



Opinion **Dynamics**

Boston | Headquarters

617 492 1400 tel
617 497 7944 fax
800 966 1254 toll free

1000 Winter St
Waltham, MA 02451



PacifiCorp Utah Low Income Weatherization

Program Evaluation for Program Years 2018–2019

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Table of Contents

- 1. Executive Summary 1
 - 1.1** Impact Results 1
 - 1.2** Process Results 2
 - 1.3** Cost-Effectiveness Results..... 3
 - 1.4** Recommendations 3
- 2. Introduction 5
 - 2.1** Program Implementation 6
 - 2.2** Evaluation Objectives 7
- 3. Data Sources 8
 - 3.1** Program Tracking Data..... 8
 - 3.2** Agency Interviews and Participant Survey Data 8
 - 3.3** Other Data Sources 8
- 4. Impact Evaluation 9
 - 4.1** Methodology 9
 - 4.2** Results 9
- 5. Process Evaluation..... 11
 - 5.1** Agency Perspective..... 11
 - 5.2** Participant Perspective 12
 - 5.2.1 Program Awareness..... 13
 - 5.2.2 Energy Education 15
 - 5.2.3 Program Delivery and Satisfaction 17
 - 5.2.4 Non-Energy Benefits 20
- 6. Cost Effectiveness..... 22
- 7. Conclusions and Recommendations 26
- Appendix A. Impact Analysis Details 28
 - A.1. LED Light Bulbs..... 28
 - A.2 Furnace Fan 28
 - A.3 Refrigerator Replacement..... 29
 - A.4 Ceiling Insulation 30
 - A.5 Duct Sealing & Insulation..... 31

A.6	Wall Insulation	32
A.7	Cooling System Tune-Up	34
A.8	Faucet Aerator	34
A.9	Windows	35

Table of Acronyms

Acronyms	Meaning
ARRA	American Recovery and Reinvestment Act
CFL	Compact Fluorescent Light Bulb
HCD	Utah Department of Workforce Services, Housing and Community Development Division
kWh	Kilowatt-hour
LIHEAP	Low Income Home Energy Assistance Program
PCT	Participant Cost Test
PTRC	PacifiCorp Total Resource Cost Test
RIM	Ratepayer Impact Measure Test
SIR	Savings-to-Investment Ratio
TRC	Total Resource Cost
TRM	Technical Reference Manual
UCT	Utility Cost Test
USDHHS	United States Department of Health & Human Services
USDOE, DOE	United States Department of Energy
WAP	Weatherization Assistance Program

1. Executive Summary

Opinion Dynamics presents its evaluation findings for the Rocky Mountain Power Low Income Weatherization Program (referred to as the “Program” throughout this report) in operation in the state of Utah during the 2018 and 2019 program years. We performed both an impact and process evaluation and results from both are presented in the report.

Rocky Mountain Power provides funding on energy efficiency measures installed in the homes of eligible residential customers through a partnership with the Utah Department of Workforce Services, Housing and Community Development Division (HCD). HCD receives state and federal government grants that are then used by several non-profit weatherization agencies to provide energy efficiency services targeted towards weatherization of existing single-family, multi-family, and manufactured homes in all territory served by Rocky Mountain Power in the state of Utah. “Low Income” qualifications are determined by HCD. Government grants are leveraged with Rocky Mountain Power funding so the energy efficiency measures installed in the homes of eligible households are installed at no cost to them. Because agencies rely on government grants in addition to funds from Rocky Mountain Power, the full cost of weatherizing customers’ homes is not incurred by Rocky Mountain Power.

Opinion Dynamics conducted this evaluation of the Program on behalf of Rocky Mountain Power with the following objectives in mind: (1) document and measure effects of the Program (energy and non-energy); and (2) identify areas of potential improvement. To quantify energy savings, we conducted a deemed savings review of current ex-ante savings assumptions. This included reviewing existing program assumptions, and researching other algorithms and savings assumptions based on Technical Reference Manuals (TRMs), studies, and other secondary sources as applicable.¹ We also conducted a process evaluation based on a program materials review, an in-depth interview with HCD agency staff, and customer responses to a telephone survey. The telephone survey asked about customer satisfaction with the Program and implementing agencies, program participation barriers and bottlenecks, best practices, and any opportunities for improvement. This report also includes the cost-effectiveness analysis conducted by a third-party consultant, AEG.

1.1 Impact Results

For the impact evaluation, we verified Program participation through participant telephone surveys. We completed surveys with 79 of the 540 Rocky Mountain Power customers who participated in 2018 through 2019. All surveyed participants (n=79) verified they participated in the Program and received measures.

We conducted a deemed savings review to estimate the ex-post energy savings from the Program. The results show the average annual net energy savings per participant for the 2018–2019 program years was 936 kWh. In Table 1, we present the ex-post net savings for each program year and in total. Overall, the Program achieved 109% of its ex-ante gross savings for the evaluation period.

¹ See Appendix A for a complete list of all assumptions and sources for TRMs and other documents.

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	245	204,235	221,428	108%
2019	295	259,176	284,068	110%
Total	540	463,411	505,496	109%

Note: For this low-income program, the net-to-gross ratio is assumed to equal 1 and therefore gross savings are equal to net savings.

Approximately 98% of the ex-post savings come from LED lighting, furnace fans, and refrigerator replacements. We describe the impact evaluation in more detail in the sections below and document all ex-post algorithms and assumptions in Appendix A.

1.2 Process Results

The process evaluation examined Program operations from multiple perspectives. Rocky Mountain Power and HCD have worked together for several years to deliver the Program. Over this time, HCD and its subcontracting agencies have developed expertise in implementing the Program using multiple funding mechanisms. Combining the funds from Rocky Mountain Power with those from government organizations allows the Program to reach more utility customers and demonstrates a best practice in low-income energy efficiency program delivery.² 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.

HCD maintains a waitlist of customers who are eligible and approved to receive weatherization services. A customer cannot be placed on the waitlist until an energy audit has been completed and the home has been approved to receive services. HCD uses a point-system to determine where customers are positioned on its list, with households including young, disabled, and elderly residents receiving more points than other households. HCD indicated they observe a wait time of 9–12 months until an eligible and approved applicant receives services while survey findings show that 75% of customers received weatherization services within 6 months of submitting an application. HCD mentioned that the wait time of 9–12 months goes down during summer months and goes up in times of economic downturn. HCD noted that supply chain issues and staffing issues have been an issue since the housing boom occurred in late 2018 as demand for supplies and personnel for construction projects has increased.

HCD did not mention any major challenges during the evaluation period and noted that implementation of the program has only gotten more difficult in the last two years as demand for construction supplies and personnel has increased. One difficulty mentioned was a transition by an agency from an outside contractor-reliant organization to a crew-based organization. Finding personnel and training staff to conduct the installations and auditing was a challenge.

The Program is meeting customer needs well. Participants continue to be highly satisfied with the Program. Nine of every ten participants reported “complete satisfaction” with the Program and virtually all participants agreed that weatherization staff were courteous and respectful towards their homes.

² 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.

While energy education is not a formal part of the Program and is offered through outreach and education to promoting the efficient use of electricity, agency staff speak to Program participants about ways to save energy in the home. Coupling informal 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 that may further reduce their energy costs. It is also considered a best practice of energy efficiency programs designed to serve low-income customers.³ Three out of every four surveyed participants recall this education and of those, 93% took recommended actions. The most common actions taken include turning off lights when not in use and installing energy efficient light bulbs. On a scale from 0 to 10 where 0 means “not at all helpful” and 10 means “extremely helpful,” three out of four surveyed participants rated the helpfulness of the energy education at an 8 or higher, with an average rating equal to 8.3. Over half of participants recalled receiving ways to improve health and safety in the home. While energy, health, and safety education are not a formal part of the Program, the information that is provided remains beneficial for participants.

In the telephone survey, we asked participants if the air quality, appearance, and comfort improved, stayed the same, or worsened after they received services. Based on responses given during the telephone survey, 75% of participants reported an improvement in home comfort. Air quality and appearance of the home were also better for 60% and 41% of participants, respectively. This provides further evidence of the positive impact of the Program beyond energy saving benefits.

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 Utah based on Program Year (PY) 2018-2019 costs and savings provided by PacifiCorp. The program passes the PacifiCorp Total Resource Cost Test (PTRC), Total Resource Cost Test (TRC), and Utility Cost Test (UCT).

Table 2: 2018-2019 Low Income Weatherization Program Cost-Effectiveness Results (without NEBs) - (Load Shape - UT_Single_Family_Cooling)

Cost-Effectiveness Test	Levelized \$/kWh	NPV Costs	NPV Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.02	\$133,486	\$363,628	\$230,142	2.72
Total Resource Cost Test (TRC) No Adder	\$0.02	\$133,486	\$330,571	\$197,085	2.48
Utility Cost Test (UCT)	\$0.02	\$133,486	\$330,571	\$197,085	2.48
Participant Cost Test (PCT)		\$0	\$721,606	\$721,606	n/a
Rate Impact Test (RIM)		\$762,079	\$330,571	(\$431,508)	0.43
Lifecycle Revenue Impacts (\$/kWh)					0.00000

1.4 Recommendations

Based on the evaluation results, we recommend the following:

³ 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.

- **Update unit energy savings (UES) values for individual measures for this program based on the values provided in Appendix A.**
 - Impact evaluation results show strong energy savings; participants saved an average of 936 kWh per year. Approximately 98% of the ex-post savings came from LED lighting, furnace fans, and refrigerator replacements. We evaluated and updated the UES per measure and provide updated values for use in ex-ante estimates in Appendix A.
- **Rocky Mountain Power should continue to use the same Program implementer moving forward.**
 - Rocky Mountain Power is adhering to best practices by delivering the Program via HCD. HCD has spent many years serving as a Program implementer on behalf of Rocky Mountain Power by subcontracting with multiple non-profit agencies in Utah to provide weatherization services to qualified homes. It is customary practice for utilities to work with one or more 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, HCD is knowledgeable about combining funding from utilities with government funding to expand the reach of programs. The implementing agency demonstrates its understanding of Program processes, requirements, and funding mechanisms. Leveraging these types of agencies is a best practice in low-income weatherization programs.
- **Consider a process for following-up with participants.** While almost all surveyed participants were satisfied with the program, some provided feedback about ways the Program could better serve households. The most common area of improvement mentioned by surveyed participants involved incomplete weatherization services. Several participants recommended a check-up on services that were provided to verify they were completed properly. Two other participants mentioned a desire for all work that had been discussed to be completed. 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 they may provide an online form for participants to complete on an as-needed basis.
- **Rocky Mountain Power should consider proactive ways to access the new infrastructure funding and layer those funds onto existing funding.** HCD noted that overcoming the reasons for deferral has been a big focus by HCD and their partner non-profit agencies in recent years. Most reasons for deferral are due to unsafe or inaccessible conditions in the home. HCD and the agencies have the ability to utilize other programs and funds to complete some rehab steps, like structural repairs, to overcome certain deferral cases. Since most agencies already operate other programs in their communities, they can complete those steps needed before weatherization can be completed or refer the customer to other programs. Further additional funding for this Program may become available through the new Bipartisan Infrastructure Law through 2027.

2. Introduction

Rocky Mountain Power’s Low Income Weatherization Program (the “Program”) provides energy efficiency measures to eligible residential customers through a partnership with the Utah Department of Workforce Services, HCD. HCD subcontracts with the following non-profit agencies to install energy efficiency measures in the homes of income-eligible households:

- Bear River Association of Governments
- Salt Lake Community Action Program
- Housing Authority of Utah County
- Six County Association of Governments
- Five County Association of Governments
- Uintah Basin Association of Governments
- Southeastern Utah Association of Local Governments
- Mountainland Association of Governments

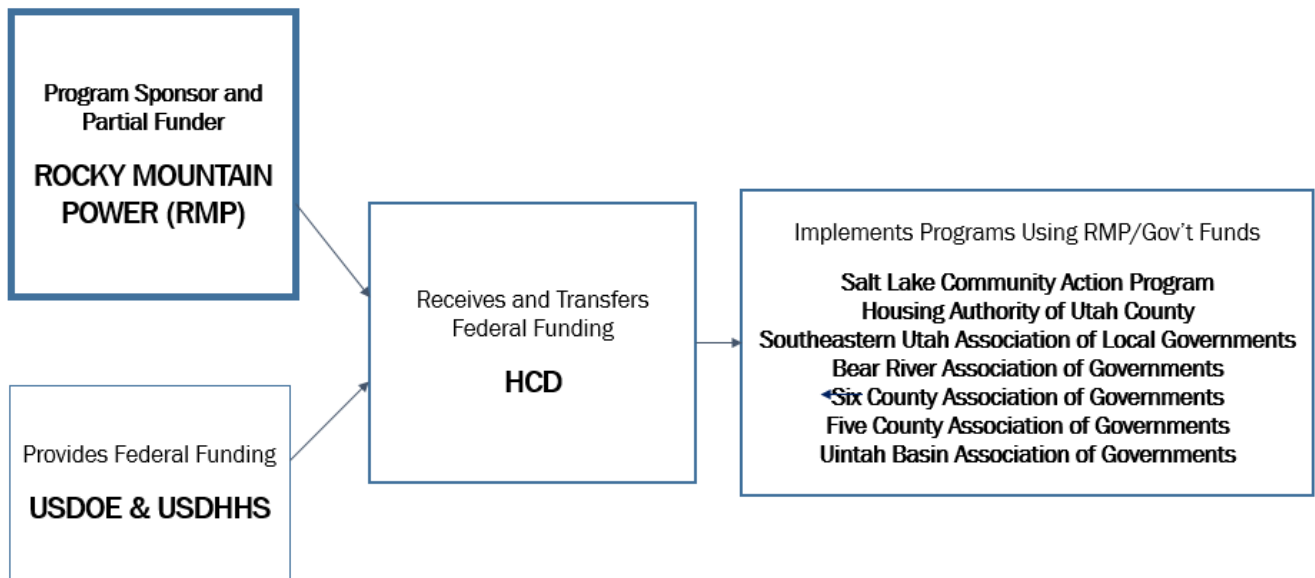
The agencies serve different counties covered by Rocky Mountain Power’s Utah service territory using funds from the utility as well as governmental funding sources.⁴

The Program operates by reimbursing agencies for 50% of the installed cost of measures for Rocky Mountain Power customers. Agencies are also reimbursed for administrative costs based on 10% of Rocky Mountain Power’s 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). HCD administers the federal government funds to the implementing agencies and monitors completed weatherization projects.

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 Rocky Mountain Power’s Program in Figure 1.

⁴ State of Utah, Workforce Services. “Public Programs and Resources.” Housing and Community Development. Updated January 30, 2023. <https://jobs.utah.gov/housing/scso/index.html>. Program names and counties served by the non-profit agencies are provided on the State of Utah’s Workforce Services website.

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



2.1 Program Implementation

Program implementation involves the following steps, which are detailed in the 2018 Utah Energy Efficiency and Peak Reduction Annual Report:⁵

- income verification based on HCD guidelines to ensure participants qualify for program participation,
- energy audit using a DOE-approved tool to determine eligible measures (audit results must indicate a savings to investment ratio [SIR] of 1.0 or greater)
- installation of eligible measures,
- post-inspections of all projects, and
- billing notification from HCD to Rocky Mountain Power Company within 60 days of job completion, which must be accompanied by a homeowner agreement, invoice form with installed measures, and associated cost for each completed home.

The Program is available to income-eligible residential customers in existing single-family, multi-family, and manufactured homes served by Rocky Mountain Power Company in the state of Utah. Duplexes and fourplexes are eligible if low-income tenants occupy at least one-half of the building. Other multifamily properties are also eligible if low-income tenants occupy at least 66% of the units. Income eligibility is determined according HCD.

Energy conservation measures broadly fall into two categories: “major” and “supplemental.” Major measures include floor, wall, and ceiling insulation and window replacement, applicable in dwellings with permanently installed operable electric space heating systems that heat at least 51% of the home. Beginning in April 19, 2019, ceiling and wall insulation also become available in homes with central air conditioning or evaporative

⁵ State of Utah, Workforce Services. “Public Programs and Resources.” Housing and Community Development. Updated January 30, 2023. <https://jobs.utah.gov/housing/scso/index.html>. Program names and counties served by the non-profit agencies care provided on the State of Utah’s Workforce Services website.

coolers. Supplemental measures requiring an electric heat system include, but are not limited to, weather stripping, attic ventilation, ground cover, timed thermostats, and thermal doors. Supplemental measures that do not require an electric heating system include low-flow showerheads, faucet aerators, and pipe insulation, which all require an electric water heater, and LEDs, furnace fans, and refrigerators.

2.2 Evaluation Objectives

Below we list the objectives of our evaluation of the Rocky Mountain 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)
- Provide data to support Program cost-effectiveness assessments (impact)
- Identify areas of potential improvement (impact and process)
- Document compliance with regulatory requirements (process)
- Survey participants and Program 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, 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 for program years 2018 through 2019 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. 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 Agency Interviews and Participant Survey Data

Primary data collection activities included an in-depth interview with staff at HCD and a participant telephone survey. The agency interview helped inform our review of Program operations 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.

3.3 Other Data Sources

We requested all sources for ex-ante assumptions and reviewed all received files. These included the Utah Technical Reference Library (TRL) file and several previous evaluations. In addition, we submitted several measure-specific questions via email to the Rocky Mountain Power Program Manager and received some clarifying answers.

The documents provided by the Program were not entirely sufficient to document all ex-ante calculations as described above in our recommendation, and we therefore relied on several additional sources to perform our ex-post analysis and update ex-ante savings values. For example, we did not have capacities of heating and cooling equipment, pre- and post-intervention R values of insulation or square footage of installed insulation or baseline refrigerator test results. For the additional resources, we attempted to use Utah-specific values to the extent possible. We list these resources below at a high-level and provide additional details on each source in Appendix A.

- ASHRAE Fundamentals 2017
- ENERGY STAR®
- Lawrence Berkeley National Labs
- National Renewable Energy Labs
- Residential Energy Consumption Survey (RECS), 2015 data
- Focus on Energy Evaluated Deemed Savings Changes, November 2014
- Technical Reference Manuals
 - Illinois TRM V10.0
- Utah participant survey conducted by Opinion Dynamics

4. Impact Evaluation

A total of 540 customers participated in the Program during the 2018–2019 Program years. In the participant telephone survey, we asked respondents whether they recall someone coming to their home to provide weatherization services and perform energy efficiency upgrades. All survey respondents (n=79) confirmed their participation and receipt of services. A list of the various measures installed from the most common, LED light bulbs, to the least common, windows, is presented in Table 3. Other common measures include furnace fans as well as refrigerator replacements.

Table 3. Utah Participation Counts and Measures for Program Years 2018 through 2019

Measures	2018	2019	Total	Percent
Total # of Homes Treated	245	295	540	100%
LED Light Bulbs	210	272	482	89%
Furnace Fans	86	117	203	38%
Refrigerator Replacements	47	54	101	19%
Ceiling Insulation	0	21	21	4%
Duct Sealing & Insulation	1	8	9	2%
Wall Insulation	0	6	6	1%
AC Tune-Up	0	2	2	0.4%
Faucet Aerators	0	1	1	0.2%
Windows	0	1	1	0.2%

4.1 Methodology

We performed an engineering review of ex-ante documentation and developed revised assumptions for the ex-post analysis. We requested, but did not receive, home-specific information such as square footages of installed insulation, pre- and post-intervention R-values, and heating/cooling characteristics of each home. In the absence of these data, we developed average savings assumptions at the measure level (e.g., LEDs, refrigerator, furnace fan) based on other TRMs and similar programs in other jurisdictions. We customized the savings assumptions and inputs to Utah as much as possible. We estimated program-level savings by multiplying the per-measure average savings by the total number of units installed for each type of measure according to the Program tracking database.

We leveraged data from the Utah participant survey to develop installation rates for the lighting measure (LEDs) and applied this installation rate (96%) to the deemed ex-post lighting savings. For all non-lighting measures, we assumed an installation rate of 100%.

Appendix A documents all ex-post equations, assumptions, and sources in detail.

4.2 Results

In Table 4, we present the annual ex-ante and ex-post net energy savings for the Program. The overall net savings realization rate is 109% for the 2018–2019 program years and the average annual net energy savings per participant was 936 kWh. Measures such as ceiling insulation, wall insulation, duct sealing and insulation, and windows are available to participants (if electric space heating system is designed to heat at least 51% of

the home), therefore we weighted ex-post savings to account for the percentage of homes with electric heating, which had an overall impact to program level realization rates.

Table 4. 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	245	204,235	221,428	108%
2019	295	259,176	284,068	110%
Total	540	463,411	505,496	109%

Note: For this low-income program the net-to-gross ratio is assumed to equal 1 and therefore gross savings are equal to net savings.

In Table 5, we present ex-post savings by measure type and the percent of contribution to the overall program ex-post savings.

Table 5. Ex-Post Net Savings by Measure

Measure	Quantity		Quantity Unit of Measure	Ex-Post Net Savings		Percent of Total Ex-Post Savings
	2018	2019		2018	2019	
LED	3,516	4,242	Bulbs	132,498	159,857	58%
Furnace Fan	88	118	Fans	61,777	82,838	29%
Refrigerators	47	54	Refrigerators	26,592	30,553	11%
Duct Sealing & Insulation	1	9	Participants	560	5,039	1%
Ceiling Insulation	0	21	Participants	0	2,047	0.4%
Wall Insulation	0	6	Participants	0	1,849	0.4%
Faucet Aerator	0	14	Aerators	0	1,594	0.3%
AC Tune-Up	0	2	Systems	0	278	0.1%
Windows	0	1	Windows	0	13	0.002%
Total	3,652	4,467		221,428	284,068	100%

Note: Percentage of total savings may not sum to 100% due to rounding.

5. Process Evaluation

We present both the implementation agency and participant perspectives on the Program in this section.

5.1 Agency Perspective

We interviewed the Director from HCD in October 2022. HCD subcontracts with multiple non-profit agencies that support HCD low-income weatherization projects on behalf of Rocky Mountain Power. We spoke with the Director to gain a deeper understanding of the Program’s operations, how funds from multiple sources are used to service customers, and any key areas of improvement that could be made to the Program. We present HCD’s perspective on topics we addressed during the interview in Table 6.

Table 6. Agency Feedback

Topic	Feedback
Balance of Funding	HCD leverages Rocky Mountain Power funds to supplement funding from government sources (Department of Energy Weatherization Program and Low Income Home Energy Assistance Program [LIHEAP]) to increase the number of homes weatherized per year. The Utah weatherization agencies expend federal funds to install the measures. After services are provided, HCD receives reimbursement funds from Rocky Mountain Power, which are then reinvested in the Program and used to weatherize additional homes.
Waitlist Process	<p>The customer waitlist is maintained at the subgrantee agency level for the service area the agency covers. The HCD director estimated that 80% of customers on the waitlist are referred from the federal programs mentioned above while the other 20% come from agency outreach. A customer is placed on the waitlist after they are qualified based on their income and, per DOE statute, if their home has not been weatherized in the last 15 years. A customer’s position on the waitlist is determined by a priority point system; households with the most points appear at the top of the waitlist. By federal statute, agencies provide preferential status (through an increase in points allocated) to households with elderly, disabled, young children (preschool age and younger), high energy users, and customers with a high energy burden.</p> <p>Customers at the top of the waitlist are called first and a home energy audit is completed. Once services are received, the agency removes them from the list. A participant may reapply to the program if they wait 15 years until their current home is eligible for weatherization or move into a new home has not been weatherized in 15 years.</p> <p>HCD indicated they observe a wait time of 9–12 months until an eligible and approved applicant receives services, while survey findings show that 75% of customers received weatherization services within six months of applying. HCD mentioned that the wait time of 9–12 months goes down during summer months and goes up in times of economic downturn.</p> <p>HCD noted that supply chain issues and staffing issues have been an issue since the housing boom occurred in late 2018 as demand for supplies and personnel for construction projects has increased.</p>
Current Waitlist	At the time of the interview, HCD was unable to provide the number of customers currently on the waitlist as it is held at the individual agency level, not at the state-wide level.
Challenges and Barriers	HCD did not mention any major challenges during the evaluation period and noted that implementation of the Program has only gotten more difficult in the last two years as demand for construction supplies and personnel has increased. One difficulty the HCD Director mentioned was a transition by an agency from an outside contractor-reliant organization to a crew-based organization. Finding personnel and training staff to conduct the installations and auditing was a challenge.

Topic	Feedback
	HCD noted that overcoming the reasons for deferral has been a big focus by HCD and the agencies in recent years. Most reasons for deferral are due to unsafe or inaccessible conditions in the home; HCD and the agencies can utilize other programs and funds to complete some rehabilitation steps, like structural repairs, to overcome certain deferral cases. Since most agencies already operate other programs in their communities, they can easily complete those steps needed before weatherization can be completed or refer the customer to other programs.
Marketing and Outreach	Throughout the weatherization process, HCD works with the households to identify savings opportunities in their households. Energy education is customized to the household, and auditors identify customer education opportunities in multiple areas. When applicable, implementation staff provide pamphlets and publications from various organizations, such as Rocky Mountain Power newsletters related to energy savings, pamphlets from the EPA on mold and lead, and brochures on indoor air quality through ASHRAE. In addition to hands-on energy education, HCD created educational videos about electric space heat, simple thermostats, HVAC filters, etc., and is looking to expand on those aspects of educational content.

5.2 Participant Perspective

The evaluation team attempted to reach a quota of 70 customers who participated in the Program in 2018 and 2019. Of the customers who participated in 2018-2019, we had valid phone numbers for 506. A total of 79 participants completed telephone interviews, yielding a response rate of 22%, a cooperation rate of 53%,⁶ and a relative precision of 16% (Table 7).

Table 7. Utah Customer Telephone Survey

Unique Telephone Numbers	Final Survey Responses	Survey Response Rate	Survey Cooperation Rate	Precision
506	79	23%	53%	16%

The call center attempted to reach participants multiple times. Table 8 lists the survey disposition categories.

⁶ Response rate is calculated using American Association for Public Opinion Research (AAPOR) Response Rate 3.

Table 8. Participant Survey Disposition

Survey Disposition	Sample
Complete	79
Answering Machine	210
Disconnected	102
Refused	47
Callback	20
Wrong Number	11
Call Blocked	9
No Answer	8
Busy	6
Screen-Out	4
Business Number	3
Do Not Call	3
Fax	2
Language Barrier	2

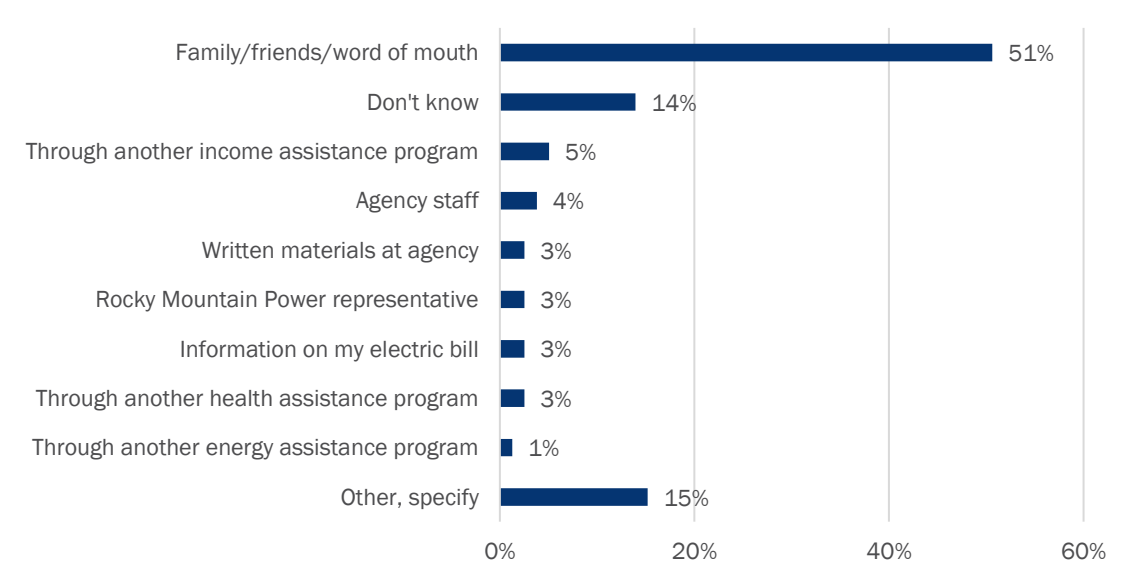
We used this survey to collect data about participant household characteristics and Program experience. Based on demographic data, approximately 84% of surveyed participants (n=66) reported residing in single-family homes, 13% reported living in mobile/manufactured homes (n=10), and 1% reported living in an apartment/condominium (n=1). A total of 96% of respondents (n=76) own their homes and 7% (n=2) rent their residences. One participant reported they live in a home owned by their son.

5.2.1 Program Awareness

Participants were asked how they heard about the Program. Figure 2 shows that just over half of respondents (51%) heard about the Program by word of mouth from family, friends, and neighbors. This source of awareness continues as 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.⁷ About 5% of participants learned about the Program through another income assistance program.

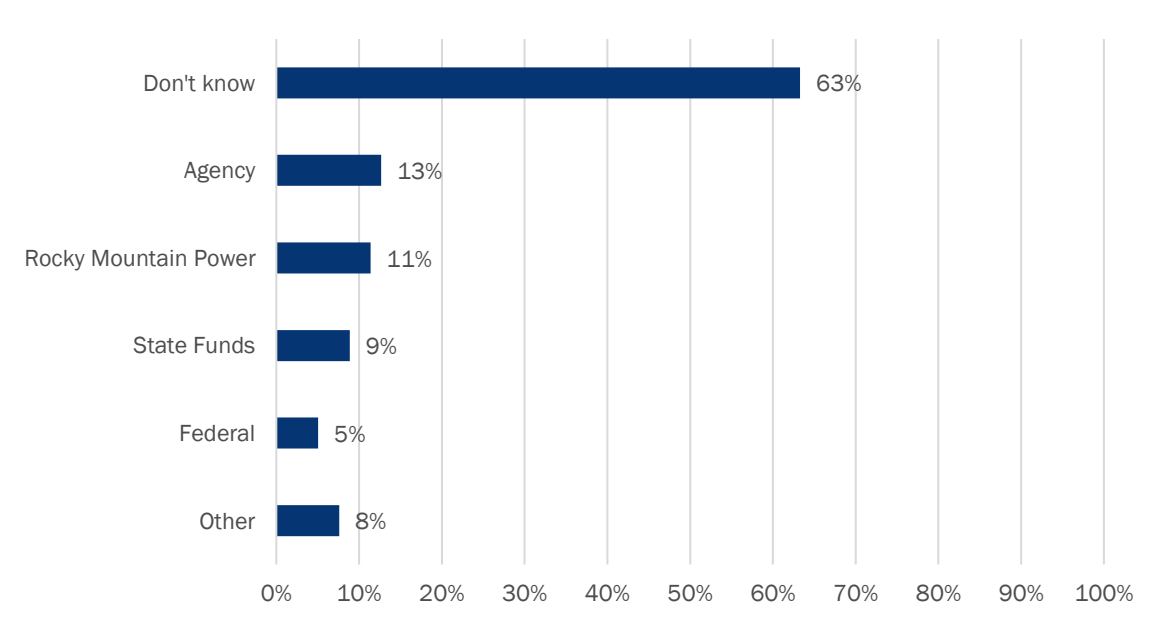
⁷ Smith & Lehmann Consulting and H. Gil Peach & Associates, *Utah Low-Income Weatherization Program Evaluation Report for Program Years 2010-2012*, Prepared for Rocky Mountain Power Company. October 29, 2014, page 27.

Figure 2. How Participants Learned of the Program (n=79)



Historically, Rocky Mountain customers have had difficulty identifying Rocky Mountain Power as a funding source of the Program. Only 11% identified Rocky Mountain Power as a funding source for the services received. While this is an increase from the previous evaluation period, ability to identify Rocky Mountain Power as a funding source remains low. As Figure 3 shows, over half of customers could not identify a funding source and those who could often associated the Program with the implementing agency and not Rocky Mountain Power.

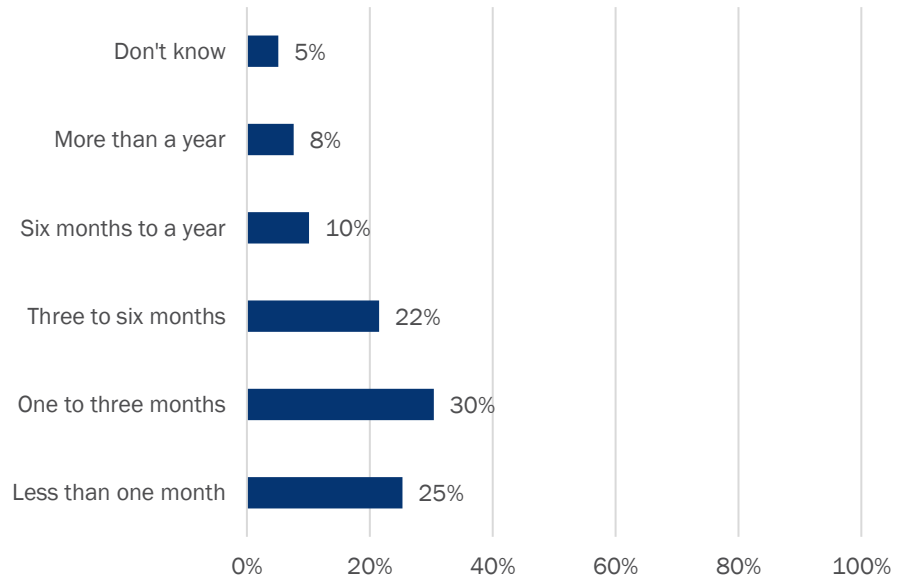
Figure 3. Participant Awareness of Program Funding Sources (n=79)



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

One quarter of surveyed participants (25%) reported waiting less than one month after applying for weatherization services and 30% reported waiting one to three months (Figure 4). This finding shows a decrease in wait time between completing the application process and receiving weatherization services as compared to the previous evaluation period.

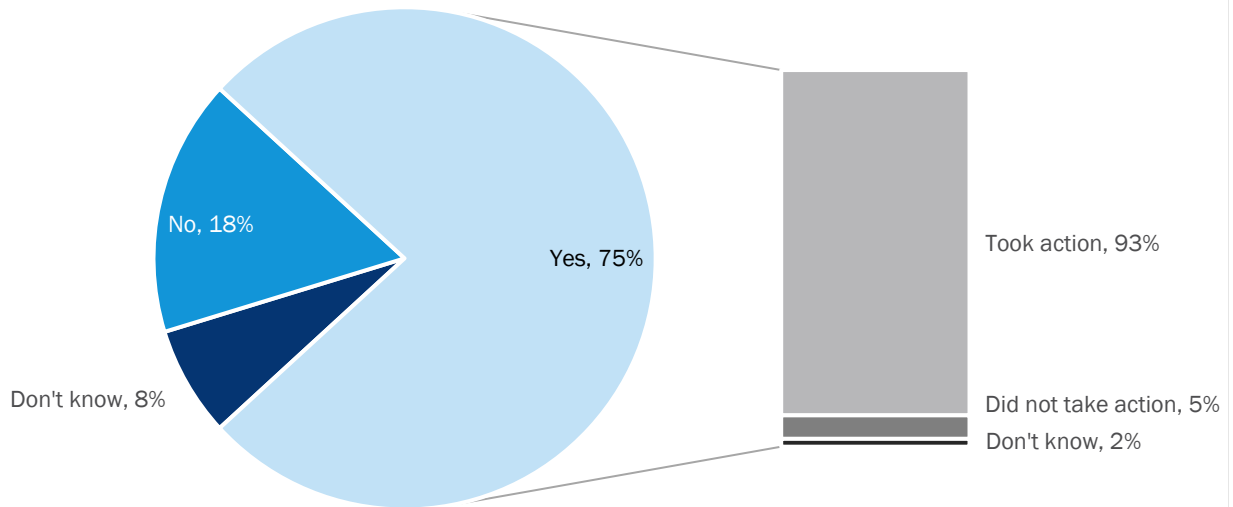
Figure 4. Time between Application Process to Receiving Weatherization Services (n=79)



5.2.2 Energy Education

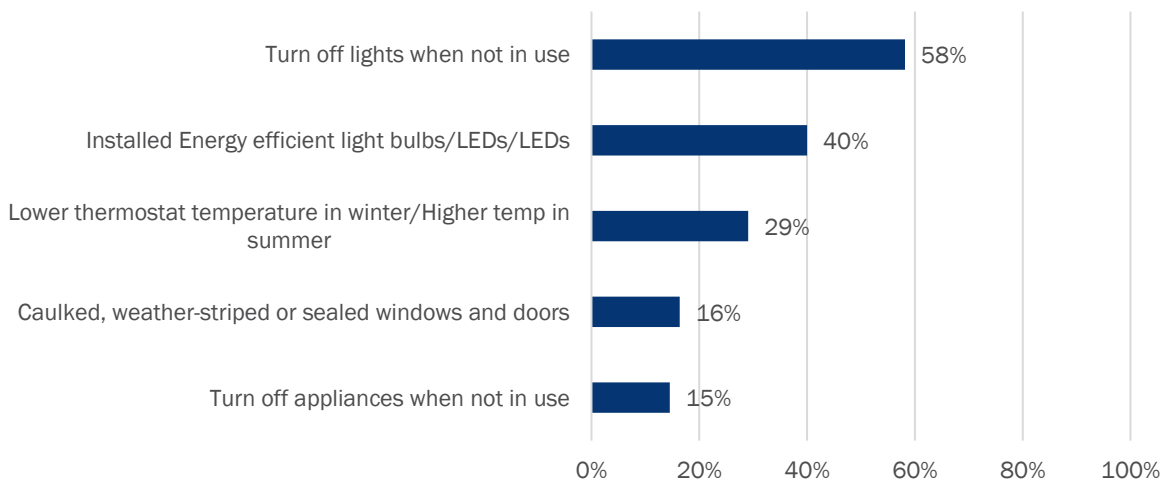
The Program offers customized customer energy education by providing information on ways to save energy beyond the direct-install measures. Figure 5 shows three in four survey respondents learned about ways to save energy from agency staff. Of those, 93%, (n=55 of 59) reported taking some recommended energy saving actions. Of the participants who had not acted on recommendations received (n=3), all stated they intended to in the future. The opportunity to present energy saving recommendations during audits or measure installations has had a positive impact on customers and likely has led to behavioral changes that enhance the energy savings coming from the Program.

Figure 5. Weatherization Staff Provided information on Ways to Save Energy in the Home (n=79)



There were 55 participants who reported taking energy saving actions following the information received when they received weatherization services. Figure 6 lists the top five energy actions taken by participants. The two most common actions relate to lighting.

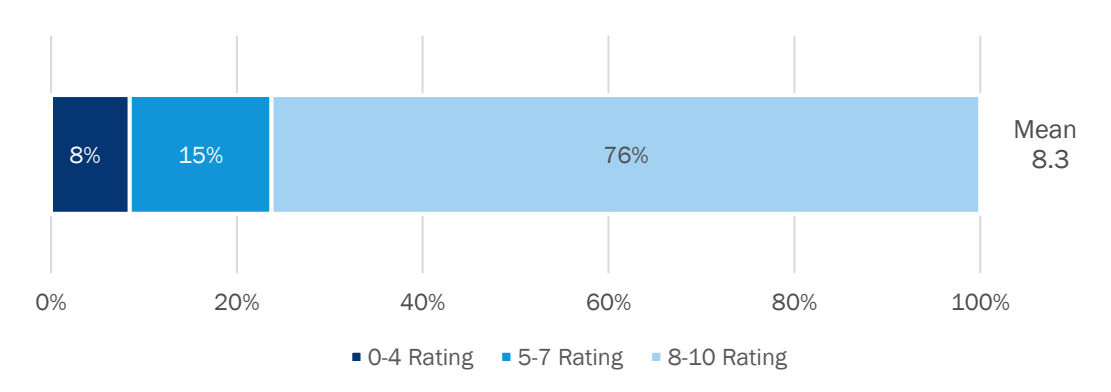
Figure 6. Top Five Energy Actions Taken (n=55)



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 7).

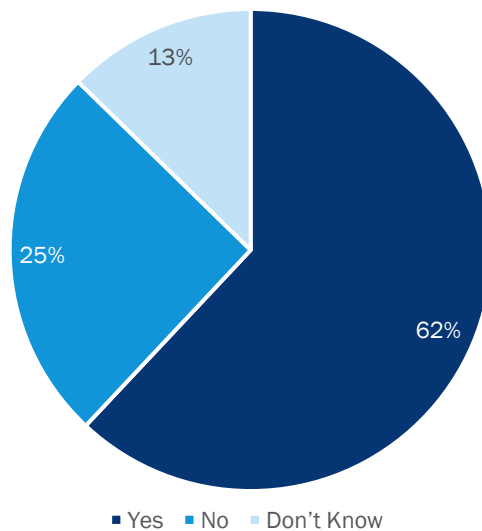
Figure 7. Helpfulness of Energy Education (n=59)



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, 62% of participants indicated weatherization staff discussed ways to improve health and safety in the home (Figure 8). These results show the additional efforts made by the agencies to improve home conditions as they implement the Program to Rocky Mountain Power customers.

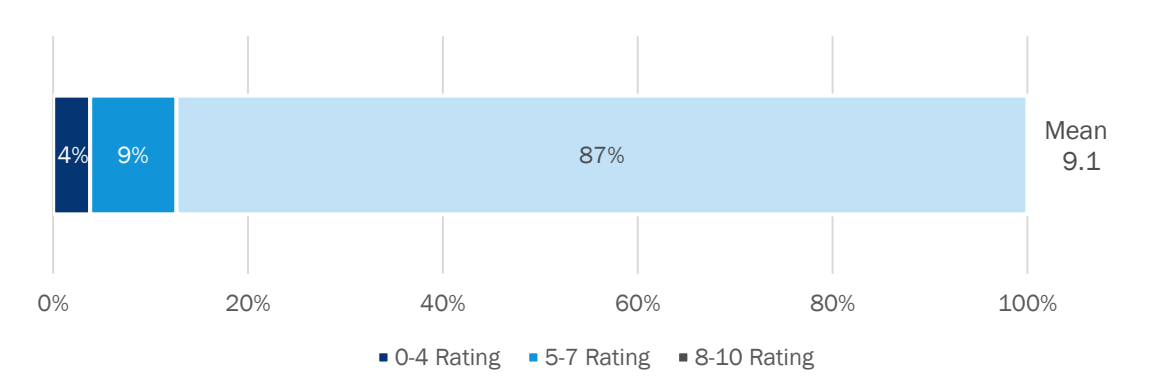
Figure 8. Staff Discussed Ways to Improve Health and Safety in the Home (n=79)



5.2.3 Program Delivery and Satisfaction

Participant feedback was extremely positive as 87% participants were “Completely Satisfied” with the Program (Figure 9). There were ten participants who reported not being completely satisfied with the Program (score of 7 or lower) and the reasons most cited were related to measures not working correctly. We list the verbatim responses as to why these customers were not completely satisfied in Table 9.

Figure 9. Program Satisfaction (n=79)



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

Table 9. Program Dissatisfaction Comments from Surveyed Participants

Verbatim Responses of Participants Who Rated Program Satisfaction Less Than or Equal to 7
[The agency staff] installed my window, but it did not help. It was a better-quality window, but they left gaps and didn't caulk it well. I did get a new furnace, but the wiring ran right by my water.
[The agency staff] didn't finish. The guys installed the windows crooked and the sliding glass door doesn't seal.
I wasn't very satisfied.
I haven't seen the effectiveness on the utility bills. We expected to see a bigger difference.
I got 24 big panels. When I get them turned on I will be very satisfied. They never turned it on. They said they will be here on the 10th. I'd recommend it to anyone who is going green.
Not all of the items originally discussed were completed, and communication was challenging throughout the process.
I see daylight around the front door.
The wait time from the application to the acceptance.
[The agency staff] didn't really take action in fixing the weather stripping around my back door. They wouldn't replace my screen on my window. Someone from the work crew took medicine from my medicine cabinet without asking.
The windows still let in cold air. They don't seem to be the best for weatherization.

Of the respondents who were not completely satisfied with the Program, just under half (n=4 of 10) stated they saw no change in their electric bill. Regardless, almost all surveyed participants (78 of 79) said they would recommend the Program to others.

Reflecting high program satisfaction, just above half of respondents (58%, n=46) had no suggestions for improving the Program. Among those who did provide suggestions (n=33), participants most often requested follow-up or follow-through on services provided (n=8). Respondents also noted the Program would benefit from expanding the availability of the Program (n=6). Table 10 includes some verbatim suggestions from survey respondents.

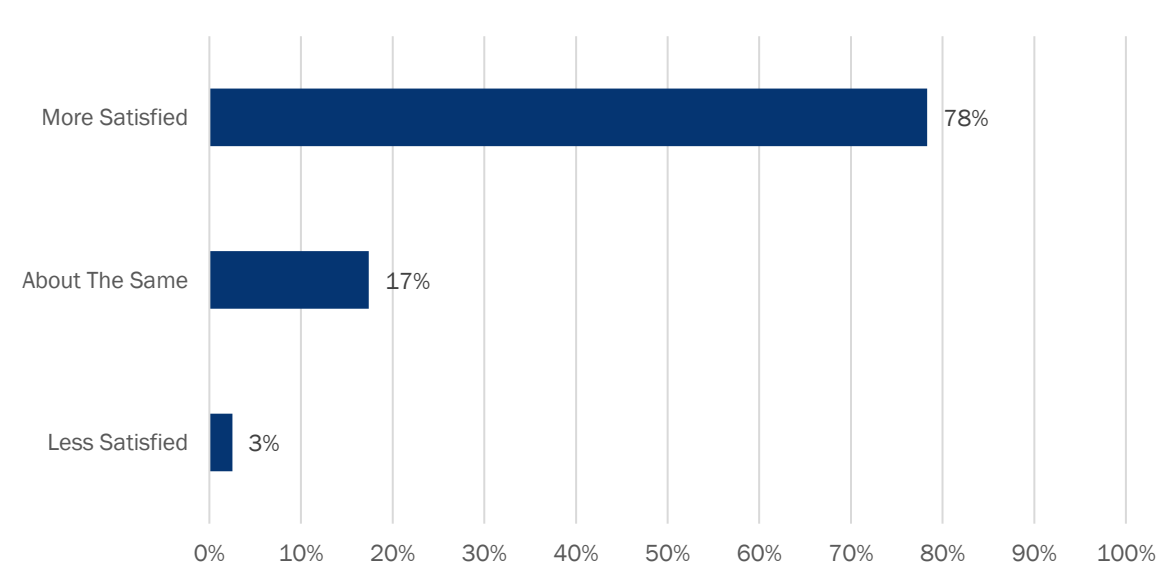
Table 10. Recommendations to Improve the Program

Participant Recommendations for Program Improvements	
Follow-up	Check if the windows are sealed
	Finish doing what they said they would do. The windows need [to be] done.
	Follow through on the original items discussed. Give referrals to other programs.
	[The agency staff] only fixed one window, when all of them were in the same shape. They only did half the work.
	Make sure they have a checklist and look around the house to see if there are other things needing to be addressed.
Expand Availability	Expand the program to more families.
	I wish the eligibility was higher.
	Lower the scales so everyone can benefit from the program that have older homes in need of repairs. Everyone is experiencing financial hardship. People could benefit from the program.
Marketing	Letting people know their services are available.
	Better advertising as far as the website and information in regard to the services provided.
	Not too many people know about it. For me, it was surprising the program was there. They should have more flyers so more people know about it.

A majority of participants were pleased with the application process, with 76% stating the process was “Extremely Easy.” The one respondent who reported difficulty with the application (i.e., rated application difficulty between 0 and 4 where 0 means “Extremely Difficult”) noted that the office had moved at the time of their appointment, and they weren’t informed of all of the materials they needed to bring to the appointment. Further, all participants were very pleased with the weatherization staff with virtually all (99%) stating “Yes” when asked if the agency staff was courteous and respectful towards them and their family members.

Of the 76 customers who were flagged as receiving LED bulbs through the Program, 70 participants recalled receiving them through the Program and 45 participants verified the number of bulbs installed. Of those 45 participants, 78% reported higher levels of satisfaction with the LEDs than their previous lighting, shown in Figure 10. The two customers not satisfied with the new lighting both reported none of the bulbs had been removed since installation. We inquired as to whether the LEDs 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.

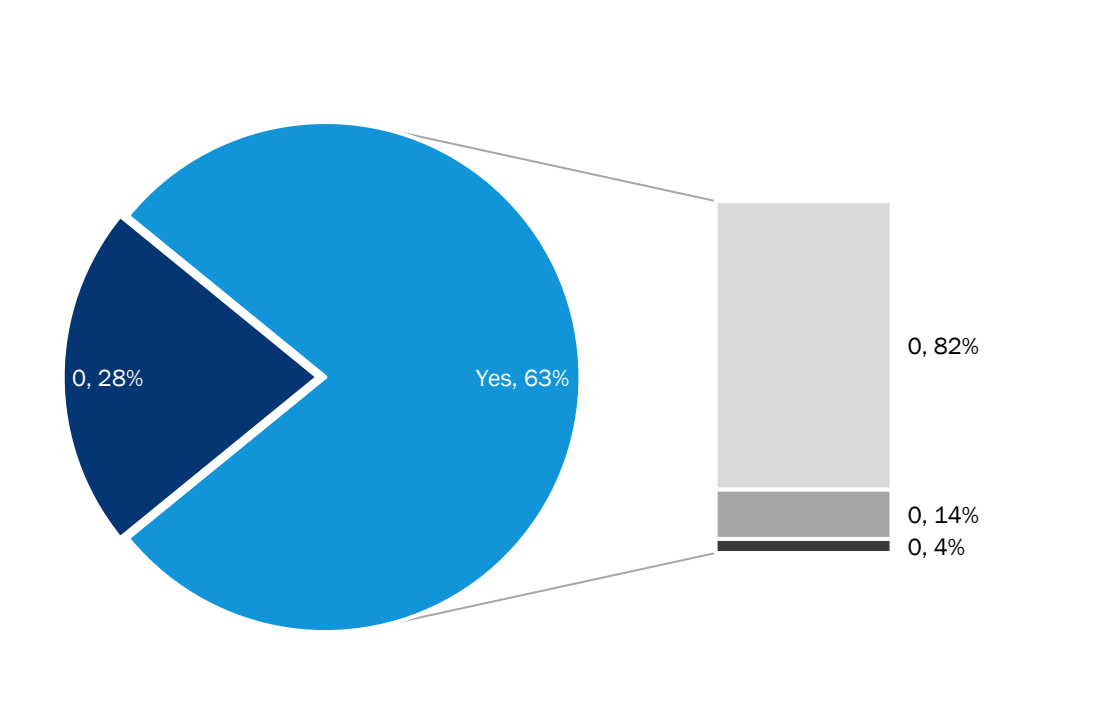
Figure 10. Satisfaction with LEDs Over Previous Bulbs in the Home (n=45)



5.2.4 Non-Energy Benefits

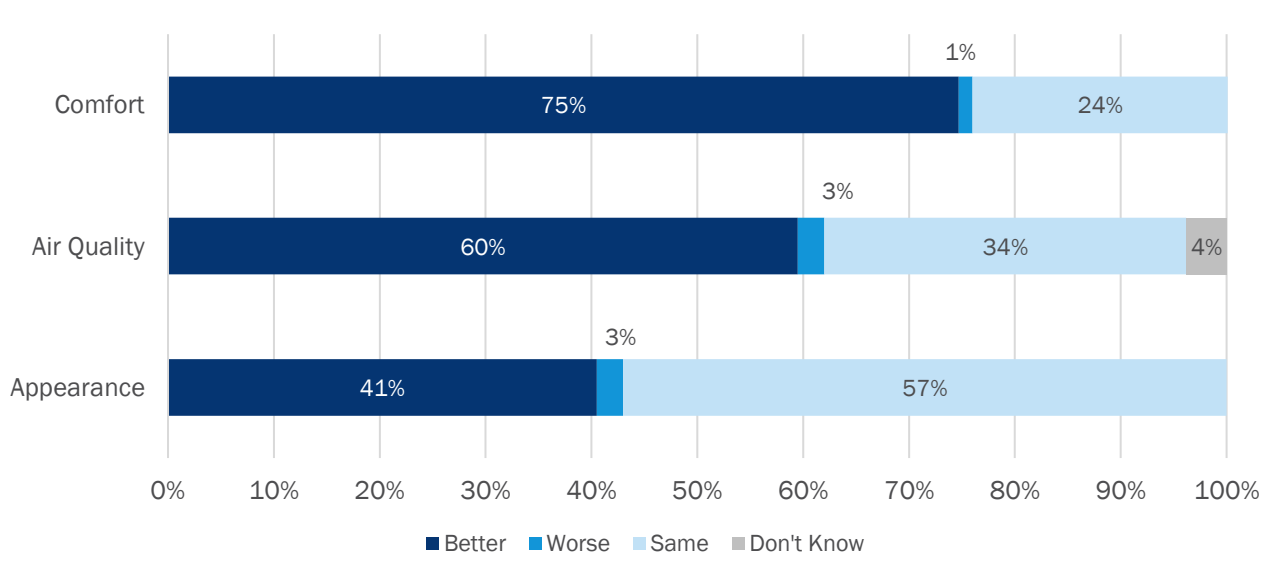
Participants were also asked if they noticed a change in their electric bill after receiving weatherization services and nearly two-thirds of respondents did. Of this set of participants, 82% said their bills were lower and just 14% said their bills rose (Figure 11).

Figure 11. Change Noticed in Electric Bill (n=79)



We also explored non-energy impacts experienced by Program clients. In the telephone survey, we asked participants if the air quality, appearance, and comfort improved, stayed the same, or worsened after they received services. As Figure 12 shows, 75% of participants reported an improvement in home comfort. Air quality and appearance of the home were better for 60% and 41% of participants, respectively. This provides further evidence of the positive impact of the Program beyond energy saving benefits.

Figure 12. Impact of Measures on Home Characteristics (n=79)



6. Cost Effectiveness

AEG estimated the cost-effectiveness of PacifiCorp’s evaluated savings for the Low Income Weatherization program in the state of Utah based on Program Year (PY) 2018-2019 costs and savings provided by PacifiCorp. The program passes the PacifiCorp Total Resource Cost Test (PTRC), Total Resource Cost Test (TRC), and Utility Cost Test (UCT).

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 Utah 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 11: Cost-Effectiveness Analysis Inputs

Parameter	Value
Discount Rate	6.57%
Residential Line Loss	9.32%
Residential Energy Rate (\$/kWh)	\$0.1069
Inflation Rate ¹	2.20%

Table 12: Low Income Weatherization Annual Program Costs, Nominal - PY2018-2019⁸

Program Year	Program Delivery	Utility Admin	Program Development	Incentives	Total Utility Budget	Gross Customer Costs
Low Income Weatherization	\$11,291	\$24,083	\$6,558	\$96,894	\$138,826	\$0
Total Program	\$11,291	\$24,083	\$6,558	\$96,894	\$138,826	\$0

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

⁸ To align with annual budget expectations, cost-effectiveness inputs are presented in nominal dollars.

Table 13: 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	463,411	109%	505,496	100%	505,496	16
Total Program	463,411	109%	505,496	100%	505,496	16

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

Cost-Effectiveness Test	Levelized \$/kWh	NPV Costs	NPV Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.02	\$133,486	\$363,628	\$230,142	2.72
Total Resource Cost Test (TRC) No Adder	\$0.02	\$133,486	\$330,571	\$197,085	2.48
Utility Cost Test (UCT)	\$0.02	\$133,486	\$330,571	\$197,085	2.48
Participant Cost Test (PCT)		\$0	\$721,606	\$721,606	n/a
Rate Impact Test (RIM)		\$762,079	\$330,571	(\$431,508)	0.43
Lifecycle Revenue Impacts (\$/kWh)					0.00000

AEG estimated the cost-effectiveness of PacifiCorp’s evaluated savings for the Low Income Weatherization program in the state of Utah based on Program Year (PY) 2018 costs and savings provided by PacifiCorp. The program passes the PacifiCorp Total Resource Cost Test (PTRC), Total Resource Cost Test (TRC), and Utility Cost Test (UCT).

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 Utah 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 15: Cost-Effectiveness Analysis Inputs

Parameter	Value
Discount Rate	6.57%
Residential Line Loss	9.32%
Residential Energy Rate (\$/kWh)	\$0.1069
Inflation Rate ¹	2.20%

Table 16: Low Income Weatherization Annual Program Costs, Nominal - PY2018⁹

Program Year	Program Delivery	Utility Admin	Program Development	Incentives	Total Utility Budget	Gross Customer Costs
Low Income Weatherization	\$3,263	\$13,340	\$1,653	\$33,956	\$52,212	\$0
Total Program	\$3,263	\$13,340	\$1,653	\$33,956	\$52,212	\$0

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

Table 17: 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	204,235	108%	221,428	100%	221,428	16
Total Program	204,235	108%	221,428	100%	221,428	16

Table 18: 2018 Low Income Weatherization Program Cost-Effectiveness Results (without NEBs) - (Load Shape - UT_Single_Family_Cooling)

Cost-Effectiveness Test	Levelized \$/kWh	NPV Costs	NPV Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.02	\$52,212	\$160,144	\$107,932	3.07
Total Resource Cost Test (TRC) No Adder	\$0.02	\$52,212	\$145,586	\$93,374	2.79
Utility Cost Test (UCT)	\$0.02	\$52,212	\$145,586	\$93,374	2.79
Participant Cost Test (PCT)		\$0	\$315,800	\$315,800	n/a
Rate Impact Test (RIM)		\$334,056	\$145,586	(\$188,470)	0.44
Lifecycle Revenue Impacts (\$/kWh)					0.00000

AEG estimated the cost-effectiveness of PacifiCorp’s evaluated savings for the Low Income Weatherization program in the state of Utah based on Program Year (PY) 2019 costs and savings provided by PacifiCorp. The

⁹ To align with annual budget expectations, cost-effectiveness inputs are presented in nominal dollars.

program passes the PacifiCorp Total Resource Cost Test (PTRC), Total Resource Cost Test (TRC), and Utility Cost Test (UCT).

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 Utah 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 19: Cost-Effectiveness Analysis Inputs

Parameter	Value
Discount Rate	6.57%
Residential Line Loss	9.32%
Residential Energy Rate (\$/kWh)	\$0.1063
Inflation Rate ¹	2.20%

Table 20: Low Income Weatherization Annual Program Costs, Nominal - PY2019¹⁰

Program Year	Program Delivery	Utility Admin	Program Development	Incentives	Total Utility Budget	Gross Customer Costs
Low Income Weatherization	\$8,028	\$10,743	\$4,905	\$62,938	\$86,614	\$0
Total Program	\$8,028	\$10,743	\$4,905	\$62,938	\$86,614	\$0

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

Table 21: 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	259,176	110%	284,068	100%	284,068	16
Total Program	259,176	110%	284,068	100%	284,068	16

¹⁰ To align with annual budget expectations, cost-effectiveness inputs are presented in nominal dollars.

Table 22: 2019 Low Income Weatherization Program Cost-Effectiveness Results (without NEBs) - (Load Shape - UT_Single_Family_Cooling)

Cost-Effectiveness Test	Levelized \$/kWh	NPV Costs	NPV Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.03	\$86,614	\$216,853	\$130,239	2.50
Total Resource Cost Test (TRC) No Adder	\$0.03	\$86,614	\$197,139	\$110,525	2.28
Utility Cost Test (UCT)	\$0.03	\$86,614	\$197,139	\$110,525	2.28
Participant Cost Test (PCT)		\$0	\$422,484	\$422,484	n/a
Rate Impact Test (RIM)		\$446,160	\$197,139	(\$249,021)	0.44
Lifecycle Revenue Impacts (\$/kWh)					0.00000

7. Conclusions and Recommendations

Impact evaluation results show strong energy savings; participants saved 936 kWh annually, on average. Approximately 98% of the ex-post savings came from LED lighting, furnace fans, and refrigerator replacements. We evaluated and updated the UES per measure and **recommend that the Program update the UES values for individual measures in ex-ante estimates moving forward based on the values provided in Appendix A.**

Rocky Mountain Power is adhering to best practices by delivering the Program via HCD. HCD has spent many years serving as a Program implementer on behalf of Rocky Mountain Power by subcontracting with multiple non-profit agencies in Utah to provide weatherization services to qualified homes. It is customary practice for utilities to work with one or more 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, HCD is knowledgeable about combining funding from utilities with government funding to expand the reach of programs. The implementing agency demonstrates its understanding of Program processes, requirements, and funding mechanisms. Leveraging these types of agencies is a best practice in low-income weatherization programs. **We recommend Rocky Mountain Power continue to use the same Program implementer moving forward.**

HCD did not mention any major challenges during the evaluation period and noted that implementation of the Program has only gotten more difficult in the last two years as demand for construction supplies and personnel has increased. One difficulty mentioned was a transition by an agency from an outside contractor-reliant organization to a crew-based organization. Finding personnel and training staff to conduct the installations and auditing was a challenge. HCD noted that overcoming the reasons for deferral has been a big focus by HCD and the agencies in recent years. Most reasons for deferral are due to unsafe or inaccessible conditions in the home; HCD and the agencies can utilize other programs and funds to complete some rehabilitation steps, like structural repairs, to overcome certain deferral cases. Since most agencies already operate other programs in their communities, they can complete those steps needed before weatherization can be completed or refer the customer to other programs. Further additional funding for this Program may become available through the new Bipartisan Infrastructure Law through 2027. We recommend that **Rocky Mountain Power consider proactive ways to access the new infrastructure funding and layer those funds onto existing funding.**

The Program is meeting customer needs well. Participants continue to be highly satisfied with the Program. Nine of every ten participants reported “Complete Satisfaction” with the Program and virtually all participants agreed that weatherization staff were courteous and respectful towards their homes. Three out of every four surveyed participants recalled receiving energy education and of those, 93% took recommended actions to save more energy beyond the measures provided. Further, 75% of participants reported an improvement in home comfort. Air quality and appearance of the home were also better for 60% and 41% of participants, respectively. This provides further evidence of the positive impact of the Program beyond energy saving benefits.

While almost all surveyed participants were satisfied with the Program, some provided feedback about ways the Program could better serve households. The most common area of improvement mentioned by surveyed participants involved incomplete weatherization services. Several participants recommended a check-up on services provided to verify they were completed properly. Two other participants mentioned a desire for all work that had been discussed to be completed. 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 they may provide an online form for participants to complete on an as-needed basis.

Appendix A. Impact Analysis Details

A.1. LED Light Bulbs

Table 23 documents the inputs and methodology for estimating LED savings.

Table 23. Algorithms and Inputs for LED Light Bulbs

Algorithms Used		
kWh Savings	= ((Baseline Watts - LED Watts) / 1,000) * (1 - Leakage) * Hours * WHFe * ISR	
Source of Algorithm: Illinois TRM V10.0 Section 5.5.8		
Parameter	Value	Source/Notes
Baseline Watts	43.0	IL TRM V10.0 halogen equivalent wattage for a standard 9W LED.
LED Watts	9.0	LED wattage distributed within the Program.
Percentage of Bulbs Outside Utility Jurisdiction (Leakage)	0%	Measures are directly installed and therefore 100% remain in utility jurisdiction.
Annual Hours of Use (Hours)	1,089	IL TRM V10.0. Average Annual Average of Use for Residential LEDs. This aligns with Program guidelines, which state that lights must be on for at least two hours a day to qualify.
Energy Waste Heat Factor (WHFe)	1.06	IL TRM V10.0 for single-family housing type (participants predominantly live in single-family or mobile homes).
In-Service Rate (ISR)	96%	Based on results from 2018-2019 Utah Participant Survey.

Table 24 provides the deemed savings for LED light bulbs using the assumptions from Table 23.

Table 24. LED Deemed Savings

Metric	Deemed Savings per Measure
Annual kWh per LED	37.68

A.2 Furnace Fan

Table 25 documents the inputs and methodology for estimating furnace fan savings.

Table 25. Algorithms and Inputs for Furnace Fans

Algorithms Used		
kWh Savings (cooling)	= CapacityCool * (1/nCool _{base} - 1/nCool _{ECM}) * FLHcool * %Cool	
kWh Savings (heating)	= FLHheat * ΔkWheat	
kWh Savings (circulation mode)	= Circulation Hours * ΔkWcirc	
kWh Savings	= Cooling kWh Savings + Heating kWh Savings + Circulation Mode Savings	
Source of Algorithm: Cadmus Focus on Energy Evaluated Deemed Savings Changes. November 14, 2014.		
Parameter	Value	Source/Notes
Capacity of Central Cooling Equipment (CapacityCool)	42 kBTU	Approximately 0.0016 tons of cooling is needed per square foot. Rounded to the nearest nominal tonnage. Total conditioned floor area (1,915 sf) from 2018–2019 Low Income Weatherization Program (Utah) Participant Survey.
Cooling Efficiency without ECM (nCool _{base})	11.88 SEER	Weighted average by equipment type and age from the IL TRM V10.0 and 2015 RECS data for Mountain North Division.
Cooling Efficiency with ECM (nCool _{ECM})	14.00 SEER	2015 Federal minimum standard central cooling efficiency.
Full Load Cooling Hours (FLHcool)	785	EPA Calculator. Assume Salt Lake City.
Full Load Heating Hours (FLHheat)	2,443	
Change in Demand for Heating (ΔkWheat)	0.116	Cadmus Focus on Energy Evaluated Deemed Savings Changes. November 14, 2014.
Hours of Circulation (Circulation Hours)	1,020	Cadmus Focus on Energy Evaluated Deemed Savings Changes. November 14, 2014.
Change in Demand for Circulation (ΔkWcirc)	0.207	Cadmus Focus on Energy Evaluated Deemed Savings Changes. November 14, 2014.
Percent of Homes with Central Cooling (%Cool)	49%	2018–2019 Low Income Weatherization Program (Utah) Participant Survey.
In-Service Rate (ISR)	100%	Assumed 100% of furnace fans remain installed as it is not likely to be removed by the participant.

Table 26 provides the deemed savings for furnace fans, using the assumptions from Table 25.

Table 26. Furnace Fans Deemed Savings

Metric	Deemed Savings per Measure
Annual kWh per Fan	702.01

A.3 Refrigerator Replacement

Table 27 documents the inputs and methodology for estimating refrigerator replacement savings.

Table 27. Algorithms and Inputs for Refrigerator Replacement

Algorithms Used	
kWh _{existing}	= [83.32 + (Age * 3.68) + (Pre-1990 * 485.04) + (Size * 27.15) + (Side-by-side * 406.78) + (Primary * 161.86) + (CDD/365.25 * unconditioned * 15.37) + (HDD/365.25 * unconditioned * -11.07)] * Part Use Factor
kWh _{ENERGYSTAR}	= 0.90 * kWh _{code}

kWh savings	= (kWh _{existing} - kWh _{ENERGYSTAR}) * ISR	
Source of Algorithm(s): Illinois TRM V10.0 Section 5.1.6, Federal Code, ENERGYSTAR		
Parameter	Value	Source/Notes
Age of Existing Refrigerator (Age)	17.00	Average Age of Refrigerator from a Refrigerator Recycling Program from a confidential client (n=3,497). This aligns with the Measure Life from IL TRM V10.0.
Percentage Refrigerators Manufactured Pre-1990 (Pre1990)	0.00	Based on Age assumption, assuming 2019 is age of replacement.
Capacity of Existing Refrigerator (Size)	22.44	Weighted capacity of refrigerators from 2015 RECS for Mountain North Division.
Percentage of Refrigerators Side-by-Side (SidebySide)	0.33	Percentage of side-by-side refrigerators from 2015 RECS for Mountain North Division.
Percentage of Refrigerators Primary Unit (Primary)	1.00	All refrigerators replace primary units.
Cooling Degree Day (CDD)	1,244	ASHRAE Fundamentals 2017 for Utah.
Heating Degree Day (HDD)	5,517	
Percentage Refrigerators Operating in Unconditioned Space (Unconditioned)	0.00	Assumed 100% of refrigerators operate in conditioned space as program targets the replacement of primary units.
Part Time Use Adjustment Factor (Part Use Factor)	1.00	Replaced refrigerator is the primary refrigerator and operates continuously.
Energy Consumption of Code Compliant Refrigerators (kWh _{code})	540.85	Federal standard for refrigerators manufactured between 2001 and 2014 based on weighted capacity from RECS data for Mountain North Division.
In-Service Rate (ISR)	100%	Assumed 100% of refrigerators remain installed as it is not likely to be removed by the participant.

Table 28 provides the deemed savings for refrigerators, using the assumptions from Table 27.

Table 28. Refrigerator Replacement Deemed Savings

Metric	Deemed Savings Per Measure
Annual kWh per Refrigerator	565.80

A.4 Ceiling Insulation

Table 29 documents the inputs and methodology for estimating ceiling insulation savings.

Table 29. Algorithms and Inputs for Ceiling Insulation

Algorithms Used	
kWh Savings (cooling)	= (((1/R _{existing} - 1/R _{attic}) * Area * (1 - Framing Factor) * 24 * CDD * DUA) / (1,000 * η _{Cool})) * ADJ _{cool} * %Cool * ISR
kWh Savings (heating)	= (((1/R _{existing} - 1/R _{attic}) * Area * (1 - Framing Factor) * 24 * HDD) / (η _{Heat} * 3,412)) * ADJ _{Heat} * %ElecHeat * ISR
kWh Savings	= Cooling kWh Savings + Heating kWh Savings
Source of Algorithm: Illinois TRM V10.0 Section 5.6.5	

Parameter	Value	Source/Notes
Existing Insulation R-value (Rexisting)	20.0	Program materials for WY (not provided for UT) indicate the baseline description is "less than R-30 in place." We assume some ceilings will already have some insulation in place and therefore assume an existing R-value of R-20 for the average.
R-value after Installing Attic Insulation (Rattic)	49.0	Utah current state energy code IECC 2015. According to the Program database, all measures were installed in Climate Zone 5.
Area of Installed Insulation (Area)	1,424	Calculated attic footprint square footage by dividing total conditioned floor area (1,915 sf) from 2018–2019 Low Income Weatherization Program (Utah) Participant Survey by the number of stories (1.34) from RECS 2015 data for Mountain North.
Framing Factor	7%	IL TRM V10.0.
Cooling Degree Day (CDD)	998	ASHRAE Fundamentals 2017 for Utah. Average Cooling and Heating Degree Days for Hill AFB, Provo Municipal, and Salt Lake City INTL. These locations are used because all insulation measures are installed in CZ 5.
Heating Degree Day (HDD)	5,805	
Discretionary Use Adjustment (DUA)	0.75	Discretionary Use Adjustment for cooling. Common to most TRMs. Accounts for fact that all cooling systems will not operate 100% of time requiring cooling.
Cooling Efficiency (nCool)	11.88 SEER	Weighted average by equipment type and age from the IL TRM V10.0 and 2015 RECS data for Mountain North Division.
Heating Efficiency (nHeat)	1.56 COP	
Cooling Savings Adjustment (ADJcool)	121%	IL TRM V10.0. Adjustment for cooling savings to account for inaccuracies in prescriptive engineering algorithms.
Heating Savings Adjustment (ADJheat)	60%	IL TRM V10.0. Adjustment for heating savings to account for inaccuracies in prescriptive engineering algorithms.
Percent of Homes with Central Cooling (%Cool)	49%	2018–2019 Low Income Weatherization Program (Utah) Participant Survey.
Percent of Homes with Electric Heating (%ElecHeat)	10%	
In-Service Rate (ISR)	100%	Assumed 100% of ceiling insulation remain installed as it is not likely to be removed by the participant.

Table 30 provides the deemed savings for ceiling insulation, using the assumptions from Table 29.

Table 30. Ceiling Insulation Deemed Savings

Metric	Deemed Savings per Measure
Annual kWh per Home	96.09

A.5 Duct Sealing & Insulation

Table 31 documents the inputs and methodology for estimating duct sealing and insulation savings.

Table 31. Algorithms and Inputs for Duct Sealing and Insulation

Algorithms Used	
kWh Savings (cooling)	$= \left(\frac{DE_{\text{after}} - DE_{\text{before}}}{DE_{\text{after}}} \right) * FLH_{\text{cool}} * Capacity_{\text{Cool}} * TRF_{\text{cool}} / 1,000 / \eta_{\text{Cool}} * \%Cool * ISR$

kWh Savings (heating)	= (((DEafter - DEbefore) / DEafter) * FLHheat * CapacityHeat * TRFheat / ηHeat / 3,412) * %ElecHeat * ISR	
kWh Savings	= Cooling kWh Savings + Heating kWh Savings	
Source of Algorithm: Illinois TRM V10.0 Section 5.3.4		
Parameter	Value	Source/Notes
DEafter (cooling)	93%	From BPI "Guidance on Estimating Distribution Efficiency." Assume average for tightly sealed ducts for all duct locations insulated to R-8.
DEafter (heating)	95%	
DEbefore (cooling)	78%	From BPI "Guidance on Estimating Distribution Efficiency." Average for duct leakage that is both average and leaky for all duct locations for uninsulated and insulated to R-2 or R-4.
DEbefore (heating)	84%	
Full Load Cooling Hours (FLHcool)	785	EPA Calculator. Assume Salt Lake City.
Full Load Heating Hours (FLHheat)	2,443	
Capacity of Central Cooling Equipment (CapacityCool)	42,000 BTU	Approximately 0.0016 tons of cooling is needed per square foot. Rounded to the nearest nominal tonnage. Total conditioned floor area (1,915 sf) from 2018–2019 Low Income Weatherization Program (Utah) Participant Survey.
Output Capacity of Heating Equipment (CapacityHeat)	67,034 BTU	Average between 20 and 50 BTU of heating required per square foot from National Renewable Energy Laboratory (NREL) and South Carolina State University studies.
Thermal Regain Factor for Cooling (TRFcool)	1.00	IL TRM V10.0. Assumed ducts located in unconditioned space.
Thermal Regain Factor for Cooling (TRFheat)	1.00	
Cooling Efficiency (nCool)	11.88 SEER	Weighted average by equipment type and age from the IL TRM V10.0 and 2015 RECS data for Mountain North Division.
Heating Efficiency (nHeat)	1.56 COP	
Percent of Homes with Central Cooling (%Cool)	49%	2018–2019 Low Income Weatherization Program (Utah) Participant Survey.
Percent of Homes with Electric Heating (%ElecHeat)	10%	
In-Service Rate (ISR)	100%	Assumed 100% of duct sealing and insulation remain installed as it is not likely to be removed by the participant.

Table 32 provides the deemed savings for duct sealing and insulation, using the assumptions from Table 31.

Table 32. Duct Sealing and Insulation Deemed Savings

Metric	Deemed Savings per Measure
Annual kWh per Home	559.93

A.6 Wall Insulation

Table 33 documents the inputs and methodology for estimating wall insulation savings.

Table 33. Algorithms and Inputs for Wall Insulation

Algorithms Used	
kWh Savings (cooling)	= (((1/Rexisting - 1/Rwall) * Area * (1 - Framing Factor) * 24 * CDD * DUA) / (1,000 * ηCool)) * ADJcool * %Cool * ISR

kWh Savings (heating)	= $\frac{((1/R_{existing} - 1/R_{wall}) * Area * (1 - Framing\ Factor) * 24 * HDD)}{(\eta_{Heat} * 3,412) * ADJ_{Heat} * \%ElecHeat * ISR}$	
kWh Savings	= Cooling kWh Savings + Heating kWh Savings	
Source of Algorithm: Illinois TRM V10.0 Section 5.6.4		
Parameter	Value	Source/Notes
Existing Insulation R-value (R _{existing})	5.0	IL TRM V10.0. Minimum of R-5 for uninsulated assemblies. "LIW TRL" sheet in program database indicates that the baseline description is no insulation for this measure.
R-value after Installing Wall Insulation (R _{wall})	15.0	"LIW TRL" sheet in program database specifies an efficiency requirement "Up to R-26." Utah's current state energy code 2015 IECC for CZ 5 (all measures installed in Climate Zone 5) requires R-20, R-13 cavity insulation + R-5 insulated sheathing (if <25% exterior structural sheathing), or R-13 cavity insulation + R-2 insulated sheathing (if >25% exterior structural sheathing). Assume R-15 as a conservative estimate.
Area of Installed Insulation (Area)	1,413	Calculated wall area by multiplying wall height (assuming 8-foot ceilings * number of stories) by wall length ($\sqrt{\text{conditioned floor area} * 4 \text{ walls}}$) where number of stories (1.34) from RECS 2015 data for Mountain North and conditioned floor area (1,915 sf) from 2018–2019 Low Income Weatherization Program (Utah) Participant Survey. Reduced by 25% as a conservative estimate provided limited program specific data.
Framing Factor	25%	IL TRM V10.0.
Cooling Degree Day (CDD)	998	ASHRAE Fundamentals 2017 for Utah. Average Cooling and Heating Degree Days for Hill AFB, Provo Municipal, and Salt Lake City INTL. These locations are used because all insulation measures are installed in CZ 5.
Heating Degree Day (HDD)	5,805	
Discretionary Use Adjustment (DUA)	0.75	Discretionary Use Adjustment for cooling. Common to most TRMs. Accounts for fact that all cooling systems will not operate 100% of time requiring cooling.
Cooling Efficiency (nCool)	11.88 SEER	Weighted average by equipment type and age from the IL TRM V10.0 and 2015 RECS data for Mountain North Division.
Heating Efficiency (nHeat)	1.56 COP	
Cooling Savings Adjustment (ADJ _{cool})	80%	IL TRM V10.0. Adjustment for cooling savings to account for inaccuracies in prescriptive engineering algorithms.
Heating Savings Adjustment (ADJ _{heat})	60%	IL TRM V10.0. Adjustment for heating savings to account for inaccuracies in prescriptive engineering algorithms.
Percent of Homes with Central Cooling (%Cool)	49%	2018–2019 Low Income Weatherization Program (Utah) Participant Survey.
Percent of Homes with Electric Heating (%ElecHeat)	10%	
In-Service Rate (ISR)	100%	Assumed 100% of wall insulation remain installed as it is not likely to be removed by the participant.

Table 34 provides the deemed savings for wall insulation, using the assumptions from Table 33.

Table 34. Wall Insulation Deemed Savings

Metric	Deemed Savings per Measure
Annual kWh per Home	308.23

A.7 Cooling System Tune-Up

Table 35 documents the inputs and methodology for estimating cooling system tune-up savings.

Table 35. Algorithms and Inputs for Cooling System Tune-Up

Algorithms Used		
kWh Savings	= (CapacityCool * FLHcool * (1/nCool))/1,000 * MFe * ISR	
Source of Algorithm: Illinois TRM V10.0 Section 5.3.10		
Parameter	Value	Source/Notes
Capacity of Central Cooling Equipment (CapacityCool)	42,000 BTU	Approximately 0.0016 tons of cooling is needed per square foot. Rounded to the nearest nominal tonnage. Total conditioned floor area (1,915 sf) from 2018–2019 Low Income Weatherization Program (Utah) Participant Survey.
Full Load Cooling Hours (FLHcool)	785	EPA Calculator. Assume Salt Lake City.
Cooling Efficiency (nCool)	11.88 SEER	Weighted average by equipment type and age from the IL TRM V10.0 and 2015 RECS data for Mountain North Division.
Maintenance Energy Savings Factor (MFe)	0.05	IL TRM V10.0.
In-Service Rate (ISR)	100%	This measure requires a trained professional perform services on the equipment and does not include installing any devices that can be removed.

Table 36 provides the deemed savings for cooling system tune-ups, using the assumptions from Table 35.

Table 36. Central AC Tune-up Deemed Savings

Metric	Deemed Savings per Measure
Annual kWh per System	138.82

A.8 Faucet Aerator

Table 37 documents the inputs and methodology for estimating faucet aerator savings.

Table 37. Algorithms and Inputs for Faucet Aerators

Algorithms Used		
kWh Savings	= (Baseline GPM – Efficient GPM) * (Minutes/Faucet) * Household * 365.25 * DF/FPH) * (8.33 * (Tmix – Tinlet)) / 3,412 / nDHW) * %ElecWH * ISR	
Source of Algorithm: Illinois TRM V10.0 Section 5.4.4.		
Parameter	Value	Source/Notes
Faucet Flow Rate without Low-Flow Aerator (Baseline GPM)	1.58	IL TRM V10.0 for unknown faucet location (e.g., kitchen, bathroom).
Faucet Flow Rate with Low-Flow Aerator (Efficient GPM)	0.94	IL TRM V10.0.
Daily Length of Faucet Use per Capita in Minutes (Minutes/Faucet)	8.65	IL TRM V10.0. Weighted for single-family (84%) and multifamily (16%) housing types from the 2018–2019 Low Income Weatherization Program (Utah) Participant Survey for unknown faucet location (e.g., kitchen, bathroom).

People per Household (Household)	2.99	2018–2019 Low Income Weatherization Program (Utah) Participant Survey.
Drain Factor (DF)	79.5%	IL TRM V10.0 for unknown faucet location.
Faucets per Household (FPH)	3.61	IL TRM V10.0. Weighted for single-family (84%) and multifamily (16%) housing types from the 2018–2019 Low Income Weatherization Program (Utah) Participant Survey for unknown faucet location (e.g., kitchen, bathroom).
Days per Year	365.25	Conversion.
Faucet Water Temperature (Tmix)	91.00 °F	IL TRM V10.0 for unknown faucet location (e.g., kitchen, bathroom).
Inlet Water Temperature (Tinlet)	56.65 °F	NREL Domestic Hot Water Event Generator for Utah.
Specific Heat of Water	8.33	Standard conversion.
BTU to kWh Conversion	3,412	Standard conversion.
Recovery Efficiency of Water Heater (nDHW)	0.98	Typical recovery efficiency for electric resistance heaters (IL TRM, IN TRM, ARK TRM).
Percent of Homes with Electric Water Heating (%ElecWH)	100%	Program requires electric water heater for participation. This is confirmed by the program manager.
In-Service Rate (ISR)	100%	One participant in 2018-2019 received low-flow faucet aerators. Due to low participation, the participant survey did not verify the installation of faucet aerators. Assumed 100%.

Table 38 provides the deemed savings for faucet aerators, using the assumptions from Table 37.

Table 38. Faucet Aerator Deemed Savings

Metric	Deemed Savings per Measure
Annual kWh per Faucet Aerator	113.86

A.9 Windows

Table 39 documents the inputs and methodology for estimating windows savings.

Table 39. Algorithms and Inputs for Windows

Algorithms Used		
Source of Algorithm: Used RESFEN6 (LBNL Software) to model a home with new windows. We estimate savings per window, and then apply to the total number of windows replaced.		
Parameter	Value	Source/Notes
Location	Salt Lake City, UT	Input for RESFEN6. The closest city in the RESFEN6 database to the one home that received new windows.
House Type	1 Story Existing Masonry	Input for RESFEN6. House Type that most closely corresponds with the one home that received new windows.
HVAC System	Electric Heat Pump	Input for RESFEN6. Electric Heat Pump is the only Electric Heating option in the RESFEN6 Modeling Software.
Window Area	9 ft ²	Input for RESFEN6. Standard Window Size for Window Savings Modeling.
U-Factor Base	0.88	Input for RESFEN6. RESFEN6 Preset Value for Single Clear, Non-Metal Frame Window.

U-Factor New	0.29	Input for RESFEN6. RESFEN6 Preset Value for Double Low-E, Medium Solar Gain, Non-Metal Thermally Improved Frame Window.
SHGC Base	0.64	Input for RESFEN6. RESFEN6 Preset Value for Single Clear, Non-Metal Frame Window.
SHGC New	0.31	Input for RESFEN6. RESFEN6 Preset Value for Double Low-E, Medium Solar Gain, Non-Metal Thermally Improved Frame Window.
Percent of Homes with Central Cooling (%Cool)	49%	2018-2019 Low Income Weatherization Program (Utah) Participant Survey.
Percent of Homes with Electric Heating (%ElecHeat)	10%	
In-Service Rate (ISR)	100%	Assumed 100% of windows remain installed as it is not likely to be removed by the participant.

Table 40 provides the deemed savings for windows, using the assumptions from Table 39.

Table 40. Window Deemed Savings

Metric	Deemed Savings per Measure
Annual kWh per Window	12.61

For more information, please contact:

Megan Campbell
Sr Vice President

858-270-5010 tel
mccampbell@opiniondynamics.com

1000 Winter Street
Waltham, MA 02451



Opinion **Dynamics**

Boston | Headquarters

617 492 1400 tel
617 492 7944 fax
800 966 1254 toll free

1000 Winter Street
Waltham, MA 02451

San Francisco Bay

510 444 5050 tel
510 444 5222 fax

1 Kaiser Plaza
Suite 445
Oakland, CA 94612

San Diego

858 270 5010 tel
858 270 5211 fax

1200 Prospect Street
Suite #G-100
La Jolla, CA 92037

Portland

503 287 9136 tel
503-281-7375 fax

1500 NE Irving Street
Suite #370
Portland, OR 97232