CDD Annual kWh Savings (based on Post*CddD Coefficient)	Annual kWh Savings
Basic Model	0.04141				1,122
Weather Alternative 1	0.03216	-441	1,272	285	1,117

Results show significant program savings related to measures that affect space heat needs in winter. We see a smaller amount of savings related to lower summer usage, presumably air-conditioning. However, this model shows an increase in base usage (negative savings for base use). Since the coefficient on the MonthIndex variable decreases in this alternative model, it appears to show that participants increase their electric base use slightly more than their matched comparison group after receiving their energy efficiency measures.

While this alternative weather-normalization model may provide a bit more insight into the components of the savings achieved by the Program, the annual savings estimate of 1,117 kWh per year is very close to the Basic model estimate of 1,122. Given the similarity of estimates, we recommend using the results of the Basic Model since it is simpler, easier to explain, and less prone to interpretation errors.

Appendix B: Alternative Financing Documentation

Arkansas Pay as You Save Tariff

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ARKANSAS PUBLIC SERVICE COMMISSION	
Original	Sheet No. 28.4
Replacing	n/a Sheet No.
Ouachita Electric Cooperative Corporation	
Name of Company	
Kind of Service: Electric	Class of Service: As Applicable
Part III. Rate Schedule No.	15
Title:	PAY AS YOU SAVE® (PAYS®) ON-BILL PROGRAM
	PSC File Mark Only

- 15.0 **PAY AS YOU SAVE® ON-BILL PROGRAM (The Program)**
- 15.1 **Eligibility:** Eligible on an optional and voluntary basis to any existing cooperative residential or small commercial member, or to the building owner of any structure occupied by an existing cooperative rental member, for energy efficiency improvements (Upgrades) where the cooperative provides electric service to the structure. It shall not be a requirement that the structure be all electric.
- 15.2 **Participation:** To participate in the Program, a member must: 1) request from the cooperative an analysis of cost effective upgrades, 2) agree to pay \$100 for the analysis at the time the member decides whether to implement recommended projects, and 3) review the Energy Efficiency Purchase Agreement described in 15.2.3, and implement any project that does not require an upfront payment from the member.
- 15.2.1 **Energy Efficiency Plans:** The cooperative will have its Program Operator or approved energy efficiency contractor perform a cost effectiveness analysis and prepare an Energy Efficiency Plan (The Plan), identifying recommended measures to improve energy efficiency and lower power costs. The cooperative may make an incentive payment for program participation that is less than the value of the Upgrades to the cooperative. Recommended Upgrades shall be limited to those where the annual Program Charges, including program fees and the cooperative's cost for capital are no greater than 80% of the estimated annual benefit from reduction to members' annual utility charges based on current rates in electricity and/or gas costs. In order to qualify a project for the Program that is not cost effective, Members may agree to pay the portion of a project's cost that prevents it from qualifying for the program as an upfront payment to the contractor. The cooperative will assume no responsibility for such upfront payments to the contractor.
- 15.2.2 **Cost Effectiveness Analysis Fee:** If the member proceeds with implementing the Energy Efficiency Plan resulting from the cost effectiveness analysis, the fee for the analysis will be included in the Program Charge, unless the fee prevents any project from qualifying for the program. Where the recommended measures and the full cost of the cost effectiveness analysis prevents any project from qualifying for the Program as per 15.2.3, the portion of the cost effectiveness analysis fee preventing a project from qualifying for the Program shall be waived. If there is no project that will qualify for the Program as described above without an upfront payment from the member and waiving a portion of the fee, the cost effectiveness analysis fee will be waived. The fee will not be waived if there is a project at a location that qualifies for the program and the

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APSC FILED Time: 12/10/2015 1:57:24 PM: Recvd 12/10/2015 1:56:15 PM: Docket 15-106-TF-Doc. 4

ARKANSAS PUBLIC SERVICE COMMISSION	
Original	Sheet No. <u>26.5</u>
Replacing <u>n/a</u>	Sheet No. _____
Ouachita Electric Cooperative Corporation	
Name of Company	
Kind of Service: <u>Electric</u>	Class of Service: <u>As Applicable</u>
Part III. Rate Schedule No. <u>15</u>	
Title: PAY AS YOU SAVE® (PAYS®) ON-BILL PROGRAM	
PSC File Mark Only	

member wants additional upgrades and agrees to pay the portion of the larger project's cost that prevents it from qualifying for the program as an upfront payment to the contractor. If the Energy Efficiency Plan identifies cost effective upgrades and the member declines to proceed, the member will pay \$100.

- 15.2.3 **Program Charge:** The cooperative will recover the costs for its investments through a monthly Program Charge assigned to the meter at the location where Upgrades are installed and paid by members occupying that location until all cooperative costs have been recovered. Program Charges will also be set for a duration not to exceed 80% of estimated life of the Upgrades or the length of a full parts and labor warranty, whichever is less. The Program Charge and duration of payments will be included in the Energy Efficiency Purchase Agreement. The maximum size of project considered for investment shall be \$25,000. The minimum size of project investment eligible for the Program shall be \$1,000.
- 15.2.4 **Approved Contractor:** Should the member determine to proceed with implementing The Plan, the cooperative shall determine the appropriate monthly Program Charge as described above. The member shall sign the Agreement and select a contractor from the cooperative's list of approved contractors.
- 15.3 **Quality Assurance:** When the energy efficiency measures are completed, the contractor shall be paid by the cooperative, following on-site or telephone inspection and approval of the installation by the cooperative or its Program Operator.
- 15.4 **Cost Recovery:** 45 days after approval by the cooperative or its Program Operator, the member shall be billed the monthly Program Charge as determined by the cooperative.
- 15.4.1 **Once the cooperative's costs for Upgrades at a location have been recovered, the monthly Program Charge shall no longer be billed, except as described in 15.7.**
- 15.4.2 As described in 15.6 or for any other reason if the monthly Program Charge is reduced or suspended, once repairs have been successfully effected or service reconnected, the number of total monthly payments shall be extended until the program charges collected equal the cooperative's cost for installation as described in 15.5. The duration of charges will also be extended if there are missed payments and the current occupant is still benefiting from the Upgrades in order for the cooperative to recover its costs to install Upgrades at a location.

Ark. Public Serv. Comm. ---APPROVED---02/08/2016 Docket 15-106-TF Order No. - 2

APSC FILED Time: 12/10/2015 1:57:24 PM: Recvd 12/10/2015 1:56:15 PM: Docket 15-106-TF-Doc. 4

ARKANSAS PUBLIC SERVICE COMMISSION	
Original	Sheet No. <u>26.6</u>
Replacing <u>n/a</u>	Sheet No. _____
Ouachita Electric Cooperative Corporation	
Name of Company	
Kind of Service: <u>Electric</u>	Class of Service: <u>As Applicable</u>
Part III. Rate Schedule No. <u>15</u>	
Title: PAY AS YOU SAVE® (PAYS®) ON-BILL PROGRAM	
PSC File Mark Only	

- 15.5 **Tied to the Meter:** Until cost recovery for Upgrades at a location is complete or the Upgrades fail as described in 15.7, the terms of this tariff shall be binding on the metered structure and any future member who shall receive service at that location.
- 15.6 **Disconnection for Non-Payment:** Without regard to any other Commission or cooperative rules or policies, the Program Charge shall be considered as an essential part of the customer's bill for electric service, and the cooperative may disconnect the metered structure for non-payment of the Program Charge under the same provisions as for any other electric service.
- 15.7 **Repairs:** Should, at any future time during the billing of Program Charges the cooperative determine that the installed Upgrades are no longer functioning as intended and that the occupant, or building owner if different, did not damage or fail to maintain the Upgrades in place, the cooperative shall reduce or suspend the Program Charges until such time as the cooperative and/or its contractor can repair the measure. If the Upgrade cannot be repaired or replaced cost effectively, the cooperative will waive remaining charges. If the cooperative determines the occupant, or building owner if different, did damage or fail to maintain the Upgrades in place, it will seek to recover all costs associated with the installation, including any fees, incentives paid to lower project costs, and legal fees. The Program Charges will continue until cost recovery is complete.

Ark. Public Serv. Comm. ---APPROVED---02/08/2016 Docket: 15-106-TF Order No. - 2

Ouachita Electric HELP PAYS Program

November 2016

Opening Opportunities with Inclusive Financing for Energy Efficiency:

Preliminary Results of the Ouachita Electric HELP PAYS® Program



Making a Best Practice Program Even Better

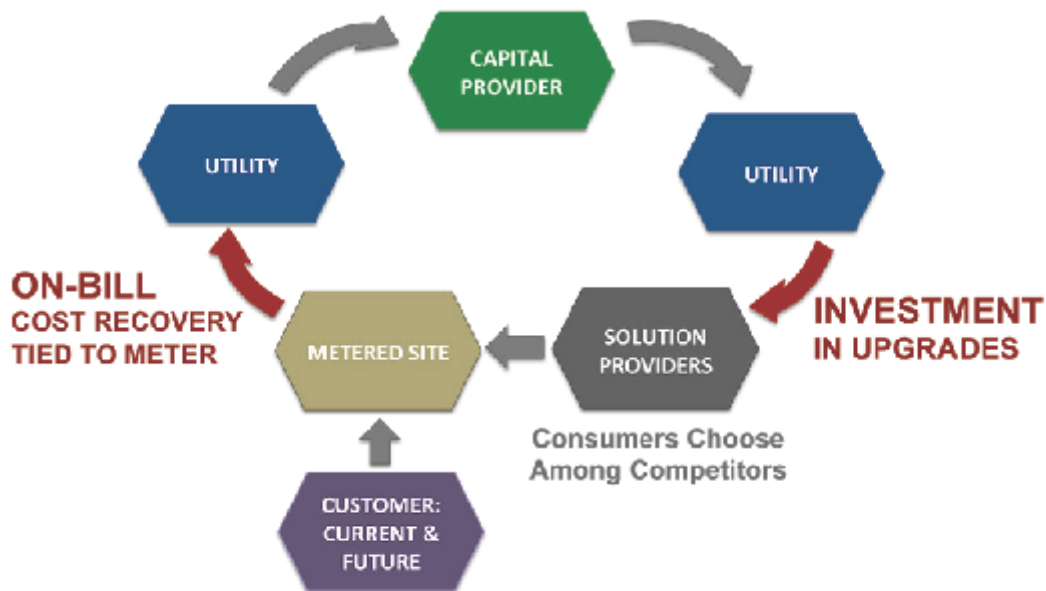
Earlier this year, the Arkansas Public Service Commission voted unanimously to approve our opt-in tariff for cost effective energy efficiency investments at the request of Ouachita Electric Cooperative.¹ Within 90 days, our utility switched from offering loans for energy efficiency upgrades (our HELP program) to offering inclusive financing through HELP PAYS®, a tariffed on-bill program based on the Pay As You Save® (PAYS®) system.



Mark Cayce, General Manager
Ouachita Electric Cooperative

With HELP PAYS, our utility can serve all customers, regardless of income, credit score, and renter status. The tariffed terms provide immediate net savings for the customer with no new debt obligation, and it assures the utility a low risk path to cost recovery through a charge on the bill that is less than the estimated savings from the upgrades. Our utility assures the upgrades continue to function throughout the period of cost recovery, and once cost recovery is complete, all upgrades belong to the owner.

PAYS offers all utility customers the option to access cost effective energy upgrades using a proven investment and cost recovery model that benefits both the customer and utility.



Pay As You Save® and PAYS® are registered trademarks of Energy Efficiency Institute, Inc.

¹ Commissions in Kansas, Kentucky, Hawaii, and New Hampshire along with utility oversight boards in California and North Carolina have approved similar tariffs also based on the Pay As You Save® (PAYS®) system.

Key Findings: HELP PAYS® Inclusive Financing vs. HELP Loan

Ouachita Electric Cooperative transitioned from its previous, nationally recognized HELP loan program to its HELP PAYS® tariffed on-bill investment program in order to benefit more of its members, and to increase the benefits it could deliver to participants. With this preliminary analysis of data for the first four months of the program, some of those benefits are being validated immediately by the market response compared to the same four months of the prior year with the HELP program in Ouachita Electric Cooperative's service area.

1. Increased Participation:

During the period April 1, 2015 – July 31, 2015, the HELP program in the same utility's service area served 46 members, all owners of single family homes. Over the same period during 2016, HELP PAYS® served 69 single family homes, 62 units of multifamily housing, and two commercial customers – approximately triple the number of participants.

2. Immediate Net Savings:

All HELP PAYS® participants benefit from immediate positive cash flow by keeping at least 20% of the estimated savings – compared to an average of zero immediate net savings in HELP, a bill neutral loan program.

3. Renters:

In the HELP PAYS® program, renters accounted for nearly half of the participants in its first quarter, customers who were ineligible to participate in the HELP loan program. Their landlords readily supported the program, agreeing to pay copayments required to qualify upgrades if needed. 100% of the renters accepted the offers they received by opting into the tariff.

4. Average investment:

In the same period during 2015, the average size of the 46 single family HELP loan project was near \$2,500. In the same period, the average investment through the HELP PAYS® program more than doubled.

5. Scale of total investment:

During the same period in 2015, the HELP loan program in the utility's service area produced investments in energy efficiency of \$116,538. With the HELP PAYS program, investment surged by more than a factor of 10 to exceed \$1.5 million.

Ouachita Electric HELP PAYS® Program

Summary of Investment Activity

April 1 – July 31, 2016

Executive Summary

Ouachita Electric worked with its program operator, EEtility, to field interest in program participation from 149 customers, all of whom are member-owners of the cooperative. Ouachita Electric serves areas of persistent poverty in southern Arkansas, yet the design of this program does not depend upon income verification of participants. Through the HELP PAYS® investment program, Ouachita Electric was able to finance upgrades in multi-family housing for the first time, and renters accounted for nearly half of the participants.

EEtility identified investment opportunities in 93% of the sites, and 95% of those customers accepted the offer of investment, including the 24% of those customers for whom the investment was conditional on a copayment. Among the renters in multi-family housing, 100% of those receiving HELP PAYS® offers accepted the investment on the terms of the opt-in tariff, and the landlords agreed to pay for 100% of the copayments associated with those units where copays were required.

The total investment exceeded \$1.5 million in the first four months of the program, and the cost of capital applied by the utility was 4.5%. Two commercial projects (at a municipal building and a college campus) accounted for one third of the portfolio, and the rest was split between single family and multi-family residential. The average investment in efficiency upgrades to participating single-family housing was \$6,387, and the average for multi-family housing units was \$6,023.

Ouachita Electric serves an area where many people are living in homes built nearly 50 years ago that have not been previously upgraded for energy efficiency. This housing stock includes very energy inefficient homes or apartments. The estimated average annual energy savings are based on engineering calculations informed by direct site measurements and calibrated for each site with historical bill data. For single family upgrades, the estimated annual energy savings was above 30% and for multi-family housing, the average was more than 35%.

HELP PAYS® assures cost recovery for the utility through a fixed charge on a participant's bill called a Program Service Charge, which is capped at 80% of the estimated savings within 80% of the useful life of the upgrades, assuming no escalation in rates. As a result, the portion of the estimated monthly net savings that a participant keeps as immediate net savings is 20% or higher, and the HELP PAYS portfolio developed in the first four months of the program exceeded that target.

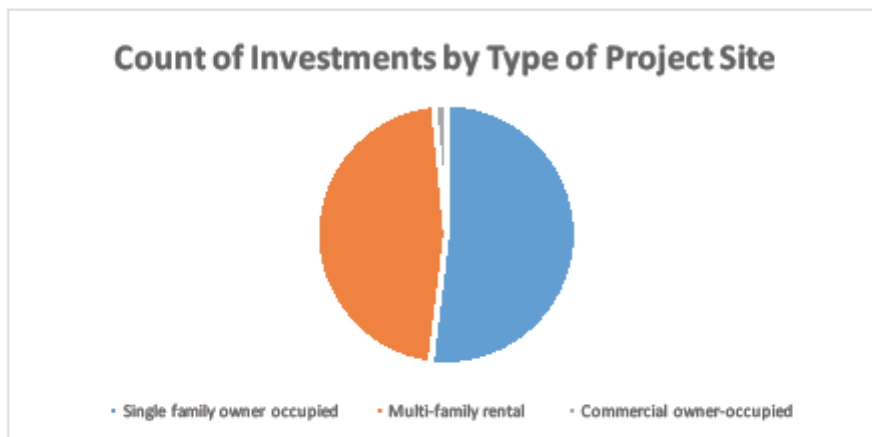
All of these program performance figures substantially exceeded similar metrics for the HELP loan program during the same period for the prior year.

1. Distribution of Interested Participants by Type of Project Site

The HELP PAYS® program completed 149 assessments of cost effective energy efficiency upgrade opportunities in buildings served by the utility.

Of the 149 assessments, 85 (57%) were for single family properties, 62 (42%) were multi-family properties and 2 (1%) were commercial properties. All 62 multi-family units were either in buildings with 4 units or were adjoining single-story units sharing one roof.

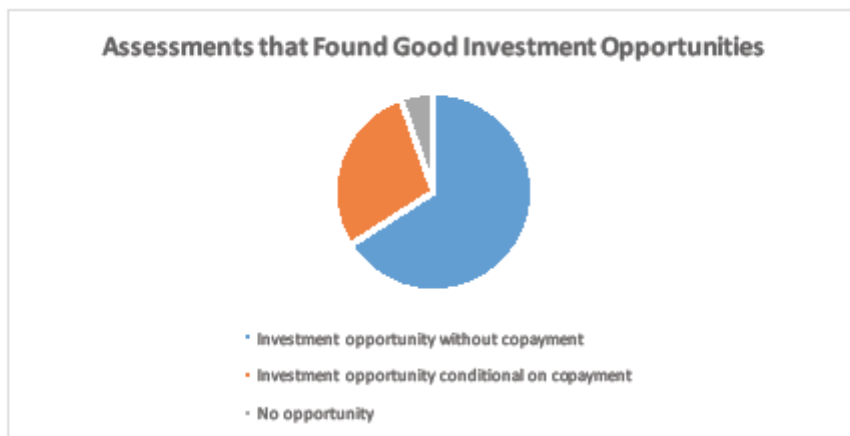
Among the single family properties, 100% were owner occupied. Among the multi-family properties, 100% were rental units. Both commercial properties were owner occupied.



2. Results of Assessments of Sites for Cost Effective Upgrades

The PAYS system requires that upgrades be cost effective even after capping the cost recovery charge to 80% of the estimated savings (based on current rates) within 80% of the useful life of the upgrades, assuming no escalation in rates. This assurance provides an assurance of net savings to the program participant. If the upgrades would not meet that threshold, the PAYS system provides an option for a customer to make a copayment upfront in order to assure that the investment will meet the PAYS standard for consumer protection, immediately providing the customer with 20% of the estimated savings.

Out of the 149 assessments, EETility identified investment opportunities at 139 sites, including 103 (69%) that met the requirements of the PAYS® system for cost effectiveness (no copayment) and 36 (24%) that were conditional upon a copayment. Ten (7%) sites did not have suitable investment opportunities.



Results of Assessments Summarized by Market Segment

Out of the assessments at 85 single family properties, EEtility did not recommend investing at 10 sites due to multiple factors.² Investment opportunities were identified at 75 of the 85 sites (88%), including 54 (63%) that met the offer requirements of the PAYS system for cost effectiveness and 21 (25%) that were conditional on copayments.

Investment opportunities were identified at all 62 of the multi-family housing units at two properties, including 49 investments (79%) that met the offer requirements of the PAYS system for cost effectiveness and 13 (21%) that were conditional on copayments by the property owners (landlords).

Investment opportunities were identified at both of the commercial properties, a school and a municipal building. The investment package at one of those sites was conditional on a copayment.

² One person died, one moved. These sites can be revisited in the future. One person was only interested in geothermal, which had approximately a 45 year payback. At the remaining 7 sites, the assessment found that the homes already had good energy performance, with only minor upgrades penciling out with minimal savings that would not justify professional installation. The program operator encouraged those customers to undertake these projects independently.

3. Acceptance of HELP PAYS® Offers to Invest in Efficiency Upgrades

Overall, 133 of 139 (96%) HELP PAYS® offers were accepted.

Offer Responses Summarized by Market Segment

Of the offers to invest at 75 single family projects, 69 (92%) accepted the HELP PAYS® offer, including 48 of the 51 (94%) offers with no copayment needed and 21 of the 24 offers (87%) that were conditional on copays.³

Out of the offers to invest in upgrades to 62 units in two multifamily properties, 62 (100%) accepted the HELP PAYS® offer. Both property owners approved all of the upgrades, and they agreed to make the copayments needed for upgrades at 12 units so that these units would meet the requirements of the PAYS system for cost effectiveness.

Of the two commercial customers that received HELP PAYS® offers, both (100%) accepted, including the one that was conditional on a copayment.

Out of the 102 sites across all property types that received a bona fide PAYS offer (no copayment), 99 (97%) were accepted. Out of 36 offers to invest that were conditional on copayments, 33 (92%) were accepted.

Acceptance Rate of HELP PAYS Offers



³ Of the 6 single family customers who declined the offer, 2 stated they were skeptical and 4 indicated they preferred to install the upgrades themselves.

4. HELP PAYS® Total Investments to Date

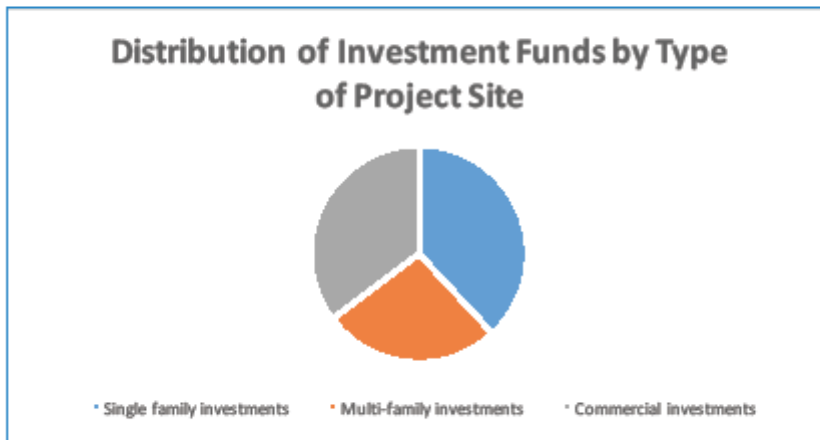
a. Distribution of Investments by Type of Project Site

Of the 133 offers accepted, 69 were single family, 62 were multi-family, and 2 were commercial.

The cost of capital the applied to all investments in the program was 4.5%.

Approximately one third of the total dollar amounts went to each type of project site.

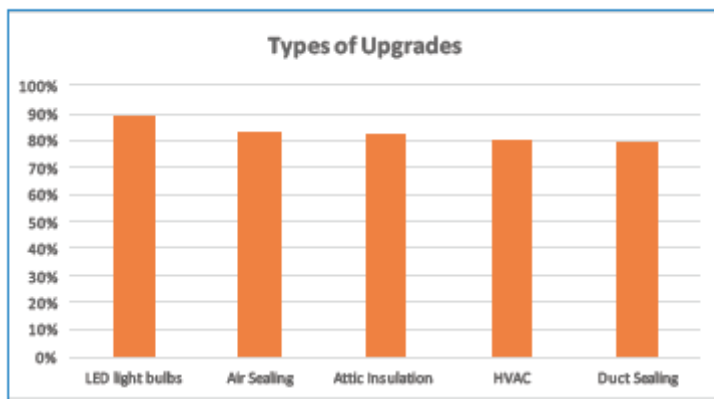
Single Family	\$596,912
Multi Family	\$418,289
Commercial	\$552,981
<hr/>	
Total	\$1,568,182



5. Types of Upgrades, across all locations

The HELP PAYS® program evaluates five common types of building energy efficiency upgrades, and each of them was included in the majority of the investment packages. The most common upgrade type was installation of LED light bulbs, occurring in 89% of sites where upgrades occurred. Air sealing was the next most common upgrade, occurring at 83% of sites where upgrades occurred.

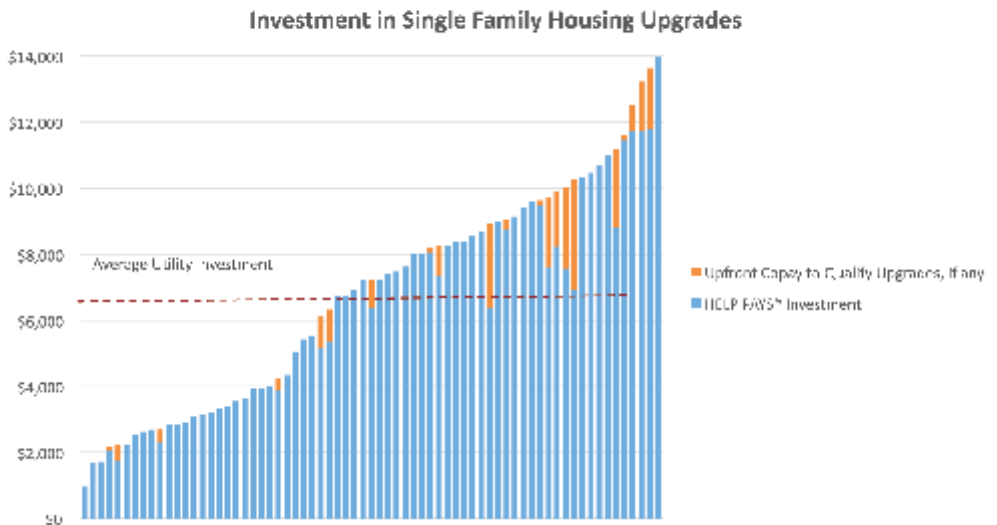
LED light bulbs	89%
Air Sealing	83%
Attic Insulation	82%
HVAC	80%
Duct Sealing	79%



6. Project Size and Utility Investment

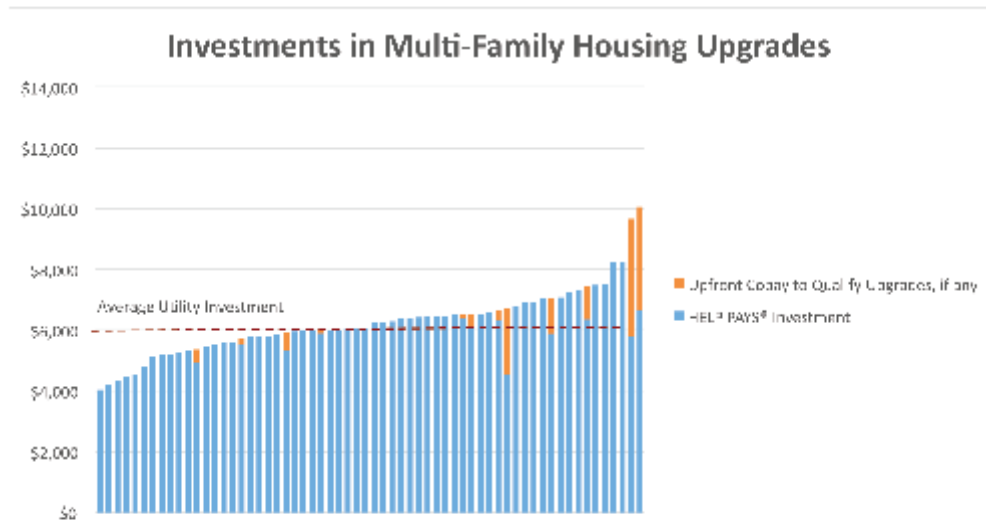
a. Single Family

Number of Investments:	69
Average Utility Investment:	\$6,387
Sites requiring a Copayment:	20
Percent with a Copayment:	30%
Average Copay, for 21 homes with a copay:	\$1,158



b. Multi Family

Number of Investments:	62
Average Utility Investment:	\$6023
Apartments requiring copayment (paid by landlord):	12
Percent apartments with a copayment:	19%
Average Copay for 12 apartments requiring copays	\$1,155
<i>* All Copays paid for by landlords</i>	



c. Commercial

One municipal project:

City of Hampton

Project investment: above \$20,000

Copayment: above \$2,000

Upgrades included: All five upgrade types

One university campus project:

Southern Arkansas Technical University

Project investment: above \$500,000

Upgrades included: Lighting only

7. Estimated Energy Savings

The HELP PAYS® program is primarily serving Ouachita members living in homes built nearly 50 years ago that have not been previously upgraded for energy efficiency. In general, the housing stock is characterized by very energy inefficient homes/apartments, and the results of the program reflect those conditions.

Annual savings are estimated based on the engineering calculations from individual on-site building analyses. These savings are recalibrated after each project is "tested out" using post upgrade air and duct sealing test results and visual insulation and HVAC Quality Control inspections. Ouachita Electric further verifies each project's performance using weather normalized smart meter data.

The average estimated annual savings for both single-family and multi-family participants was above 30%, with a wide range that reflects variation in the quality of the housing stock. Two commercial customers participated: The City of Hampton and Southern Arkansas Technical University. Both projects have average estimated annual energy savings above 25% for the projects scoped. For the university, the project scope was lighting only.

8. Estimated Monthly Savings and Cost Recovery

For the customers that are dual fuel, the estimated monthly savings include both gas and electric savings. The estimated monthly savings are based on current rates over the useful life of the upgrades, a condition that is specified in the HELP PAYS® tariff.

As defined in the HELP PAYS® tariff established by Ouachita Electric, the Program Service Charge is the cost recovery charge included on the monthly utility bill until the utility's costs are recovered. The charge is capped at 80% of the average estimated monthly savings based on current rates and a cost recovery period that is capped at 80% of the useful life of the upgrade package.

a. Single Family

Average Estimated Monthly Energy Bill Savings	\$71.34
Average Monthly Program Service Charge	\$56.26
Average Monthly Estimated Net Savings	\$15.07
Average Monthly Estimated Net Savings (%)	21%
Average Cost Recovery Period	12 years

b. Multi Family

Average Estimated Monthly Savings	\$65.48
Average Monthly Program Service Charge	\$51.88
Average Monthly Estimated Net Savings	\$13.91
Average Monthly Estimated Net Savings (%)	21%
Average Cost Recovery Period	12 years

c. Commercial

Average statistics for a sample size of two will not yield meaningful results. The estimated annual savings for the municipal building project is above \$2,000. The estimated annual energy savings for the lighting upgrade on the college campus is above \$90,000. The cost recovery period for the municipal building is 12 years, whereas the lighting project at the university campus has a cost recovery period of 10 years.

9. Looking Ahead

Even with more than a million dollars invested, we have only just begun. We are already considering ways to expand the application of our program. For example, our market conditions reward investments in demand response capabilities, so we will study the data from our smart meters to better understand the benefits of demand savings we are achieving with our investments. We are also exploring our opportunity to finance deployment of smart thermostats to add flexibility to our system.

We will seek opportunities to share our experiences and to gain insight from other utilities with similar programs. We have called on the assistance of cooperatives with similar programs, including Roanoke Electric in North Carolina, and we have benefited from the expertise of our own generation and transmission cooperative, Arkansas Electric. With that same spirit, we look forward to engaging more cooperatives interested in offering an inclusive financing solution to their members as well.

We are continuing to learn as we gain experience with program implementation. Some aspects of our program will require a full year of data to begin assessing, and we will continue to make adjustments. In the meanwhile, we are proud to be among the contenders for the national Georgetown University Energy Prize: Our partner, Calhoun County, is the only rural community among the finalists, and we will update this report to close out our quest over the last two years to chart a path that achieves deep savings while also fueling local economic development.

Contractors that participate in the HELP PAYS program are expanding their workforce as the scale of investment grows. Future reports will include information on the jobs supported by the program as well as the program's approach to continuous workforce development to support quality assurance and opportunities for advancement.

For more information and updates about our work, please visit us online at:
www.oecc.com/help

Acknowledgements

We thank Resource Media for developing the graphic design for this report. Cover photos were taken by staff at Ouachita Electric and Arkansas Electric Cooperative Corporation, which also produced a video that has helped us share the experience of offering inclusive financing to our members.

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