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PacifiCorp Washington Low Income Weatherization

Program Evaluation for Program Years 2018–2019

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Opinion Dynamics

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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 2018–2019 program years. We performed both an impact and process evaluation and present results from these evaluations in this report. Additionally, we conducted a payment analysis, an arrearage analysis, and an economic impacts assessment to estimate non-energy impacts. Last, we also include cost-effectiveness test results, determined using several approaches, in this report. AEG performed the cost-effectiveness tests.

Four Washington non-profit agencies known for serving low income communities implement the Program: Opportunities Industrialization Center of Washington (OIC), Yakima Valley Farm Workers Clinic/Northwest Community Action Center (NCAC), Yakima Nation Housing Authority (YNHA), and Blue Mountain Action Council (BMAC). These agencies provide energy efficiency services targeted towards weatherizing existing single family (including manufactured) and multi-family homes, if 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. 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 US Bureau of Economic Analysis. The energy benefits and non-energy impacts were used as inputs to cost-effectiveness tests conducted by AEG and provided in Section 6 of this report. We also 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

The evaluation team conducted a consumption analysis using a Linear Fixed Effect Regression (LFER) model, with the goal of determining the overall ex-post net program savings. The result shows that the average annual ex-post net energy savings per participant was 1,020 kWh during the 2018–2019 evaluation period. In Table 1, we present the ex-post net savings for each program year and in total. Overall, the Program achieved 58% of its ex-ante gross savings for the evaluation period.

The savings are 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 significantly more measures were installed in the past evaluation periods (2013–2015) compared to the 2018–2019 evaluation period.

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
2018	109	182,237	111,230	61%
2019	81	149,617	82,657	55%
Total	**190**	**331,854**	**193,887**	**58%**

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. Just over two-thirds of participants recalled receiving tips on how to save energy from the implementation staff, and of those, 81% reported taking actions based on the recommendations they received. The Program has installed deep energy savings measures that will likely provide persistent savings since many, such as insulation, have a long effective useful life. Further, most participants will continue to experience these savings over a long period since most of them (84%) own their homes.

1.1.2 Non-Energy Impact Analyses

External Assistance

To estimate some of the non-energy impacts of the Program, we compared the change in external assistance payments between 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 2018 and 2019 program years. The non-energy impacts of the Program are used to estimate the Program's cost-effectiveness for the evaluation period.

The table below presents the annual change in external assistance payments annually and overall for the evaluation period. For the program participants, external payment assistance per participant increased by $0.34. For the control group on the other hand, the external payment assistance decreased by $9.37 over the evaluation period. A net increase in external payments of $9.72 is shown after participation in the program, which is a non-energy impact of 0.

Table 2. Payment Assistance Amounts Summary for Participants and Comparison Group

Year	Participant Group				Comparison Group				Net Difference
	Pre	Post	Change	%Change	Pre	Post	Change	%Change	
2018	$56.84	$22.89	(33.95)	-60%	$56.81	$42.15	$(14.66)	-26%	$19.29
2019	$48.01	$82.64	$34.64	72%	$46.65	$42.56	$(4.09)	-9%	$(38.72)
Total	**$52.42**	**$52.77**	**$0.34**	**6%**	**$ 51.73**	**$ 42.35**	**$(9.37)**	**-17%**	**$(9.72)**

Economic Impacts

Additionally, we conducted an economic impact assessment. 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 2018 and 2019. The measure of the program's impact on output (i.e., the last column in Error! Reference source not found.) serves as a net-energy benefit and an input to the cost-effectiveness analysis.

Table 3. Economic Impacts Summary for Pacific Power Washington's LIWP for PY2018-2019

Impact Type	Employment (Job-Years)	Labor Income	Value Added	Output
Total Effect	11.5	$637,614	$394,507	$922,361

To contextualize the results, the model's estimated impacts can be compared to spending. Dividing the output in Table 3 by the total local spending ($2,147,122 in 2019 dollars) estimates that each dollar of program spending on weatherization resulted in $0.43 of additional total output in the region.

1.1.3 Cost-Effectiveness Results

AEG estimated the cost-effectiveness of PacifiCorp's evaluated savings for the Low Income Weatherization program in the state of Washington based on Program Year (PY) 2018-2019 costs and savings provided by PacifiCorp. The program does not pass any of the cost effectiveness tests with or without Non-Energy Benefits (NEBs).

Table 2: 2018-2019 Low Income Weatherization Benefit/Cost Ratios by Program

Program Year	PTRC	TRC	UCT	RIM	PCT
Low Income Weatherization with NEBs	0.85	0.84	0.11	0.10	n/a
Low Income Weatherization	0.16	0.14	0.11	0.10	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, all parties 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.

Among Pacific Power participants, 49% received OIC services, 26% received BMAC services, 20% received NCAC services, and 5% received services from YNHA. The agencies can serve most qualifying participants

[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.

relatively quickly. Over half (52%) of surveyed participants reported waiting less than three months. YNHA, BMAC, and NCAC all maintain a waitlist, with 50%–75% of the list comprised of Pacific Power customers. All agencies prioritize households with disabled, elderly, and minor (under 18) residents in the home.

From the agencies' perspective, the Program is operating smoothly with high levels of participant satisfaction, somewhat quick turnaround times for services, and improved comfort. There is, however, one key issue impacting participation rates and program administrative costs and it's a very common structural barrier for low income weatherization programs across the country. Often, the Program cannot install energy efficiency measures due to structural or safety issues in the home that need to be addressed first but are not covered by the Program. Some agencies leverage other funds for these repairs or refer these customers to other low-income programs that provide these types of repairs. The agencies rarely see these repairs completed, however, and consequently, these cases are closed.

The Program also educates 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] Two in three survey respondents reported learning ways to save energy from the agency staff and over half of 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 their home air quality, appearance, and comfort were better, the same, or worse after they participated in the Program. Eighty-one percent of respondents reported an improvement in comfort, 42% in air quality, and 42% in home appearance. Only a few respondents reported that these home characteristics were worse since participation. Additionally, 48% 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 90% would recommend the Program to others; these findings are consistent with previous program evaluation results.[3]

1.1.5 Recommendations

- Pacific Power is adhering to best practices by delivering the Program through community-based agencies. 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 demonstrated their understanding of Program processes, requirements and funding mechanisms. Leveraging these types of agencies is a best practice in low income weatherization programs. **We recommend Pacific Power continue to use the same Program implementers moving forward**.

[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.

- Participants continue to be highly satisfied with the Program, the application process, energy education, and agency staff. The Program provides energy conservation recommendations that allow it to supplement measure savings with behavioral-based savings as well. Most participants recalled this education, found it extremely helpful, and many reported they took some of the recommended actions. This education may be contributing to the overall energy savings per participant. Respondents expressed some dissatisfaction with the contractors' professionalism in the home and a lack of energy savings after project completion. Among those who did provide suggestions to improve the program (n=12), participants most often requested more communication from Program staff (n=2), follow-through on work (n=4), and expansion of the Program to include more people (n=2). Given this feedback, **we recommend a process for follow-up with Program participants**. Agency staff could complete a final checklist or walk-through with participants, or provide an online form for participants to complete on an as-needed basis.
- The weatherization agencies reported challenges with Program implementation due to supply-chain issues, material pricing, staffing issues, and needing outside contractors for specific types of work. Some of these issues are unique economic factors that all industries are experiencing post-COVID, but some issues could be overcome with additional funding. Further, the Program faces structural barriers to installing weatherization measures. Agencies reported that they defer participants who need to address safety issues prior to weatherization. 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. Blending funding from other sources could help overcome this barrier to participation. Additional funding for this Program may become available through the new Bipartisan Infrastructure Law through 2027. We recommend that **Pacific Power consider proactive ways to access the new infrastructure funding and layer those funds onto existing funding.**

2. Introduction

Pacific Power's Low Income Weatherization Program provides energy efficiency measures to eligible residential participants through a partnership with four local weatherization agencies in Washington: Opportunities Industrialization Center of Washington,[4] Yakima Valley Farm Workers Clinic/Northwest Community Action Center,[5] Blue Mountain Action Council,[6] and Yakima Nation Housing Authority. 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 Program are available.[7] 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

[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.

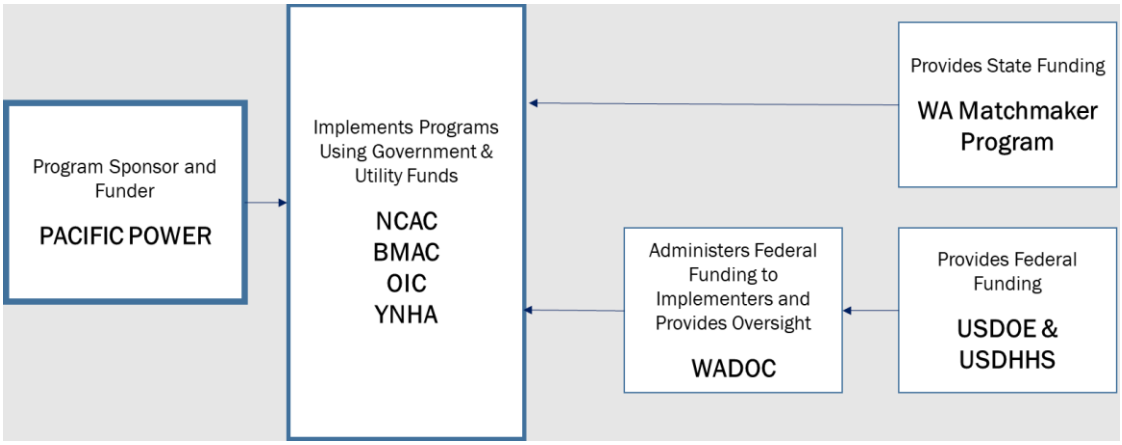
7 The Matchmaker Program increases resources for low income home weatherization by leveraging local matching dollars and resources from utilities, rental owners, and other sources. It provides a dollar for dollar match up to a state budget amount, to help increase the reach of low income weatherization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

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 (DOE) 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.

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 2020 Washington Annual Report on Conservation Acquisition:[8]

- income verification based on Washington Department of Commerce guidelines to ensure that participants qualify for program participation,[9]
- energy audit using a DOE-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.

[8] Washington Annual Report on Conservation Acquisition, June 2020, Pacific Power
[9] The Washington Department of Commerce Weatherization Manual, Policies and Procedures and Supporting Documents, Section 1.2.1 describes the current income eligibility guidelines in detail. The Department of Commerce provides annual updates of the federal poverty guidelines to the implementing agencies.

The Program is available to low income 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 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 indicate the evaluation type in which the objective is covered in parentheses:

- 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.

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 to support both the impact and process evaluations. These data are tracked at the measure level; therefore, Program participants who received more than one measure or treatment are listed multiple times. We received all necessary data fields to conduct both the impact and process evaluation components of the study.

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

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.

While we did not evaluate the 2020 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 consumption data for 2018, 2019, and 2020 Program participants spanning from January 2017 through January 2023. We retained 12 months pre- and post-participation consumption data for the 2018 and 2019 participants and a similar time span for the 2020 Program participants to adjust for exogenous changes in the consumption analysis. Upon limiting the consumption data to the relevant time span, we merged the data with the participant tracking data and performed further cleaning, such as removing invalid and outlier consumption values, and participant records with insufficient consumption data.

3.3 Monthly External Payment Records

The external payment analysis relied on monthly client assistance payments received by participants and the comparison group. Key client payment data we received included the following variables for program participants:

- Client identifier
- Client assistance payment amount
- Client assistance payment date (noted as Created Date)

3.4 Inputs for RIMS-II Model

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 3 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 2019 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 3. Inputs for RIMS-II Economic Impact Model in 2019 Dollars

Input Category	Description	Amount	Sector
Program Spending Categories	Agency Administration[1]	$176,822	Construction
	Agency Weatherization[2]	$1,245,005	Construction
	State/Federal Government Contributions	$725,295	Construction
Program Costs	Costs to Ratepayers: tariff collections[3]	$1,476,393	Household
Energy Savings for Participants	Present Value of participants' avoided energy costs[4]	$1,762,575	Household
Revenue Loss for Pacific Power	Reduction in Pacific Power Revenue[5]	($1,762,575)	Utilities
NOTES:			
[1]Agency Administration refers to the weatherization agency's costs to administer the program including labor costs			
[2]Agency Weatherization represents Pacific Power's direct reimbursement for measures installed			
[3]These represent the program costs covered by the tariffs collected from ratepayers.			
[4]Energy savings for participants are quantified as net benefits from the PCT			
[5]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 full present value of participants' energy savings			

3.5 Agency Interviews and Participant Survey Data

Primary data collection activities included in-depth interviews with staff members at three of the four weatherization agencies: NCAC, YNHA, and BMAC. We attempted to contact OIC multiple times but were unsuccessful in reaching them. 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 findings.

4. Impact Evaluation

A total of 190 customers participated in the Program over 2018 and 2019. 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=31 out of 33 surveyed) confirmed their participation. Given this, we assume 100% of participants confirmed their participation. A list of the various measures installed from the most common (infiltration) to the least common (weather strip windows) is presented in Table 4. Other common measures include LED light bulbs, floor insulation, water pipe insulation, attic ventilation, and weather strip doors.

Table 4. Washington Participation Counts and Measures for Program Years 2018–2019

Measures	2018	2019	Total	Percent
Total Number of Homes Weatherized	109	81	190	100%
Air Sealed & Infiltration	96	62	158	83%
LEDs	92	62	154	81%
Floor Insulation	86	50	136	72%
Water Pipe Insulation	87	47	134	71%
Attic Ventilation	89	42	131	69%
Weather Strip Doors	80	37	117	62%
Ceiling Insulation	71	46	117	62%
Ground Cover	55	44	99	52%
Faucet Aerator	57	29	86	45%
Duct Insulation	56	26	82	43%
Low Flow Shower Head	52	22	74	39%
Wall Insulation	21	10	31	16%
Heat Pump	13	17	30	16%
Water Heater Replacement	14	10	24	13%
Refrigerator Replacement	9	6	15	8%
Window Replacement	8	5	13	7%
Water Heater Blanket	11	1	12	6%
Thermal Door	6	5	11	6%
Lighting Fixtures	2	5	7	4%
Thermostat	2	4	6	3%
Weather Strip Windows	1	2	3	2%

4.1 Methodology

The evaluation team conducted a consumption analysis using an LFER model, with the goal of determining the overall ex-post net program savings. The model allows all household factors that do not vary over time to be absorbed by (and therefore controlled for) the individual constant terms in the equation. In other words, this method uses account-specific intercepts.

As part of the consumption analysis of Low Income Weatherization Program (LIWP) participants, the evaluation team followed a standard series of steps for data collection, data cleaning, model specification, and analysis. Our methodology compares pre- and post-participation energy usage, using 2018 and 2019 participants as the treatment cohort and 2020 participants as a comparison group to control for exogenous factors that may have influenced participant energy consumption over time.

4.1.1 Comparison Group Selection

A key challenge for estimating energy savings via a consumption analysis is the identification of an appropriate comparison group to represent a baseline of how much energy the customers would have consumed in the absence of the program. We consider two main factors in the design of a comparison group. A comparison group must (1) have similar energy usage patterns (compared to participants) before participation (i.e., pre-participation period) and (2) effectively address self-selection bias (the correlation between the propensity to participate in a program and energy use). In an ideal experimental design, a randomized control group would be used, and it would be equivalent to the treatment group in all aspects, save for the treatment being evaluated (in this case, participation in the LIWP). A perfect post-participation match is impossible when studying the effects of energy efficiency programs, since we cannot know if any group of non-participants is equivalent to the participant group, especially on the dimension of what the participants would have done absent the program. We generally aim to use a comparison group that, on average, exhibits very similar usage patterns prior to participation. Achieving this ensures that estimates from our quasi-experiment are representative on usage patterns at least, which reflects not only a household's level of use but its energy-related responses to changes in the environment. It is more difficult to assure that the comparison group represents what the participants would have done absent the program (i.e., whether they capture who would have been a free rider if they had participated). It is difficult to know whether we have captured factors involved in customers' self-selection into the program, some of whom would have installed program-qualified measures outside of the program.

There are several approaches to comparison group selection, including past participants, future participants, and non-participants. The use of future participants allowed us to better control for self-selection, because those customers in the comparison group also chose to participate in the same program, just later. Leveraging future participants as a comparison group may not always be possible; however, due to differences in participant composition over time, resulting from targeting, natural self-selection, and other reasons.

To support the evaluation of this program, we first constructed a comparison group comprised of future participants who participated between January 1, 2020, and May 31, 2020. We verified the equivalency of the participant and future comparison groups by conducting equivalency checks based on their pre-period energy usage and weather. The sections below provide additional details for these equivalency checks.

4.1.2 Consumption Data Preparation

Upon merging participant and consumption data, we performed the following consumption data cleaning steps:

- **Duplicate records.** We explored duplicate records and made adjustments to arrive at a single bill per period.
- **Inadequate days.** We identified and dropped bill periods with zero or negative days.
- **Extremely low Average Daily Consumption**. We checked for and dropped bills with very low (less than zero kWh) or missing average daily consumption.

- **Extremely high Average Daily Consumption**. We checked for customers with entire pre- or post-installation periods having very high (exceeding three times the standard deviation) average usage.
- **Inadequate billing history before or after program participation**. Many energy saving measures in these programs are expected to generate energy savings throughout the year. To assess changes in consumption due to program measures before and after installation, we need to ensure that participants have a sufficient billing history. As such, we excluded participants who did not have at least nine months of pre- and post-period participation data.

The largest drops were associated with insufficient pre-period and post-period consumption data. Upon completing data cleaning, we retained 62% of treatment group participants and 63% of comparison group participants.

4.1.3 Weather Data Preparation

To include weather patterns in our model, we used hourly weather data from numerous weather stations across the WA territory, utilizing the site closest to each account's geographic location. By using multiple sites, we increase the accuracy of the weather data associated with each account. We obtained these data from the National Climatic Data Center (NCDC).

The daily data are based on hourly average temperature readings from each day. We calculated Cooling Degree Days (CDD) and Heating Degree Days (HDD) for each day (in the analysis based on average daily temperatures, using the same formula used in weather forecasting).[11] We merged daily weather data into the consumption dataset so that each billing period captures the HDD and CDD for each day within that billing period (including start and end dates).[12] For analysis purposes, we then calculated average daily HDD and average daily CDD, based on the number of days within each billing period.

4.1.4 Comparison Group Equivalency Assessment

The appropriate use of the future participant comparison group design depends on its equivalency with the treatment group on as many dimensions as possible. Therefore, as part of our assessment of the comparison group equivalency, we explored the following dimensions:

- Pre-period consumption
- Weather

Figure 2 summarizes average daily consumption (ADC) between the 2018 treatment participants and 2020 comparison participant for the pre-participation period of the 2018 treatment participants. Figure 3 and Figure 4 contain weather data expressed in HDD and CDD respectively for the same period between the 2018 treatment participants and 2020 participants. Figure 5, Figure 6, Figure 7 draw similar comparisons but for 2019 treatment participants and 2020 comparison participants. As can be seen in the figures, energy usage

[11] A "degree-day" is a unit of measure for recording how hot or how cold it has been over a 24-hour period. The number of degree-days applied to any particular day of the week is determined by calculating the mean temperature for the day and then comparing the mean temperature to a base value of 65°F (HDD) and 75°F (CDD). (The "mean" temperature is calculated by adding together the high for the day and the low for the day, and then dividing the result by two.) If the mean temperature for the day is five degrees higher than 75°F, then there have been five cooling degree-days. On the other hand, if the weather has been cool, and the mean temperature is, say, 55°F, then there have been 10 heating degree-days (65 minus 55). "Degree Days," National Weather Service, https://www.weather.gov/ffc/degdays.

[12] Daily weather data are merged based on the given dates of the billing period. Assigning weather this way provides a more accurate representation of the weather experienced during the billing period than does using weather for the calendar month of the bill.

and weather between treatment and comparison group participants are closely aligned, thus ascertaining similarity between the treatment and comparison group populations before program interventions.

Figure 2. Participant and Comparison Group Usage During their Pre-Participation Period – 2018 Participants

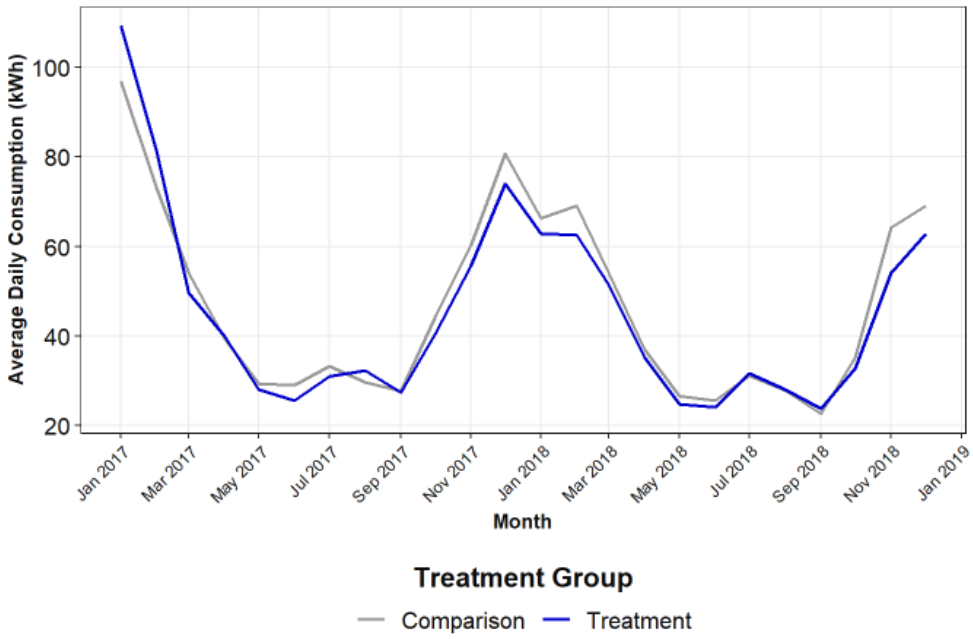


Figure 3. Average HDD Experienced by Treatment and Comparison Groups – 2018 Participants

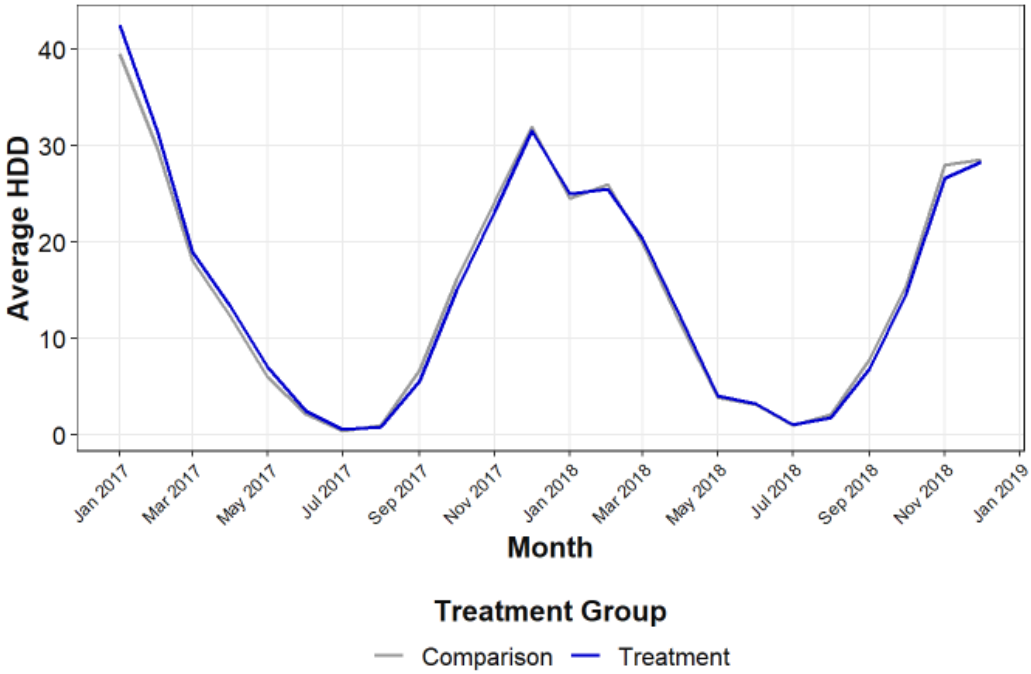


Figure 4. Average CDD Experienced by Treatment and Comparison Groups – 2018 Participants

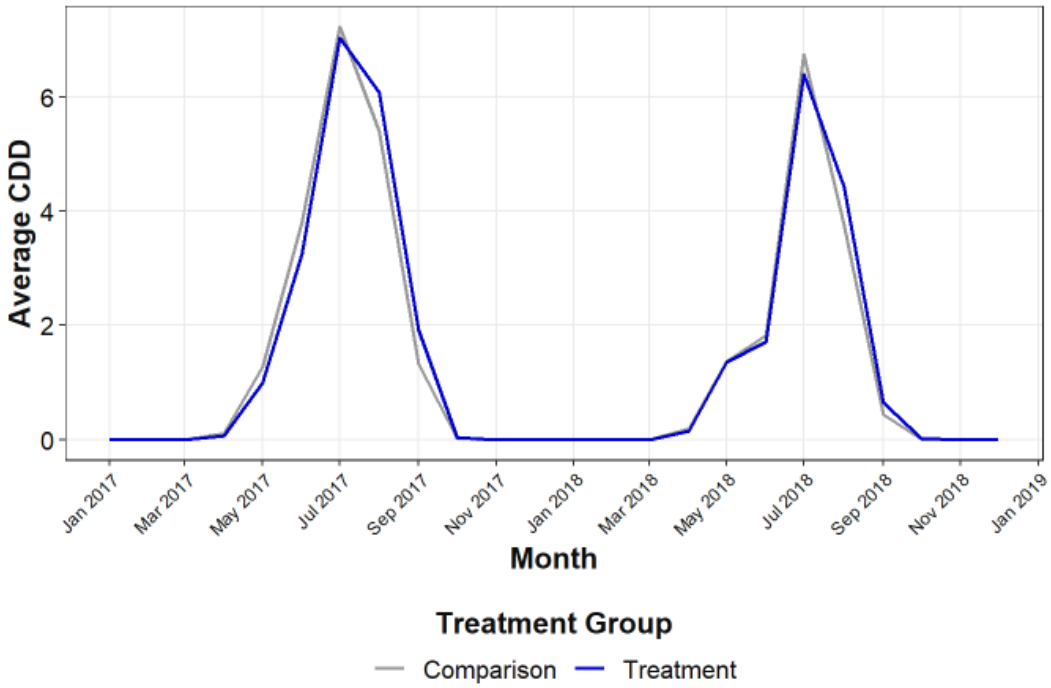


Figure 5. Participant and Comparison Group Usage During their Pre-Participation Period – 2019 Participants

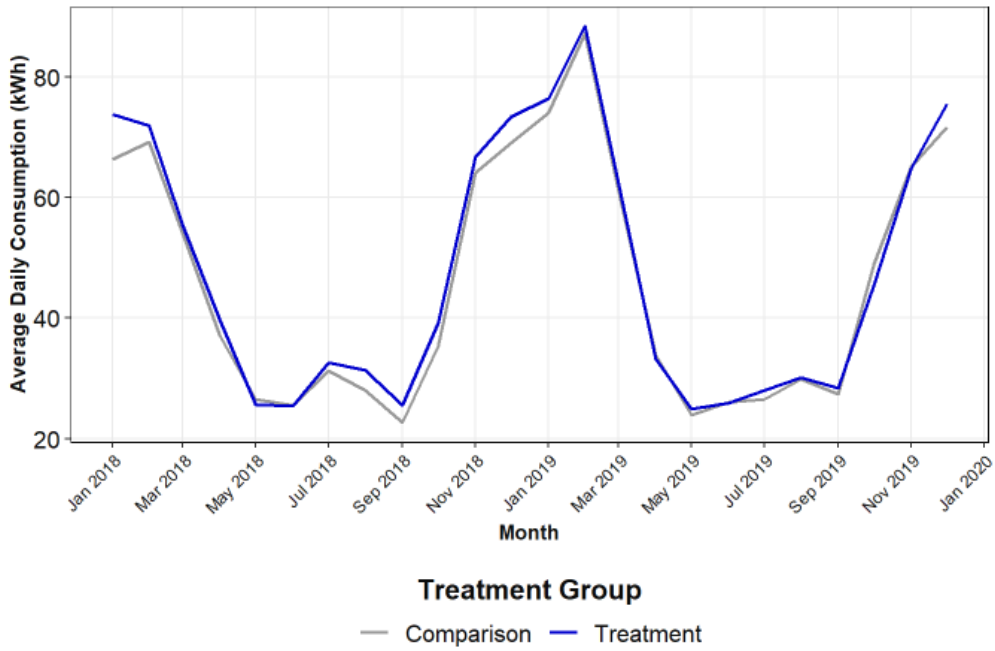


Figure 6. Average HDD Experienced by Treatment and Comparison Groups – 2019 Participants

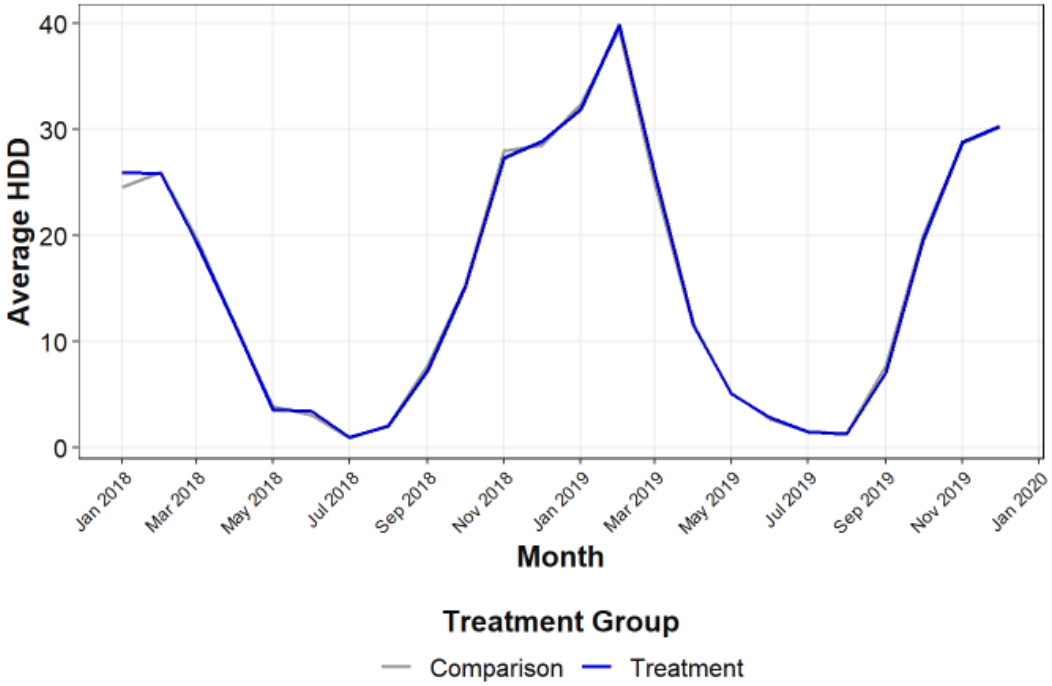
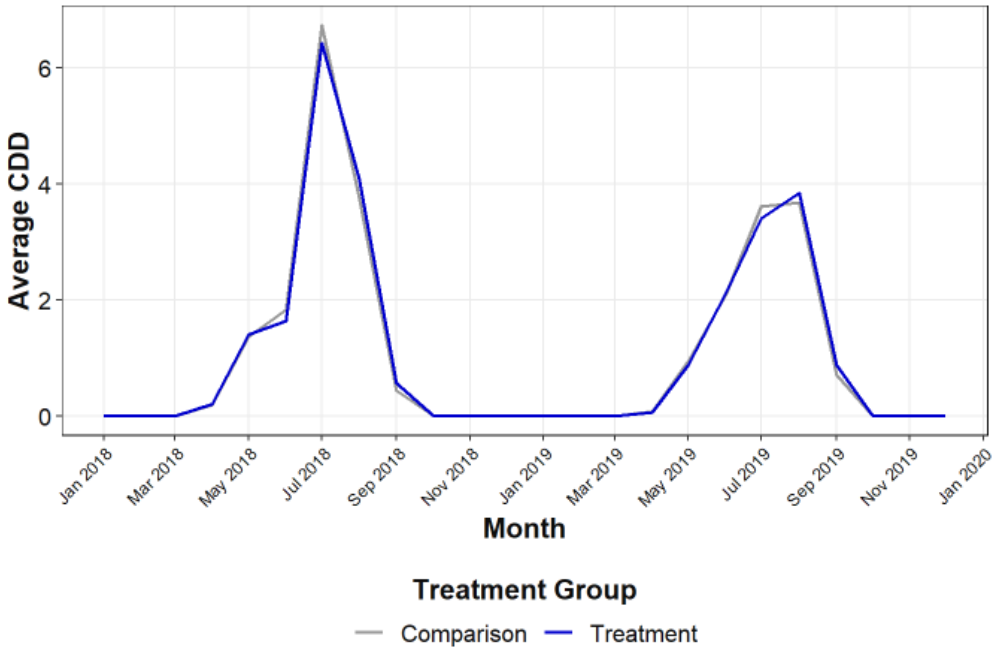


Figure 7. Average CDD Experienced by Treatment and Comparison Groups – 2019 Participants



4.1.5 Modeling Specifications

To estimate savings for the LIWP, Opinion Dynamics specified a LFER model in a pre-/post-design that incorporates weather and interaction terms that show the effect of weather in the post-installation period. The fixed effect for the model is set at the account level, which allows us to control for all household factors that do not vary over time. In the process of determining the appropriate model for the analysis, we specified a range of models from simple pre-post to more complex models incorporating a variety of terms and controls. Notably, we attempted to model 2018 and 2019 participants separately to determine program-year specific energy savings estimates. Due to the small participant population sizes; however, the year-specific models did not result in statistically significant savings estimates.

We judged our final models on several criteria. Primarily, we aimed to use a model that explained as much about changes in the dependent variable as possible. The most direct measure of this is the adjusted R-squared, which gives an estimate of how much the model explains of the difference between post-period usage and the baseline. We also compared Akaike Information Criterion (AIC) values of each model specification within the same sample. The AIC provides a measure of relative quality between models; a lower value indicates a relatively more efficient model. This method inherently incorporates explained variation as well as how many variables we use to achieve that level.

Equation 1 contains final model specification.

Equation 1. Final Model Specification

$$ADC_{it} = B_h + B_1 TreatPost_{it} + B_2 HDD_{it} + B_3 CDD_{it} + B_{4-16} MonthDummies_t + B_{17} TreatPost_{it}{:}\, HDD_{it} + B_{17} TreatPost_{it}{:}\, CDD_{it} + \varepsilon_{it}$$

Where:
ADC_{it} = Average daily consumption (in kWh) for the billing period
$TreatPost$ = Indicator for treatment group in post-installation period (coded "0" in the pre-participation period, coded "1" in post-installation period)
HDD = Average daily heating degree days from NCDC
CDD = Average daily cooling degree days from NCDC
$TreatPost{:}\, HDD$ = Indicator for treatment group in post-installation period (coded "0" in the pre-participation period, coded "1" in post-installation period) interacted with average daily heating days
$TreatPost{:}\, CDD$ = Indicator for treatment group in post-installation period (coded "0" in the pre-participation period, coded "1" in post-installation period) interacted with average daily cooling days
B_h = Average household-specific constant
B_1 = Main program effect (change in ADC associated with being a participant in the post-installation program period)
B_2 = Increment in ADC associated with one-unit increase in HDD
B_3 = Increment in ADC associated with one-unit increase in CDD
B_{4-15} = Increments in ADC associated with each calendar month, excluding January
B_{17} = Change in ADC associated with being a participant in the post-installation program period and having a one-unit increase in HDD.
B_{18} = Change in ADC associated with being a participant in the post-installation program period and having a one-unit increase in CDD.
ε_{it} = Error term

Table 5 details the final model output.

Table 5. Final Model Coefficients

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
hdd	1.83374	0.1207	15.1895	0.0000
cdd	2.08958	0.2931	7.1288	0.0000
month02	-1.23224	0.7710	-1.5983	0.1122
month03	-0.99889	1.0932	-0.9138	0.3624
month04	-3.88767	1.6369	-2.3750	0.0189
month05	-4.19642	2.1081	-1.9906	0.0484
month06	-3.01101	2.1080	-1.4284	0.1554
month07	-2.02426	2.3693	-0.8544	0.3943
month08	-1.07651	2.3118	-0.4657	0.6422
month09	-7.03250	1.9388	-3.6273	0.0004
month10	-8.69377	1.3238	-6.5671	0.0000
month11	-4.50929	0.8299	-5.4336	0.0000
month12	-0.59953	0.8081	-0.7419	0.4594
treat:post	1.74016	1.4568	1.1945	0.2343
treat:post:hdd	-0.28161	0.0903	-3.1173	0.0022
treat:post:cdd	-0.03625	0.2723	-0.1332	0.8943

4.1.6 Savings Estimation

The LFER model results presented in the section above show a statistically significant reduction in electric consumption for all territories. Table 6 shows an estimate of the average daily per-participant savings associated with the Program. These values reflect actual savings under actual weather conditions observed in the post period.

Table 6. Modeled Savings Estimates

Input	Result
Modeled Treatment Participants	117
Average Daily Savings Estimate (kWh)	2.80
Average Daily Modeled Baseline (kWh)	46.57
Standard Error	0.49
t	83.79
P>[t]	-
Adjusted R-squared	0.78
90% Confidence Interval – Lower Bound	1.99
90% Confidence Interval – Upper Bound	3.60

Table 7 shows the average annual baseline consumption per participant, average per household annual savings, and savings as a percentage of baseline consumption for the evaluation period.

Table 7. Estimated Annual Savings from Consumption Analysis

Input	Result
Average Annual Baseline Energy Consumption per Participant (kWh)	16,999
Average per Participant Ex Post Net Annual Savings (kWh)	1,020
Average per Participant Savings Percentage	6%

4.2 Results

We found an average savings of 1,020 kWh per participant per year after Program measures were installed. This represents a reduction of 6% of participants' annual energy usage.

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.[13] The Program achieved 193,887 kWh in energy savings between 2018 and 2019 program years. The net savings realization rate is 58% for the 2018–2019 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
2018	109	182,237	111,230	61%
2019	81	149,617	82,657	55%
Total	**190**	**331,854**	**193,887**	**58%**

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

The net savings estimate of 1,020 kWh per participant derived as part of this evaluation is lower than the savings observed in the previous evaluations. More specifically, per participant energy savings in 2018 and 2019 are 21% lower than the per participant savings derived through the previous evaluation (2016–2017). 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. Naturally occurring energy efficiency trends also tend to change customer energy usage patterns over time. Program tracking data shows that significantly more measures were installed in the past evaluation periods (2013–2015) compared to the 2018–2019 evaluation period.

[13] 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.

5. Analyses of Non-Energy Impacts

5.1 Payment Analysis

We completed an external payment analysis to quantify some non-energy impacts of the program. We compared changes to external assistance payments between program participants and a comparison group over the evaluation period and relied on a difference-in-differences approach. These cost savings serve as non-energy benefit inputs to calculate cost-effectiveness for the Program.

In addition to the external payment data described in the Data Sources, additional data used in the analysis came from the program tracking data. We merged the cost recovery date, which allowed us to determine the pre- and post-participation periods based on when the client received the energy efficient measures. With this data, we calculated the difference in external payments made to participants and the comparison group during pre- and post-periods of participation. The pre-period is the time for which we have data before the cost recovery date and the post-period is the time for which we have data after the cost recovery date. For the comparison group, we estimated the average participation for all participants and used it for every household in the comparison group.

Opinion Dynamics first reviewed the participant and comparison group external payment data provided by Pacific Power. We removed participant and comparison group customers who did not have external payment data available in the data provided. After applying the screening criterion, we were left with 110 participants and 24 comparison group clients out of the original counts of 190 participants and 44 comparison group clients for the payment analysis.

The table below presents the annual change in assistance payments annually and overall for the evaluation period. Assistance payments increased by an average of 6% for Program participants while it decreased by 17% for the comparison group. A net increase in external payments of $9.72 is shown after participation in the program, which is a non-energy impact of 0.

Table 2. Payment Assistance Amounts Summary for Participants and Comparison Group

Year	Participant Group				Comparison Group				Net Difference
	Pre	Post	Change	%Change	Pre	Post	Change	%Change	
2018	$56.84	$22.89	(33.95)	-60%	$56.81	$42.15	$(14.66)	-26%	$19.29
2019	$48.01	$82.64	$34.64	72%	$46.65	$42.56	$(4.09)	-9%	$(38.72)
Total	**$52.42**	**$52.77**	**$0.34**	**6%**	**$ 51.73**	**$ 42.35**	**$(9.37)**	**-17%**	**$(9.72)**

5.2 Economic Impact Assessment

We conducted an economic impact assessment of the Program in operation for the 2018-2019 program years. The economic impact results serve as one set of non-energy impacts used to evaluate the cost-effectiveness of the Program.

We present the RIMS-II results in Table 9. 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 9. Economic Impacts Summary for Pacific Power Washington's LIWP for PY2018-2019

Impact Type	Employment (Job-Years)	Labor Income	Value Added	Output
Total Effect	11.5	$637,614	$394,507	$922,361

To contextualize the results, the model's estimated impacts can be compared to spending. Dividing the output in Table 9 by the total local spending ($2,147,122 in 2019 dollars) estimates that each dollar of program spending on weatherization resulted in $0.43 of total output in the region.

6. Cost-Effectiveness

AEG estimated the cost-effectiveness of PacifiCorp's evaluated savings for the Low Income Weatherization program in the state of Washington based on Program Year (PY) 2018-2019 costs and savings provided by PacifiCorp. The program does not pass any of the cost effectiveness tests with or without Non-Energy Benefits (NEBs).

The following assumptions were utilized in the analysis:

- Avoided Costs: Hourly values provided by PacifiCorp based on the 2017 Integrated Resource Plan (IRP) Preferred Portfolio, converted into annual values using Washington load shapes from the same IRP.
- Modeling Inputs: evaluated measure savings, costs, measure lives, incentive levels, and portfolio costs were based on estimates provided by PacifiCorp.
- Other Economic Assumptions: Discount rate, line loss, retail rate, and inflation rate values were provided by PacifiCorp and are presented in table below.

Tables below summarize cost-effectiveness assumptions for the Low Income Weatherization program. All costs and impacts are presented at the program level.

Table 10: Cost-Effectiveness Analysis Inputs

Parameter	Value
Discount Rate	6.57%
Residential Line Loss	9.67%
Residential Energy Rate ($/kWh)	$0.0872
Inflation Rate[1]	2.20%

Table 11: Low Income Weatherization Annual Program Costs, Nominal - PY2018-2019[14]

Program Year	Program Delivery	Utility Admin	Program Development	Inspection Costs	Incentives	Total Utility Budget	Gross Customer Costs
Low Income Weatherization	$174,772	$41,398	$3,577	$9,103	$1,230,706	$1,459,555	$0
Total Program	$174,772	$41,398	$3,577	$9,103	$1,230,706	$1,459,555	$0

Tables below present the savings and cost-effectiveness results at the program level.

Table 12: 2018-2019 Low Income Weatherization kWh Savings by Program

Program Year	Gross kWh Savings at Site	Realization Rate	Adjusted Gross kWh Savings at Site	Net to Gross Ratio	Net kWh Savings at Site	Measure Life
Low Income Weatherization	349,149	58%	203,442	100%	203,442	27
Total Program	349,149	58%	203,442	100%	203,442	27

Table 13: 2018-2019 Low Income Weatherization Benefit/Cost Ratios by Program

Program Year	PTRC	TRC	UCT	RIM	PCT
Low Income Weatherization with NEBs	0.85	0.84	0.11	0.10	n/a
Low Income Weatherization	0.16	0.14	0.11	0.10	n/a

Table 14: 2018-2019 Low Income Weatherization Program Cost-Effectiveness Results (without NEBs) - (Load Shape - WA_Single_Family_Heat_Pump)

Cost-Effectiveness Test	Levelized $/kWh	NPV Costs	NPV Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	$0.49	$1,426,867	$222,058	($1,204,809)	0.16
Total Resource Cost Test (TRC) No Adder	$0.49	$1,426,867	$201,871	($1,224,996)	0.14
Utility Cost Test (UCT)	$0.49	$1,426,867	$201,871	($1,224,996)	0.14
Participant Cost Test (PCT)		$0	$1,491,873	$1,491,873	n/a
Rate Impact Test (RIM)		$1,715,252	$201,871	($1,513,382)	0.12
Lifecycle Revenue Impacts ($/kWh)					0.00003

Tables below present the NEB impacts for the Low-Income Weatherization program and the cost-effectiveness results including NEBs at the program level.

[14] To align with annual budget expectations, cost-effectiveness inputs are presented in nominal dollars.

Table 15: 2018-2019 Low Income Weatherization NEBs

Non-Energy Benefit	Program Impact	Perspective Adjusted
Home Repair Costs pd by Company	$65,493	PTRC, TRC
Economic Benefit	$922,361	PTRC, TRC
Arrearage	($38,724)	PTRC, TRC, UCT, RIM
Payment Assistance	$46,274	PTRC, TRC
Total	**$995,404**	

Table 16: 2018-2019 Low Income Weatherization Program Cost-Effectiveness Results (Including NEBs) - (Load Shape - WA_Single_Heat_Pump)

Cost-Effectiveness Test	Levelized $/kWh	NPV Costs	NPV Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	$0.49	$1,426,867	$1,217,462	($209,405)	0.85
Total Resource Cost Test (TRC) No Adder	$0.49	$1,426,867	$1,197,274	($229,592)	0.84
Utility Cost Test (UCT)	$0.49	$1,426,867	$163,147	($1,263,720)	0.11
Participant Cost Test (PCT)		$0	$1,491,873	$1,491,873	n/a
Rate Impact Test (RIM)		$1,715,252	$163,147	($1,552,106)	0.10
Lifecycle Revenue Impacts ($/kWh)					0.00003

AEG estimated the cost-effectiveness of PacifiCorp's evaluated savings for the Low Income Weatherization program in the state of Washington based on Program Year (PY) 2018 costs and savings provided by PacifiCorp. The program does not pass any of the cost effectiveness tests with or without Non-Energy Benefits (NEBs).

The following assumptions were utilized in the analysis:

- Avoided Costs: Hourly values provided by PacifiCorp based on the 2017 Integrated Resource Plan (IRP) Preferred Portfolio, converted into annual values using Washington load shapes from the same IRP.
- Modeling Inputs: evaluated measure savings, costs, measure lives, incentive levels, and portfolio costs were based on estimates provided by PacifiCorp.
- Other Economic Assumptions: Discount rate, line loss, retail rate, and inflation rate values were provided by PacifiCorp and are presented in the table below.

Tables below summarize cost-effectiveness assumptions for the Low Income Weatherization program. All costs and impacts are presented at the program level.

Table 17: Cost-Effectiveness Analysis Inputs

Parameter	Value
Discount Rate	6.57%
Residential Line Loss	9.67%
Residential Energy Rate ($/kWh)	$0.0872
Inflation Rate[1]	2.20%

Table 18: Low Income Weatherization Annual Program Costs, Nominal - PY2018[15]

Program Year	Program Delivery	Utility Admin	Program Development	Incentives	Total Utility Budget	Gross Customer Costs
Low Income Weatherization	$113,152	$19,902	$3,212	$789,214	$925,480	$0
Total Program	$113,152	$19,902	$3,212	$789,214	$925,480	$0

Tables below present the savings and cost-effectiveness results at the program level.

Table 19: 2018 Low Income Weatherization kWh Savings by Program

Program Year	Gross kWh Savings at Site	Realization Rate	Adjusted Gross kWh Savings at Site	Net to Gross Ratio	Net kWh Savings at Site	Measure Life
Low Income Weatherization	182,237	61%	111,230	100%	111,230	30
Total Program	182,237	61%	111,230	100%	111,230	30

Table 20: 2018 Low Income Weatherization Benefit/Cost Ratios by Measure Category

Program Year	PTRC	TRC	UCT	RIM	PCT
Low Income Weatherization with NEBs	0.66	0.65	0.09	0.08	n/a
Low Income Weatherization	0.14	0.13	0.09	0.08	n/a

[15] To align with annual budget expectations, cost-effectiveness inputs are presented in nominal dollars.

Table 21: 2018 Low Income Weatherization Program Cost-Effectiveness Results (without NEBs) - (Load Shape - WA_Single_Family_Heat_Pump)

Cost-Effectiveness Test	Levelized $/kWh	NPV Costs	NPV Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	$0.55	$929,323	$132,753	($796,570)	0.14
Total Resource Cost Test (TRC) No Adder	$0.55	$929,323	$120,685	($808,638)	0.13
Utility Cost Test (UCT)	$0.55	$929,323	$120,685	($808,638)	0.13
Participant Cost Test (PCT)		$0	$958,392	$958,392	n/a
Rate Impact Test (RIM)		$1,098,501	$120,685	($977,816)	0.11
Lifecycle Revenue Impacts ($/kWh)					0.00002

Tables below present the NEB impacts for the Low-Income Weatherization program and the cost-effectiveness results including NEBs at the program level.

Table 22: 2018 Low Income Weatherization NEBs

Non-Energy Benefit	Program Impact	Perspective Adjusted
Home Repair Costs pd by Company	$34,869	PTRC, TRC
Economic Benefit	$461,181	PTRC, TRC
Arrearage	($36,288)	PTRC, TRC, UCT, RIM
Payment Assistance	$22,953	PTRC, TRC
Total	**$482,715**	

Table 23: 2018 Low Income Weatherization Program Cost-Effectiveness Results (Including NEBs) - (Load Shape - WA_Single_Heat_Pump)

Cost-Effectiveness Test	Levelized $/kWh	NPV Costs	NPV Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	$0.55	$929,323	$615,468	($313,855)	0.66
Total Resource Cost Test (TRC) No Adder	$0.55	$929,323	$603,399	($325,924)	0.65
Utility Cost Test (UCT)	$0.55	$929,323	$84,397	($844,926)	0.09
Participant Cost Test (PCT)		$0	$958,392	$958,392	n/a
Rate Impact Test (RIM)		$1,098,501	$84,397	($1,014,104)	0.08
Lifecycle Revenue Impacts ($/kWh)					0.00002

AEG estimated the cost-effectiveness of PacifiCorp's evaluated savings for the Low Income Weatherization program in the state of Washington based on Program Year (PY) 2019 costs and savings provided by PacifiCorp. The program does not pass any of the cost effectiveness tests with or without Non-Energy Benefits (NEBs).

The following assumptions were utilized in the analysis:

- Avoided Costs: Hourly values provided by PacifiCorp based on the 2017 Integrated Resource Plan (IRP) Preferred Portfolio, converted into annual values using Washington load shapes from the same IRP.
- Modeling Inputs: evaluated measure savings, costs, measure lives, incentive levels, and portfolio costs were based on estimates provided by PacifiCorp.
- Other Economic Assumptions: Discount rate, line loss, retail rate, and inflation rate values were provided by PacifiCorp and are presented in Table 1 below.

Tables below summarize cost-effectiveness assumptions for the Low Income Weatherization program. All costs and impacts are presented at the program level.

Table 24: Cost-Effectiveness Analysis Inputs

Parameter	Value
Discount Rate	6.57%
Residential Line Loss	9.67%
Residential Energy Rate ($/kWh)	$0.0872
Inflation Rate[1]	2.20%

Table 25: Low Income Weatherization Annual Program Costs, Nominal - PY2019[16]

Program Year	Program Delivery	Utility Admin	Program Development	Inspection Costs	Incentives	Total Utility Budget	Gross Customer Costs
Low Income Weatherization	$61,620	$21,496	$364	$5,260	$441,492	$530,232	$0
Total Program	$61,620	$21,496	$364	$5,260	$441,492	$530,232	$0

Tables below present the savings and cost-effectiveness results at the program level.

Table 26: 2019 Low Income Weatherization kWh Savings by Program

Program Year	Gross kWh Savings at Site	Realization Rate	Adjusted Gross kWh Savings at Site	Net to Gross Ratio	Net kWh Savings at Site	Measure Life
Low Income Weatherization	166,912	55%	92,212	100%	92,212	24
Total Program	166,912	55%	92,212	100%	92,212	24

[16] To align with annual budget expectations, cost-effectiveness inputs are presented in nominal dollars.

Table 27: 2019 Low Income Weatherization Benefit/Cost Ratios by Program

Program Year	PTRC	TRC	UCT	RIM	PCT
Low Income Weatherization with NEBs	1.15	1.13	0.16	0.13	n/a
Low Income Weatherization	0.18	0.16	0.16	0.13	n/a

Table 28: 2019 Low Income Weatherization Program Cost-Effectiveness Results (without NEBs) - (Load Shape - WA_Single_Family_Heat_Pump)

Cost-Effectiveness Test	Levelized $/kWh	NPV Costs	NPV Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	$0.41	$530,232	$95,172	($435,061)	0.18
Total Resource Cost Test (TRC) No Adder	$0.41	$530,232	$86,520	($443,713)	0.16
Utility Cost Test (UCT)	$0.41	$530,232	$86,520	($443,713)	0.16
Participant Cost Test (PCT)		$0	$565,369	$565,369	n/a
Rate Impact Test (RIM)		$654,109	$86,520	($567,590)	0.13
Lifecycle Revenue Impacts ($/kWh)					0.00001

Tables below present the NEB impacts for the Low-Income Weatherization program and the cost-effectiveness results including NEBs at the program level.

Table 29: 2019 Low Income Weatherization NEBs

Non-Energy Benefit	Program Impact	Perspective Adjusted
Home Repair Costs pd by Company	$30,625	PTRC, TRC
Economic Benefit	$461,181	PTRC, TRC
Arrearage	($2,436)	PTRC, TRC, UCT, RIM
Payment Assistance	$23,320	PTRC, TRC
Total	**$512,689**	

Table 30: 2019 Low Income Weatherization Program Cost-Effectiveness Results (Including NEBs) - (Load Shape - WA_Single_Family_Heat_Pump)

Cost-Effectiveness Test	Levelized $/kWh	NPV Costs	NPV Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	$0.41	$530,232	$607,861	$77,629	1.15
Total Resource Cost Test (TRC) No Adder	$0.41	$530,232	$599,209	$68,977	1.13
Utility Cost Test (UCT)	$0.41	$530,232	$84,084	($446,149)	0.16
Participant Cost Test (PCT)		$0	$565,369	$565,369	n/a
Rate Impact Test (RIM)		$654,109	$84,084	($570,026)	0.13
Lifecycle Revenue Impacts ($/kWh)					0.00001

7. Process Evaluation

7.1 Agency Perspective

We conducted a total of three agency interviews in November and December 2022. We spoke with a representative from YNHA, another from NCAC, and lastly, 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. Of all Program participants, 49% received OIC services, 26% received BMAC services, 20% received NCAC services and 5% received services from YNHA.

7.1.1 Yakima Nation Housing Authority (YNHA)

YNHA serves many Pacific Power participants and successfully uses all available Program funds it receives from the utility. YNHA receives funding from Pacific Power along with additional state and federal funding sources to make up the total costs of energy efficiency and weatherization services. YNHA services between 16–20 homes per year with its available funds, 75% of which are Pacific Power customers.

YNHA places customers on a waitlist once they pass income requirements, and their homes are evaluated. The agency prioritizes homes with elderly or disabled residents, children under 18, and a high-energy burden. Customers can expect to be on the waitlist for up to six months after applying. At the time of the staff interview, there were 20 customers on the waitlist. YNHA does not utilize subcontractors to do their work, which assists in keeping project timelines on track.

YNHA noted that supply issues, staffing issues within the agency, and needing outside contractors for specific types of work are the biggest challenges they face in program implementation. As is common with other low income weatherization programs, YNHA noted difficulties servicing homes that needed remedial repairs due to safety. YNHA tries to take advantage of other funds available to them to complete those repairs or refer those participants to other programs.

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

NCAC services between 30 and 40 participants a year, 80% of which are Pacific Power participants. NCAC receives funding from Pacific Power along with additional state and federal funding sources to make up the total costs of energy efficiency and weatherization services.

NCAC does maintain a waitlist of applicants waiting for services, which included six participants at the time of writing, but there were no customers waiting for approval to the Program at the time of writing. NCAC tries to service applicants as soon as they apply, and projects usually are completed between six to nine months from application to project completion.

NCAC weatherization staff conveyed a few challenges related to Program implementation. Specifically, NCAC only has one contractor, who it shares with other agencies in the area, and has struggled to recruit other contractors to do the work due to the administrative work involved with federal and state funding. NCAC also noted they defer participants who do not meet eligibility requirements or when they need to address maintenance and repair issues such as unsafe wiring, leaky roofs, and plumbing. Once customers remedy these issues, NCAC staff can provide low income weatherization services.

7.1.3 Blue Mountain Action Council (BMAC)

BMAC serves many Pacific Power participants and successfully uses all available Program funds it receives from the utility. BMAC receives funding from Pacific Power along with additional state and federal funding sources to make up the total costs of energy efficiency and weatherization services. BMAC services between 20–30 homes per year with its available funds, 70% of which are Pacific Power customers.

BMAC had roughly 30 participants on the waitlist at the time of writing, 50%–70% of waitlisted participants were Pacific Power customers and projected four to six months for project completion due to contractor availability. 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.

BMAC indicated that issues with subcontractor availability, material availability, and material pricing are their largest challenges for implementation. All these factors 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 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 2018 and 2019 with a telephone survey. Of the 190 participants who participated in 2018-2019, we had valid phone numbers for 184. A total of 31 participants completed telephone interviews, yielding a response rate of 31% and cooperation rate of 59%.[17] (see Table 31). Surveys were fielded in both English and Spanish.

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

Table 31. Washington Participant Telephone Survey

Population Frame	Unique Telephone Numbers	Final Survey Responses	Survey Response Rate	Survey Cooperation Rate
190	184	31	31%	59%

The call center attempted to reach participants multiple times. Table 32 lists the survey disposition categories.

Table 32. Participant Survey Disposition

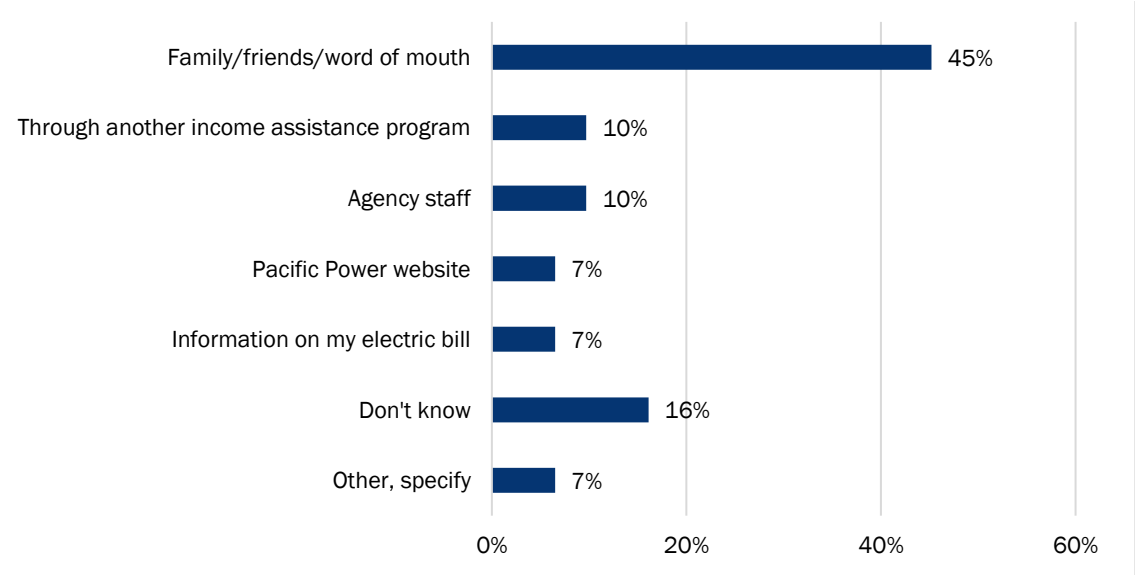
Survey Disposition	Sample
Completed	**31**
Disconnected Phone	56
Answering Machine	45
Initial Refusal	12
Wrong Number	10
No Answer	9
Callback	7
Language Barrier	4
Call Block	4
Do Not Call List	3
Screened Out	2
Fax	1
Total	**184**

We used this survey to collect data about participant household characteristics and Program experience. Approximately 74% of responded (n=23) resided in single family or manufactured homes and 19% lived in mobile homes (n=6). A total of 84% (n=26) owned their homes while the remaining 16% rented their residences.

7.2.1 Program Awareness

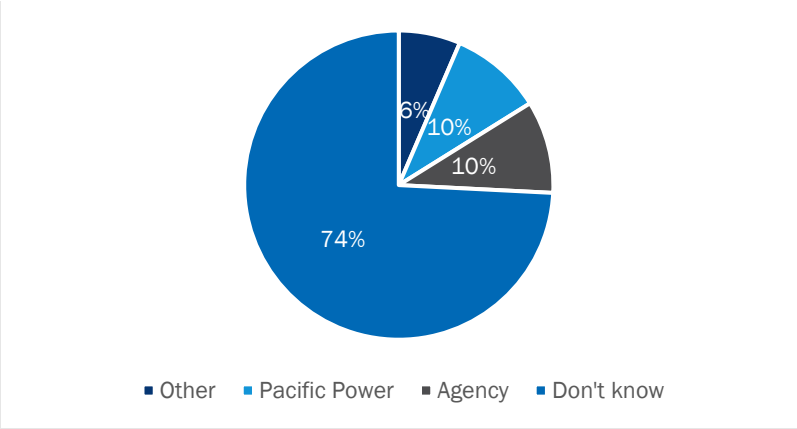
Participants were asked how they heard about the Program. Figure 8 shows that close to half heard about the Program by word of mouth from family, friends, and neighbors (45%). This source of awareness continues to be the predominant source for most customers since a similar proportion of participants noted friends, family, and neighbors were the main way they heard about the Program during the previous evaluation period. About 10% of participants learned about the Program from agency staff and an additional 10% learned about the program from another income assistance program.

Figure 8. How Participants Learned of the Program (n=31)



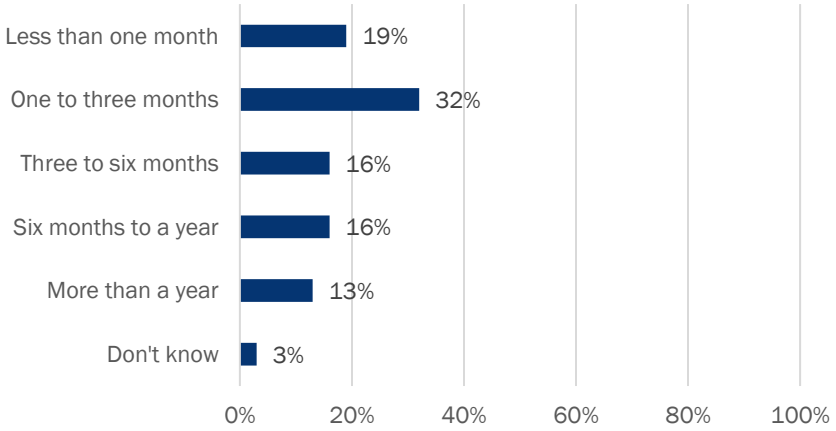
Historically, Pacific Power participants have had difficulty identifying Pacific Power as a funding source of the Program. As Figure 9 shows, 74% of participants could not identify a funding source and about one-third of those who could associated the Program with the implementing agency rather than Pacific Power. Ten percent of participants correctly identified Pacific Power as a funding source.

Figure 9. Participant Awareness of Program Funding Sources (n=31)



Just over half of surveyed participants (51%) reported receiving weatherization services within three months of submitting their application.

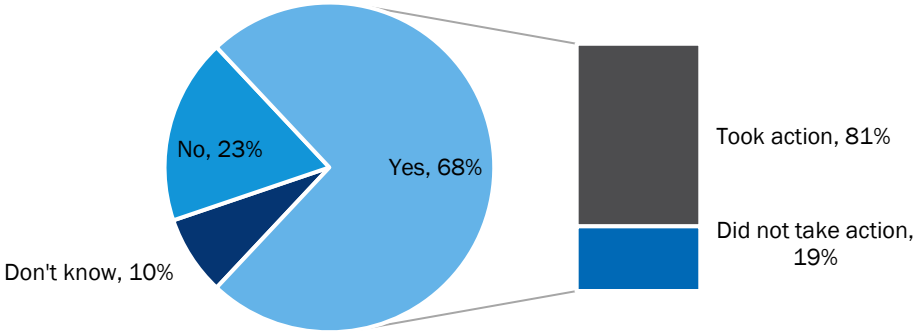
Figure 10. Time between Application Process to Receiving Weatherization Services (n=31)



7.2.2 Energy Education

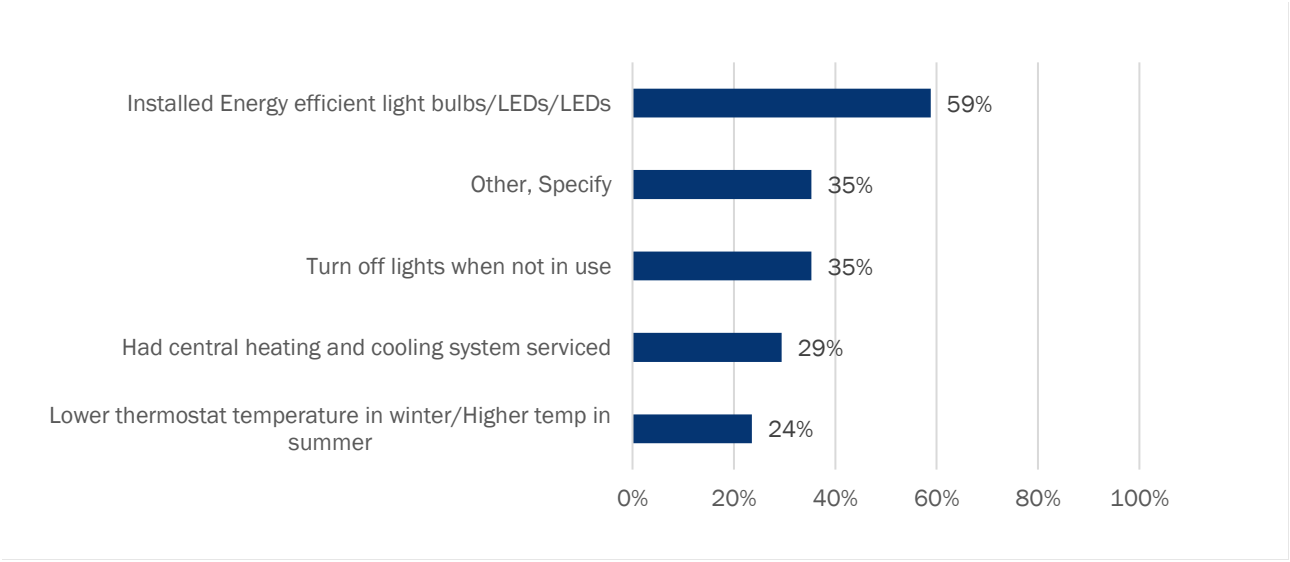
The Program does not offer energy education formally; however, Figure 11 shows approximately 68% of survey respondents learned about ways to save energy from the agency staff. Of those, 81%, (n=17 of 21) reported taking some recommended energy saving actions. Half of the participants who had not acted on recommendations received stated they intended to in the future (n=2 of 4). The opportunity to present energy saving recommendations during audits or measure installations has had a positive impact on Program participants.

Figure 11. Weatherization Staff Provided Information on Ways to Save Energy in the Home (n=31)



There were 17 participants who reported taking energy saving actions after receiving information during the weatherization project. Figure 12 lists the top five energy actions taken by participants. Other actions included changing or closing blinds and cutting back on laundry.

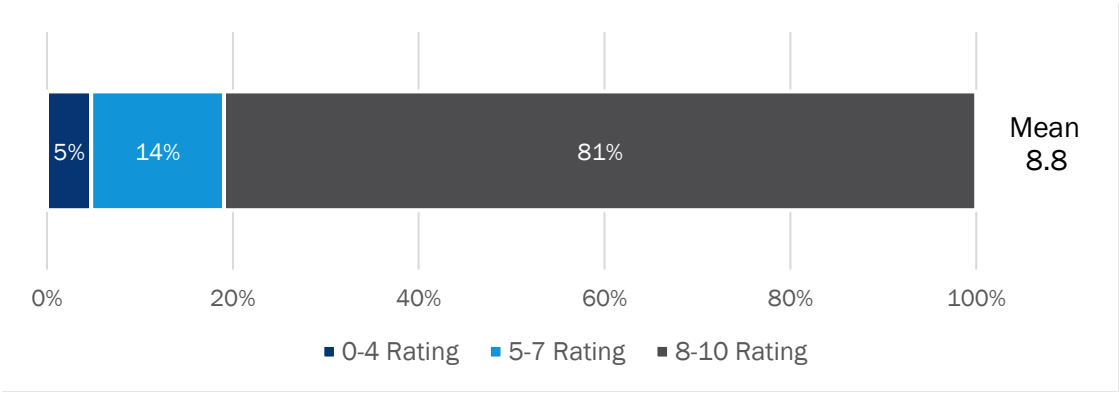
Figure 12. Top Five Energy Actions Taken (n=17)



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 Eighty-one percent of respondents indicated the education they received was "extremely helpful" (Figure 13).

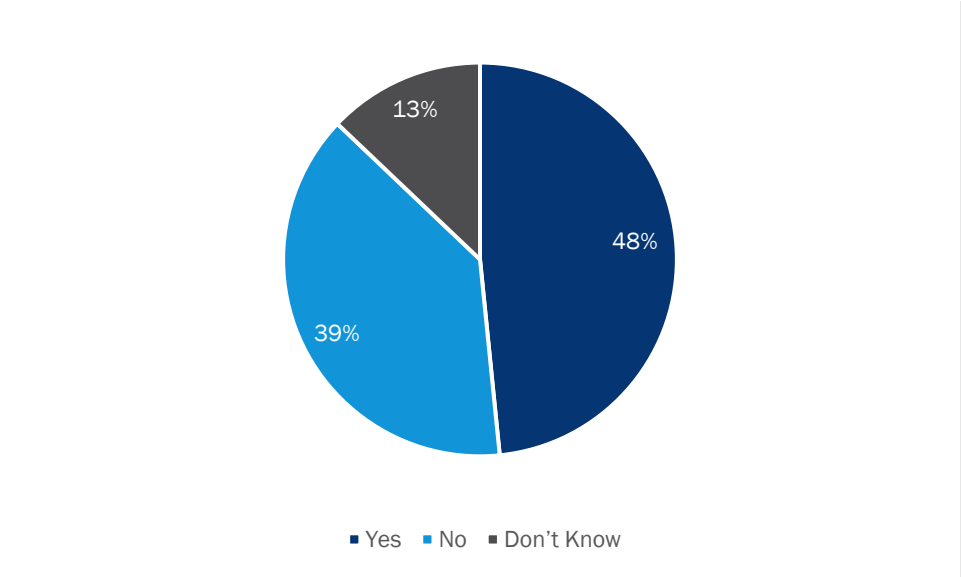
Figure 13. Helpfulness of Energy Education (n=21)



Note: 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, the weatherization staff discussed ways to improve health and safety in the home according to 48% percent of respondents (Figure 14).

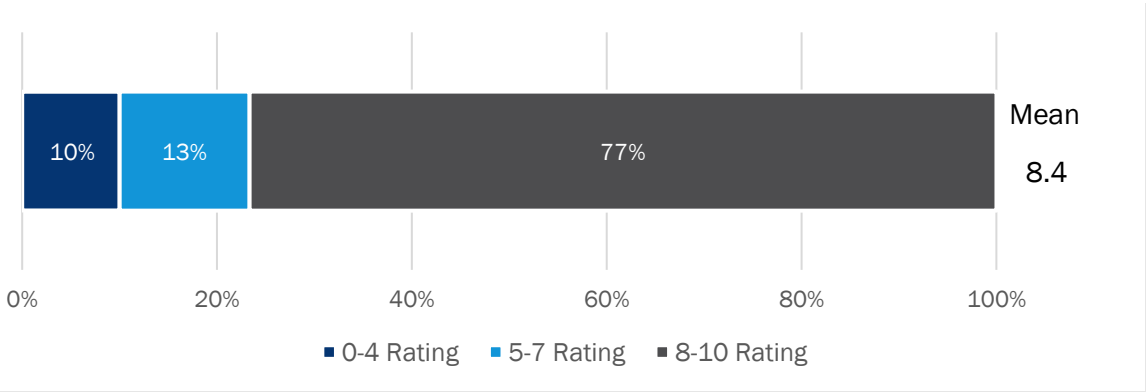
Figure 14. Ways to Improve Health and Safety in the Home (n=31)



7.2.3 Program Delivery and Satisfaction

Participant feedback was positive and three in four participants were "completely satisfied" with the Program (Figure 15). Some of the positive comments received are listed in Table 33. There were seven participants who were not completely satisfied with the Program (score of 7 or lower) and the most cited reason was related to communication with agency staff. Of these seven respondents, two saw no change in their electric bill, and one noted their electric bill was higher following the Program. We list the verbatim responses as to why these participants were not completely satisfied in Table 33 as well.

Figure 15. Program Satisfaction (n=31)



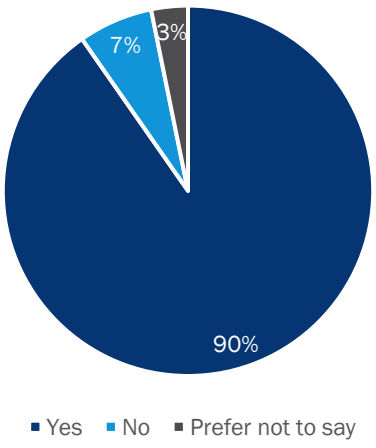
Note: Scale from 0 to 10 where 0 is "Completely Dissatisfied" and 10 is "Completely Satisfied"

Table 33. Program Comments from Surveyed Participants

Sample of Verbatim Reponses of Participants who rated Program Satisfaction greater than 7
It was very complete and the people who came into my home were very nice and focused.
Everything turned out well. The personnel was respectful and they did a good job.
Customer services, the professionalism, the courtesy, the overall experience!
Because they have given me help every time I have asked.
It made the house airtight. It stays nice and warm in here.
They did everything they said they would do, and it didn't take them too long.
Because my heat bill has dropped over 100 dollars. That is helpful for our savings.
Because they showed up when they told us they would arrive, and they did a good job.
All Verbatim Reponses of Participants who rated Program Satisfaction less than or equal to 7
I don't have insulation in my trailer, and for a week I didn't have water. I was with my son. I left many messages and no one responded.
In 2013, we put the application in. They noticed the wiring was bad and we changed all the electrical wires. Then we waited for years and tried to reapply. When they came, the job they did was incorrect.
Because my electrical bill went up considerably over the last few years after I went with the program. I realize that there are circumstances that happen for that, but they don't make sense.
They don't attend (to) the people well.
We have a few cold spots in the flooring in our home and the company that does the repairs left the outside pretty messy. I tried to repair it. They came out and tried to repair it. They hit some wires where they drilled and tried to blow insulation in.
They no longer do windows.
I just expected more than what had happened.

Regardless, most participants are satisfied with the Program and 90% said they would recommend it to others (Figure 16).

Figure 16. Recommend Program to Family and Friends (n=31)



Reflecting high program satisfaction, a majority of respondents (61% n=19) had no suggestions for improving the Program. Among those who did provide suggestions (n=12), participants most often requested more

communication from Program staff (n=2), follow-through on work (n=4), and expansion of the Program to include more people (n=2). Table 34 includes some verbatim suggestions from survey respondents.

Table 34. Program Improvement Recommendations from Surveyed Participants

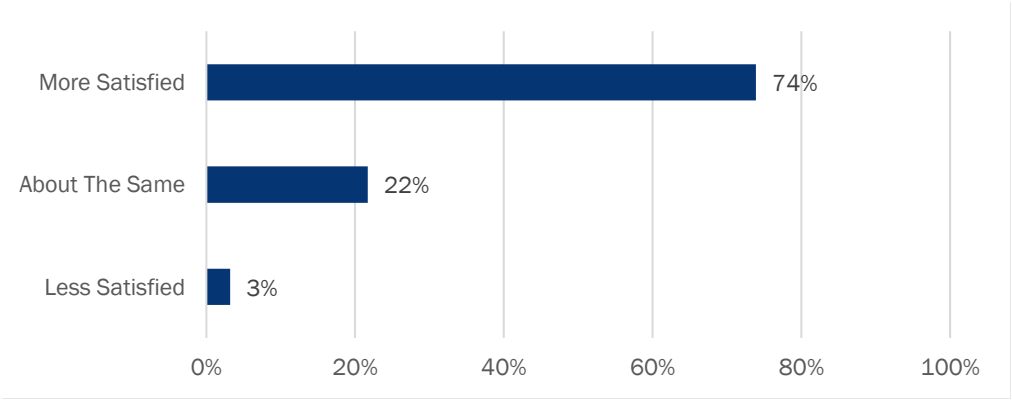
Participant Recommendations for Program Improvements	
Follow-Through	The workers should take more time to get the work done. For example, they just work for a little while one day and come back the next day only to do just a little more.
	The people doing the work pay better attention. Choose the right sheen paint.
	More education for people. The work done as well. Bring in more professions who know what they are doing.
	I guess make a better result on the bottom line on the electrical bill. Make it reduce the amount on the electrical bill.
Communication	Put insulation in and answer when needed.
	Interactions between the people doing the work and the homeowner needs to be addressed. The one gentleman was competent and really nice, but the other was not.
Expansion	To change the income so more people can participate.
	Getting more money so more families can have more opportunities to participate in this program.

Participants were pleased with the application process, with 74% stating the process was “extremely easy.” Further, all participants were very pleased with the weatherization staff with virtually all (97%) stating “Yes” when asked if the agency staff was courteous and respectful towards them and their family members.

7.2.4 Impact of Program

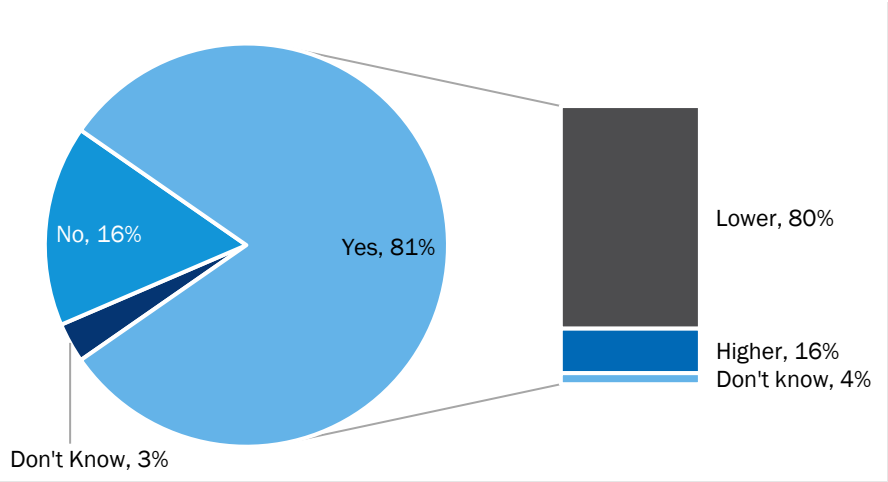
There were 23 participants who recalled receiving LED bulbs through the Program. Of those, three-quarters (n=17 out of 23) reported higher levels of satisfaction with the LEDs than their previous lighting as Figure 17 shows. We inquired as to whether the LEDs remained installed in the homes and found about 22% of participants have removed at least some of the LEDs installed through the Program, as opposed to the 50% who removed their CFLs in past program years.

Figure 17. Satisfaction with LEDs (n=23)



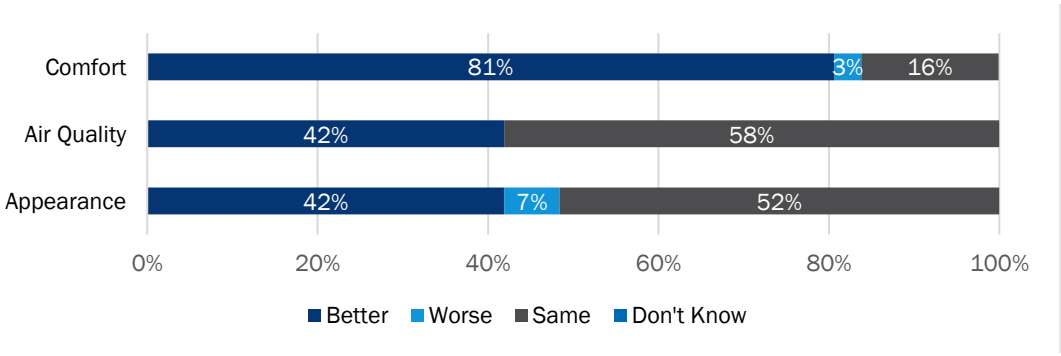
Participants were asked in the survey if they noticed a change in their electric bill after receiving weatherization services and four in five participants reported they did. Of this set of participants, 80% said their bills were lower and 16% said their bills rose (see Figure 18).

Figure 18. Change Noticed in Electric Bill (n=31)



We also explored non-energy impacts. In the telephone survey, we asked Program participants if the air quality, appearance, and comfort of their homes improved, stayed the same, or got worse after they participated. As Figure 19 shows, 81% of participants reported an improvement in home comfort. Air quality and appearance of the home were better for 42% of participants as well. This provides further evidence of the positive impact of the Program beyond energy saving benefits.

Figure 19. Impact of Measures on Home Characteristics (n=31)



8. Conclusions and Recommendations

- Pacific Power is adhering to best practices by delivering the Program through community-based agencies. 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. **We recommend Pacific Power continue to use the same Program implementers moving forward**.

- We estimated the ex-post net energy savings equal to 1,020 kWh per participant using a consumption analysis approach. The savings per participant is lower than previous program cycles. We believe this lower estimate stems from a difference in the measure mix installed in low income homes and changes in occupancy of treated homes. On average, participants saved 6% of their annual electric usage.
- Participants continue to be highly satisfied with the Program, the application process, energy education, and agency staff. The Program provides energy conservation recommendations that induce savings due to behavioral changes as well as measure savings. Most participants recalled this education, found it extremely helpful, and many took some of the recommended actions. This education may be contributing to the energy savings per participant. There is some level of dissatisfaction with the contractors' professionalism in the home and a lack of energy savings after project completion. Among those who did provide suggestions to improve the program (n=12), participants most often requested more communication from Program staff (n=2), follow-through on work (n=4), and expansion of the Program to include more people (n=2). Given this feedback, **we recommend a process for follow-up with Program participants**. Agency staff could complete a final checklist or walk-through with participants or provide an online form for participants to complete on an as-needed basis.
- The weatherization agencies reported challenges with Program implementation due to supply-chain issues, material pricing, staffing issues, and needing outside contractors for specific types of work. Some of these issues are unique economic factors all industries are experiencing post-COVID but some issues could be overcome with additional funding. Further, the Program faces an issue commonly found in low income weatherization programs throughout the country: overcoming the structural barriers to installing weatherization measures. Agencies reported that they defer participants who need to address safety issues prior to weatherization. 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. Blending funding from other sources could help overcome this barrier to participation. Additional funding for this Program may become available through the new Bipartisan Infrastructure Law through 2027. We recommend that **Pacific Power consider proactive ways to access the new infrastructure funding and layer those funds onto existing funding.**

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