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Final Wyoming Low Income Weatherization Program Evaluation for Program Years 2014 - 2015

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Table of Acronyms

Acronyms	Meaning
ARRA	American Recovery and Reinvestment Act
CCS	Council of Community Services
CFL	Compact Fluorescent Light Bulb
kWh	Kilowatt-hour
LED	Light Emitting Diode
LIEAP	Low Income Energy Assistance Program
PCT	Participant Cost Test
PTRC	PacifiCorp Total Resource Cost Test
QCI	Quality Certification Inspector
RIM	Ratepayer Impact Measure Test
SIR	Savings-to-Investment Ratio
TRC	Total Resource Cost
TRL	Technical Reference Library
TRM	Technical Resource Manual
UCT	Utility Cost Test
USDHHS	United States Department of Health & Human Services
USDOE, DOE	United States Department of Energy
WAP	Weatherization Assistance Program
WFS	Wyoming Department of Family Services
WWS	Wyoming Weatherization Services

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 Wyoming during the 2014 and 2015 program years. We performed both an impact and process evaluation and results from these are presented in the report.

Two Wyoming sub-grantee agencies known for serving low income communities have historically implemented the Program: Council of Community Services (CCS) and Wyoming Weatherization Services (WWS). These agencies hold subcontracting agreements with the Wyoming Department of Family Services (WFS) from which they receive government funding. WFS receives state and federal government grants that are then used by the sub-grantee agencies to provide energy efficiency services targeted towards weatherization to existing single family, multi-family, and manufactured homes in all territory served by Rocky Mountain Power in the state of Wyoming.¹ The agencies leverage these funds in addition to Rocky Mountain Power funds to so that customers receive energy efficiency measures at no cost to them. “Low Income” eligibility guidelines are determined by WFS. Note that during 2014 and 2015, only WWS billed Rocky Mountain Power for these services.²

Opinion Dynamics conducted this Program evaluation on behalf of Rocky Mountain Power with the following objectives in mind: (1) document and measure effects of the Program; 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 as available, and researching other algorithms and savings assumptions based on Technical Reference Manuals (TRMs), studies, and other secondary sources as applicable. We also conducted a process evaluation based on a program materials review, an in-depth interview with WWS agency staff, and participant responses to a telephone survey. The telephone survey asked about participant satisfaction with the Program, program barriers and bottlenecks, best practices, and any opportunities for improvement. Last, this report includes the cost-effectiveness analysis conducted by a third-party consultant, Navigant Consulting, on behalf of the Company.

1.1.1 Impact Results

For the impact evaluation, we verified Program participation through participant telephone surveys. We completed surveys with eight of the 40 Rocky Mountain Power customers who participated in 2014 and 2015. All surveyed participants (n=8) verified they participated in the Program and received measures.

Given the small number of program participants, we conducted a deemed savings review to estimate the energy savings from the Program. The results show that the average annual net energy savings per participant for the 2014-2015 program years is 2,997 kWh. In Table 1, we present the ex-post net savings for each program year and in total. Overall, the Program achieved 114% of its ex-ante gross savings for the evaluation period.

¹ Rocky Mountain Power Electric Service Schedule No. 118, State of Wyoming. “Low Income Weatherization” Issued December 28, 2015.

² CCS completed no weatherization projects on behalf of Rocky Mountain Power Company since at least 2012, but billed for homes they completed in 2017.

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
2014	23	57,382	82,393	144%
2015	17	48,111	37,506	78%
Total	40	105,493	119,899	114%

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 70% of the ex-post savings come from duct sealing and insulation measures. We describe the impact evaluation in more detail in the sections below and document all ex-post algorithms and assumptions in Appendix A.

1.1.2 Process Results

The process evaluation examined Program operations from multiple perspectives. Rocky Mountain Power and WWS have worked together for several years to deliver the Program. Over this time, WWS has 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.³ 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.

WWS receives Program applications directly from the Low Income Energy Assistance Program (LIEAP) and once received, customers are placed on a waitlist. WWS 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. As WWS receives new applications, it reviews and adds them to the waitlist based on its points system. Some customers may wait for years because they are not prioritized.

Agency staff noted that once a customer reaches the top of the waitlist, its goal is to complete an energy audit within a week and complete weatherization services within the next 30 days. WWS reports that it typically meets this goal. Survey participants noted longer wait times to receive services, though they were asked how long it took to receive services once they submitted their application. Their responses are therefore not reflective of when they reached the top of the waitlist. Half (4/8) of those surveyed reported receiving weatherization services within three months of submitting their application, three said between three to six months, and one customer between six months and a year. While agency staff reported that some customers could wait years to receive services (see Section 5.1), no customers noted wait times of years during the survey. This is perhaps because these customers were not included in our set of customers who responded to the survey.

The Program is meeting customer needs well. Participant experience with the Program is mixed but favorable with four of the eight surveyed participants reporting they were “extremely satisfied” and three participants reporting “moderate satisfaction” with the Program. Participants who were “moderately satisfied” wished the program provided additional services such as repair of moisture and attic leaks and installation of additional

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.

windows. All surveyed participants reported that they would recommend the program to others, which is consistent with previous program evaluation results.⁴

The Program helps educate participants on ways to save energy beyond the direct-install measures. While energy education is not a formal part of the Program, agency staff 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 energy costs. This is also considered a best practice of energy efficiency programs designed to serve low income customers.⁵ Five in eight survey respondents recalled learning about ways to save energy from the agency staff and four of them found the energy education to be helpful. Most (5/8) respondents recalled that Program staff informed them of ways to save energy in their home and all of them noted they acted on the recommendations received. These actions included:

- Turning off lights when not in use
- Installing energy efficient light bulbs such as CFLs and LEDs
- Caulking, weather-stripping or sealing windows and doors
- Turning off appliances when not in use

Rocky Mountain Power tried to increase awareness about its sponsorship of the Program with additional efforts in 2015. However, none of the surveyed participants recognized Rocky Mountain Power as a funding source for their weatherization services. Instead, half of those surveyed believe that LIEAP is the sole source of funding.

1.1.3 Cost Effectiveness Results

The Company’s third-party consultant, Navigant, conducted cost-effectiveness analysis of the Program using various approaches: the PacifiCorp Total Resource Cost (PTRC) test, Total Resource Cost (TRC) test, Utility Cost Test (UCT), Ratepayer Impact Measure (RIM) test, and the Participant Cost Test (PCT). Opinion Dynamics and PacifiCorp provided the inputs to Navigant for their calculations. The PCT was considered “not applicable” as a measure of cost-effectiveness for this program since customers do not pay for the measures and the PCT examines cost-effectiveness from the perspective of the participating customer. The annual evaluation period benefit/cost ratios are presented in Table 2 and show that the program is considered cost-effective based on the PTRC, TRC, and UCT tests. Note that the Program’s cost-effectiveness is determined by the TRC test.

Table 2. Benefit/Cost Ratios - Low Income Weatherization

Program Year	PTRC	TRC	UCT	RIM	PCT
2014	3.98	3.62	3.62	0.61	n/a
2015	1.58	1.44	1.44	0.40	n/a
2014-2015	2.86	2.60	2.60	0.54	n/a

⁴ Smith & Lehmann Consulting and H. Gil Peach & Associates, *Wyoming Low-Income Weatherization Program Evaluation Report for Program Years 2011-2012*, Prepared for Rocky Mountain Power Company. August 17, 2015, page 30.

⁵ Same as footnote 3.

1.1.4 Recommendations

Based on the evaluation results, we recommend the following:

- **Update unit energy savings (UES) values for individual measures for this program based on the deemed values provided in Appendix A.**
- The ex-post impact evaluation relied on many high-level engineering assumptions to estimate impacts because participant- or program-specific data was not collected. For example, information on square footage of insulation installed per home, R-values of pre- and post-insulation, and type of heating and cooling equipment in participant homes was not available so we relied on state-wide averages and other sources to make estimates for these and other parameters. We understand that this is a small program with a desire to minimize burden on agencies in collecting these data, but collecting and providing this type of information can greatly improve the accuracy of UES estimates and avoid under- or overestimating savings. **We recommend collecting and providing these data to the evaluator moving forward to improve the accuracy of UES savings estimates.**
- Rocky Mountain Power is adhering to best practices by delivering the Program through a community-based agency.⁶ WWS has served as a Program implementer on behalf of Rocky Mountain Power for years. It is a common 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, these agencies are knowledgeable about using funding from utilities in combination 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. **Rocky Mountain Power should continue to use the same Program implementer moving forward.**
- While Rocky Mountain Power relies on WWS to provide weatherization services, the backlog of customers on its waitlist tends to be long. Servicing these customers is a challenge because WWS knows that there are several households that will not benefit from weatherization for some time. At the time of our interview with agency staff, WWS had 2,100 approved and eligible customers on its waitlist, of which 20% were Rocky Mountain Power customers. Some customers wait for several years to receive services because households with children, disabled, or elderly residents are prioritized. As a result, other households get pushed down on the waiting list as new customers send in applications for services and are prioritized. WWS mentioned customers would benefit from a standalone Program funded entirely through Rocky Mountain Power as it would streamline participation requirements. **Based on the agency's feedback and the reported wait times for certain customers to receive services, Rocky Mountain Power should consider increasing funding towards the Program.**
- Participants continue to be highly satisfied with the Program, as suggested by all surveyed participants noting that they would recommend it to family and friends. Seven out of eight surveyed participants reported moderate to high levels of satisfaction with the Program and half of those surveyed noted that their electric bills were lower after receiving services. In most cases, Program implementation

⁶ Two sub-grantee agencies are contracted with Rocky Mountain Power to deliver weatherization services on its behalf (CCS and WWS), but CCS completed no weatherization projects for the utility during this evaluation period. They have billed Rocky Mountain Power for homes completed in 2017.

staff provide energy conservation recommendations that allow customers to go beyond measure savings with behavior savings as well, such as turning off lights when not in use and turning down the temperature setting on thermostats. Most surveyed participants recall this education and find it helpful (5 out of 8). The one-on-one interactions that occur through the Program provide a fortuitous opportunity to provide customers with useful behavioral related tips to become more energy efficient. **Though not a formal part of the Program, this education may lead customers to save energy beyond the savings from the installed weatherization measures and should continue.**

- Agency staff noted that they sometimes have difficulty contacting customers to arrange for weatherization services when their names come up on the waitlist. This could occur for numerous reasons such as customers relocating to a different home, incorrect or illegible information provided on the application, or customers no longer wanting to receive services and therefore do not return calls to the agency. **To ensure accurate contact information, we recommend the agency confirm customer addresses and phone numbers with Rocky Mountain Power when staff has difficulty contacting customers to arrange for weatherization services.**

- Rocky Mountain Power has tried to increase awareness about its funding of the program, given that the utility provides at least 50% of the costs of measures installed in participants' homes. However, based on feedback from surveyed customers, none identified Rocky Mountain Power as a funding source. In fact, approximately half of those surveyed believe LIEAP serves as the sole source of funding for the weatherization services they received. In 2015, Rocky Mountain Power started to send letters and magnets to participants to thank customers for participating and to increase awareness of the utilities' role in the program. The effect of these outreach efforts may be seen in the next evaluation period. **If it is a priority for Rocky Mountain Power to make sure they are recognized for their sponsorship of the Program, Rocky Mountain Power might also consider branding the agency staff who conduct the audits and installation services by wearing shirts that note the Program's affiliation with Rocky Mountain Power.**

2. Introduction

Rocky Mountain Power's Low Income Weatherization Program (the "Program") provides energy efficiency measures to eligible residential customers through a partnership with two non-profit agencies in Wyoming: Council of Community Services (CCS)⁷ and Wyoming Weatherization Services (WWS).⁸ Note that during the evaluation period, CCS completed no weatherization projects on behalf of Rocky Mountain Power's program. However, following a management change at the agency, it has billed Rocky Mountain Power for homes completed in 2017. Partnering with agencies that historically serve Wyoming's low income communities provides Rocky Mountain Power with streamlined access to the customers targeted by this program.

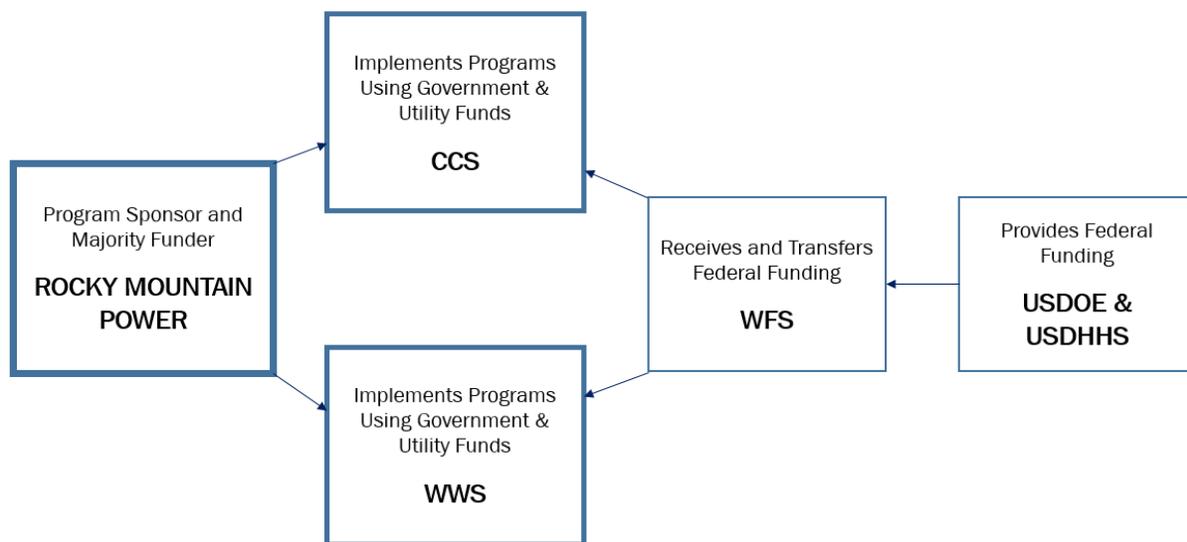
The Program operates by reimbursing agencies for 50% of the installed cost of measures. Importantly, reimbursements are calculated after property owner contributions are deducted. Agencies may also be reimbursed for administrative costs based on 10% of Rocky Mountain Power's rebate on installed measures. 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). The Wyoming Department of Family Services (WFS) 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.

⁷ <http://www.ccsgillette.org/causes/weatherization-for-vulnerable-and-low-income/>

⁸ <http://www.wyweatherizationservices.org/>

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



2.1.1 Program Implementation

Program implementation involves the following steps, which are detailed in the 2015 Wyoming Annual Demand-Side Management Report⁹:

- income verification based on Wyoming Department of Family Services¹⁰ to ensure that participants qualify for program participation,
- energy audit using a U.S. Department of Energy 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 to Rocky Mountain Power within 60 days of job completion, which must be accompanied by a home owner 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 Wyoming. Duplexes and fourplexes are eligible if low-income tenants occupy at least one-half of the unit. Other multifamily units are

⁹ http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Demand_Side_Management/2016/2015-DSM-WY-Annual-Report-081616.pdf

¹⁰ <http://dfsweb.wyo.gov/economic-assistance/wap>

also eligible if low-income tenants occupy at least 66% of the units. Income eligibility is determined by Wyoming Department of Family Services Guidelines.¹¹

Energy conservation measures broadly fall into two categories: “major” and “supplemental.” Major measures include floor, wall and ceiling insulation. Electric heat supplemental measures include, but are not limited to, weather stripping, attic ventilation, and timed thermostat installation, and are only available if an electric heating system heats at least 51% of the home. Supplemental measures that do not require an electric heating system include, for example, LED light fixtures and pipe insulation.

2.1.2 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 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 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, and cost effectiveness results.

¹¹ Income eligibility depends on the number of individuals residing in the household. The most current guidelines can be found at the Wyoming Department of Family Services – Weatherization Assistance Program website: <https://sites.google.com/a/wyo.gov/dfsweb/economic-assistance/wap>

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 the 2014 and 2015 program years to support both 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 the following key variables in the Program tracking data:

- Customer name, address, and phone number
- Project name (embedded within this is the implementing agency that provided services)
- Project ID
- Primary utility number (customer identifier)
- Bill account number
- Cost recovery date
- Project creation date
- Project last update date
- Measure category, type, sub-type, and name
- Measure level kWh/year savings for some measures
- Direct install costs
- Measure costs

The Program tracking data included kWh/year savings at the measure level for CFLs, refrigerator replacements, pipe insulation, and showerheads, however no measure level savings are included for weather stripping, thermal doors, windows, ground cover or ceiling, floor, or wall insulation. Instead, for each participant who received any of these measures, the tracking data included a single bundled deemed savings value, which was listed as “WY Weatherization.”

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 members at Wyoming Weatherization Services and a participant telephone survey. The agency interview helped inform our review of Program operations, compliance with regulatory requirements, as well as major accomplishments and challenges related to Program implementation. We used information gathered through the participant telephone survey to verify the installation of measures, estimate lighting in-service rates, and inform process related Program findings.

3.3 Other Data Sources

We requested all sources for ex-ante assumptions and reviewed all received files. These included the Wyoming Technical Reference Library (TRL) file, the 2006 and 2015 Wyoming Low Income Weatherization Program studies.¹² In addition, we submitted several measure-specific questions via email to the Wyoming program manager and received some clarifying answers.

The above documents were not entirely sufficient to document all ex-ante calculations. We therefore relied on several additional sources to perform our ex-post analysis. For the additional resources, we attempted to use Wyoming-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
- Michigan Evaluation Working Group Showerhead and Faucet Aerator Meter Study. June 2013.
- National Renewable Energy Labs
- Residential Energy Consumption Survey (RECS), 2015 data
- Technical Reference Manuals
 - Illinois TRM
 - Indiana TRM
 - Iowa TRM
 - Mid-Atlantic TRM
- Wyoming participant survey conducted by Opinion Dynamics

¹² Wyoming Low Income Weatherization Program: Analysis in Support of Tariff Filing. July 31, 2006 and Wyoming Low-Income Weatherization Program Evaluation Report for Program Years 2011-2013, Prepared for Rocky Mountain Power by Smith and Lehmann Consulting, September 2015.

4. Impact Evaluation

A total of 40 customers participated in the Program during the 2014 and 2015 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=8) confirmed their participation. A list of the various measures installed from the most common, compact fluorescent light bulbs (CFLs), to the least common, wall insulation, is presented in Table 3 below. Other common measures include weather-stripping as well as water pipe, floor, and ceiling insulation.

Table 3. Wyoming Participation Counts and Measures for Program Years 2014 to 2015

Measures	2014	2015	Total	Percent
Total # of Homes Treated	23	17	40	100%
Compact Fluorescent Light Bulbs	22	17	39	98%
Weather-stripping	21	15	36	90%
Water Pipe Insulation and Sealing	15	8	23	58%
Floor Insulation	17	4	21	53%
Ceiling Insulation	8	9	17	43%
Low Flow Showerheads	11	6	17	43%
Replacement Windows	7	6	13	33%
Replacement Refrigerators	3	9	12	30%
Thermal Doors	6	6	12	30%
Duct Insulation	10	1	11	28%
Ground Cover	4	1	5	13%
Wall Insulation	3	1	4	10%

4.1 Methodology

Given the small number of participants, 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-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., CFLs, refrigerator, ceiling insulation, showerhead) based on other TRMs and similar programs in other jurisdictions. We customized the savings assumptions and inputs to Wyoming as much as possible. We used these average savings per measure to estimate program-level savings by multiplying the per-measure savings by the total installed measures of each type from the program tracking database. To minimize potential overlap of interactive effects between measures¹³, we used conservative assumptions as much as possible in the per-measure savings estimates.

¹³ For example, savings from duct sealing may be somewhat offset by installing additional insulation in a home.

We leveraged data from the Wyoming participant survey to develop installation rates for lighting measures and applied this installation rate (72.5%) to the deemed ex-post lighting savings. For all non-lighting measures, we assumed an installation rate of 100% based on survey feedback and program records.

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

4.2 Results

In Table 4, we present the ex-ante and ex-post net energy savings for the Program. The overall net savings realization rate is 114% for the 2014-2015 program years and the average annual ex-post net savings per participant are 2,997 kWh during the evaluation period. The realization rate varied between 2014 and 2015 because of a difference in measure mix between the two years (see Table 5). The change in measure mix results in adjustments to ex-post savings at the measure level, which in turn, influences the overall realization rate for that year. Table 5 presents ex-post savings by measure type and the percent contribution to the overall program ex-post savings.

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
2014	23	57,382	82,393	144%
2015	17	48,111	37,506	78%
Total	40	105,493	119,899	114%

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.

Table 5. Ex-Post Net Savings by Measure

Measure	Quantity		Quantity Unit of Measure	Ex-Post Net Savings		Percent of Total Ex-Post Savings
	2014	2015		2014	2015	
Floor Insulation	17	4	Participants	38,088	8,962	39%
Duct Sealing	10	1	Participants	15,404	1,540	14%
Refrigerators	3	9	Participants	3,617	10,850	12%
Ceiling Insulation	8	9	Refrigerator	4,049	4,555	7%
Wall Insulation	3	1	Participants	6,159	2,053	7%
CFL	170	122	Bulb	4,053	2,909	6%
Window	36	17	Window	3,112	1,470	4%
Weather Stripping	21	15	Participants	2,263	1,616	3%
Showerhead	11	6	Showerhead	2,441	1,332	3%
Domestic Water Heater Pipe Insulation	15	8	Participants	1,853	988	2%
Thermal Doors	11	10	Door	1,354	1,231	2%
Total				82,393	37,506	100%

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

5. Process Evaluation

5.1 Agency perspective

We interviewed staff from Wyoming Weatherization Services (WWS) in December 2016 as this was the only agency to complete low income weatherization projects on behalf of Rocky Mountain Power for the evaluation period. We spoke with a representative from WWS to gain a deeper understanding of the Program’s operations and any key areas of improvement. We present the agency’s perspective on various topics addressed during the interview in Table 6 below.

Table 6. Agency Feedback

Topic	Feedback
Balance of funding	<ul style="list-style-type: none"> - WWS uses Rocky Mountain Power funds to supplement funding from government sources to help increase the number of homes they can weatherize per year. - Agency staff provided no additional information about how they balance funds across the sources.
Waitlist Process	<ul style="list-style-type: none"> - A customer’s position on the waitlist for services is based on a point system, where points are awarded based on whether the customer or customer’s dependents are elderly or disabled; Customers with the most points appear at the top of the waitlist. The waitlist is revised and updated as customers receive services and are removed from the list. - WWS receives Program applications directly from the LIEAP program and customers are immediately placed on the waitlist when their application is received. WWS receives new applications daily after customers apply for LIEAP. Customers with low priority points could wait years to be serviced. As WWS noted: <ul style="list-style-type: none"> o <i>“We have some customers who may be on the waitlist and have 5-10 priority points, and very well could have been on the wait list for the past 12-15 years.”</i> - Customers at the top of WWS’ waitlist are called first and once reached, WWS will attempt to complete an energy audit within a week and close the job within 30 days. WWS stated the time goal is usually always met. While WWS reports meeting its time goals, participants’ responses during the telephone survey report much longer wait times.
Current waitlist	<ul style="list-style-type: none"> - At the time of the interview WWS had 2,100 approved and eligible applicants on its wait list, 20% of which are electric Rocky Mountain Power customers. WWS noted: <ul style="list-style-type: none"> o <i>“If we just worked off of what we have currently, assuming we can get a hold of all these people and get into their home, [it would] probably still be 5 years [until everyone on the waitlist could be serviced]”</i>
Challenges and Barriers	<ul style="list-style-type: none"> - WWS has very few deferrals. However, the staff mentioned customers can be difficult to reach, thus making it difficult to get into their homes. - WWS noted they have a large backlog of customers on the Program waiting list. Their ability to reach all potential customers is largely caused by a lack of Program funding. - WWS indicated the biggest challenge is increased federal scrutiny. The DOE encouraged WWS to improve upon their tracking of federal funding. <ul style="list-style-type: none"> o <i>“The DOE has had us track a lot more, making sure they get their reimbursement for use of the truck, tools, and other [equipment]. They</i>

Topic	Feedback
	<p><i>originally told us we didn't have to track [equipment] so we had to go back a few years in our tracking."</i></p> <ul style="list-style-type: none"> - WWS mentioned customers would benefit from a standalone Program funded entirely through Rocky Mountain Power as it would streamline participation requirements.

5.2 Participant perspective

The evaluation team attempted to reach a census of customers who participated in the Program in 2014 and 2015 with a telephone survey. Of the 40 customers who participated in 2014-2015, we had valid phone numbers for 39. A total of 8 participants completed telephone interviews, yielding a response rate of 32% and cooperation rate of 57% (see Table 7).¹⁴

Table 7. Wyoming Participant Telephone Survey

Population Frame	Unique Telephone Numbers	Final Survey Responses	Survey Response Rate	Survey Cooperation Rate
40	39	8	32%	57%

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

Table 8. Participant Survey Disposition

Survey Disposition	Sample
Complete	8
Disconnected phone	7
Customer said wrong number	6
Answering machine	4
Initial refusal	4
Privacy line/Number blocked	3
Not available	3
Callback to complete	1
Non-specific callback/secretary	1
Hard Refusal - Do not call	1
Not available	1

We used this survey to collect data about participant household characteristics and Program experience. Of the eight surveys completed, we reached a mix of customers from varying housing types: three customers in single-family homes, four in manufactured/mobile homes, and one in a townhome. Six of the eight customers own their homes. Below we summarize participant feedback on their Program experience across an array of topic areas.

¹⁴ Response rate is calculated using American Association for Public Opinion Research (AAPOR) Response Rate 3.

Table 9. Participant Feedback

Topic Area	Participant Feedback
Program Awareness	<ul style="list-style-type: none"> - Respondents generally heard about the Program through word of mouth from family, friends, and neighbors (3/8) or from another energy assistance program (3/8), such as LIEAP. - Historically, Rocky Mountain Power customers have had difficulty identifying Rocky Mountain Power as a funding source of the Program. This is still a challenge, as none of the respondents identified Rocky Mountain Power as a funding source. Half of the respondents believed LIEAP was the sole source of funding. - Half of respondents (4/8) reported receiving weatherization services within three months of submitting their applications, three said between three to six months, and one customer between six months and a year. WWS attempts to complete an energy audit within a week of an application coming up on the waiting list and tried to close the job within 30 days; however, customers are called in order of priority points and can spend a significant amount of time on the waitlist before moving up to the top of the waiting list.
Energy Education	<ul style="list-style-type: none"> - The Program does not offer energy education formally, however most (5/8) respondents recalled that Program staff informed them of ways to save energy in their home. All five respondents noted they acted on the recommendations received. These actions included: <ul style="list-style-type: none"> o Turning off lights when not in use o Installing energy efficient light bulbs such as CFLs and LEDs o Caulking, weather-stripping or sealing windows and doors o Turning off appliances when not in use - The additional education is of value to customers. Of the participants who recalled receiving energy education (5/8), some (2/5) rated the education extremely helpful with some (2/5) rated it as moderately helpful. - Fewer respondents said Program staff informed them of ways to improve the health and safety in the home (3/8); however, that may be customized to each participant depending on the state of the home. A few respondents recalled that the Program staff checked their home for needed repairs, outside of the Program measures, during the home visit (2/8).
Program Delivery Satisfaction	<ul style="list-style-type: none"> - All respondents (8/8) would recommend the Program to family and friends. - After receiving the weatherization services, most surveyed participants noticed a change in their electric bill (5/8). Four of the five noted their electric bill was lower and one respondent noted it was higher. The participant who reported a higher bill noted that the CFLs that were installed through the program had burned out and they were replaced with incandescent bulbs, which provides a partial explanation for the participant not seeing a decreased bill. - Half of respondents (4/8) had no suggestions for Program improvement. The four respondents who suggested improvements each cited a different issue: the initial audit, quality of the job performed, quality of the products installed, and the waitlist to receive services. Some verbatim quotes on this topic are below: <ul style="list-style-type: none"> ▪ “[Need a] better walkthrough at beginning of process.” ▪ “Have a person who knows what they are doing and actually do a good job rather than just throwing things up and leaving right away.” ▪ “[I had issues with the] quality of material installed” ▪ “They could get to people a little quicker to get the jobs done.” - Respondents were asked to rate the Program on a scale of 0 - 10 where 0 is "Extremely dissatisfied" and 10 is "Extremely satisfied"

Topic Area	Participant Feedback
	<ul style="list-style-type: none"> ○ Half (4/8) of respondents were extremely satisfied and rated the Program a “10”. ○ Some respondents (3/8) gave moderate satisfaction scores (ratings of 4, 5 or 6). Their verbatim quotes on why they gave moderate scores include: <ul style="list-style-type: none"> ▪ <i>I was “satisfied but there could have been other things that could have been done.”</i> ▪ <i>“There were a couple windows that they left out that we thought...needed to take care of.”</i> ▪ <i>“We still had a lot of moisture leaks and it actually started molding on us. The attic was still leaking.”</i> <p>One respondent indicated they were very dissatisfied with the program. “It did not help at all. They did a bad job, it didn't help at all.”</p>
CFL Verification and Satisfaction	<ul style="list-style-type: none"> - Almost all respondents who received CFLs recalled receiving the bulbs (7/8). - Of those who recalled receiving the bulbs, two were more satisfied with the lighting in their homes after installing CFLs and five were neutral about their lighting. - Since receiving CFLs through the program, two customers purchased additional lighting for their homes; both reported buying CFLs.

6. Cost Effectiveness

This section presents the cost-effectiveness findings for Navigant’s analysis of the Wyoming Low Income Weatherization Program for program years 2014-2015. Navigant completed cost-effectiveness tests of the Program using various approaches: PacifiCorp Total Resource Cost (PTRC) test, Total Resource Cost (TRC) test, Utility Cost Test (UCT), Ratepayer Impact Measure (RIM) test, and the Participant Cost Test (PCT). Each scenario is analyzed using modeled assumptions provided by Opinion Dynamics and Rocky Mountain Power. Note that cost-effectiveness of the Program is based on the results of the TRC test.

All scenarios utilize the following assumptions:

- **Avoided Costs:** Navigant performed a custom analysis of calculating avoided costs by using the Residential Whole House decrement cost and the Residential Whole House load shape for program years 2014-2015. The decrements values were populated using the 2013 PacifiCorp Integrated Resource Plan (IRP) for program years 2014 and the 2015 PacifiCorp IRP for program year 2015.
- **Modeling Inputs:** Navigant utilized program level savings provided by Opinion Dynamics and administration costs provided by Rocky Mountain Power in the file *WY LIW Evaluation Cost Effectiveness Inputs.xlsx*.
- **Benefit/Cost Tests:** Multiple benefit/cost tests are reported including; PacifiCorp Total Resource Cost Test (PTRC), Total Resource Cost Test (TRC), Utility Cost Test (UCT), Rate Impact Test (RIM), and Participant Cost Test (PCT).

The cost-effectiveness inputs are as follows:

Table 10. Low Income Weatherization Program Inputs

Parameter	2014	2015
Discount Rate	6.88%	6.66%
Residential Line Loss	9.51%	9.51%
Residential Energy Rate (\$/kWh) ¹	\$0.11	\$0.11
Inflation Rate	1.90%	1.90%

¹ Future rates determined using a 1.9% annual escalator

Table 11. Low Income Weatherization Program Annual Program Costs

Program Year	Utility Admin	Admin Program Delivery	Eval, Marketing, Prog Devel.	Incentives	Total Utility Costs	Gross Customer Costs
2014	\$5,582	\$2,087	\$76	\$20,871	\$28,616	\$0
2015	\$6,357	\$1,635	\$702	\$16,351	\$25,045	\$0
2014-2015	\$11,940	\$3,722	\$778	\$37,221	\$53,661	\$0

Table 12. Low Income Weatherization Program Annual Program Savings

Program Year	Gross kWh Savings	Realization Rate	Adjusted Gross kWh Savings	Net to Gross Ratio	Net kWh Savings	Measure Life
2014	57,382	144%	82,393	100%	82,393	26
2015	48,111	78%	37,506	100%	37,506	26
2014-2015	105,493	114%	119,899	100%	119,899	26

The benefit/cost ratios for each of the cost-effectiveness tests are presented in Table 13.

Table 13. Benefit/Cost Ratios - Low Income Weatherization

Program Year	PTRC	TRC	UCT	RIM	PCT
2014	3.98	3.62	3.62	0.61	n/a
2015	1.58	1.44	1.44	0.40	n/a
2014-2015	2.86	2.60	2.60	0.54	n/a

Table 14 provides the cost-effectiveness results for the combination of program years 2014 through 2015.

Table 14. LIW Program Level Cost-Effectiveness Results – PY2014-2015

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.0308	\$53,661	\$153,558	\$99,897	2.86
Total Resource Cost Test (TRC) No Adder	\$0.0308	\$53,661	\$139,598	\$85,938	2.6
Utility Cost Test (UCT)	\$0.0308	\$53,661	\$139,598	\$85,938	2.6
Rate Impact Test (RIM)		\$259,543	\$139,598	(\$119,945)	0.54
Participant Cost Test (PCT)		\$0	\$243,103	\$243,103	n/a
Lifecycle Revenue Impacts (\$/kWh)					\$0.0000004780
Discounted Participant Payback (years)					n/a

Table 15 and Table 16 provide the cost-effectiveness results for each individual program year.

Table 15. LIW Program Level Cost-Effectiveness Results – PY2014

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.0241	\$28,616	\$113,870	\$85,254	3.98
Total Resource Cost Test (TRC) No Adder	\$0.0241	\$28,616	\$103,518	\$74,902	3.62
Utility Cost Test (UCT)	\$0.0241	\$28,616	\$103,518	\$74,902	3.62
Rate Impact Test (RIM)		\$168,623	\$103,518	(\$65,105)	0.61
Participant Cost Test (PCT)		\$0	\$160,878	\$160,878	n/a
Lifecycle Revenue Impacts (\$/kWh)					\$0.0000002612
Discounted Participant Payback (years)					n/a

Table 16. LIW Program Level Cost-Effectiveness Results – PY2015

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.0453	\$25,045	\$39,688	\$14,643	1.58
Total Resource Cost Test (TRC) No Adder	\$0.0453	\$25,045	\$36,080	\$11,035	1.44
Utility Cost Test (UCT)	\$0.0453	\$25,045	\$36,080	\$11,035	1.44
Rate Impact Test (RIM)		\$90,920	\$36,080	(\$54,840)	0.4
Participant Cost Test (PCT)		\$0	\$82,225	\$82,225	n/a
Lifecycle Revenue Impacts (\$/kWh)					\$0.0000002169
Discounted Participant Payback (years)					n/a

7. Conclusions and Recommendations

Rocky Mountain Power is adhering to best practices by delivering the Program through a community-based agency.¹⁵ WWS has served as a Program implementer on behalf of Rocky Mountain Power for years. It is a common 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, these agencies are knowledgeable about using funding from utilities in combination 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. **Rocky Mountain Power should continue to use the same Program implementer moving forward.**

While Rocky Mountain Power relies on WWS to provide weatherization services, the backlog of customers on its waitlist tends to be long. Servicing these customers is a challenge because WWS knows that there are several households that will not benefit from weatherization for some time. At the time of our interview with agency staff, it had 2,100 approved and eligible customers on its waitlist, of which 20% were Rocky Mountain Power customers. Some customers wait for several years to receive services because households with children, disabled, or elderly residents are prioritized. As a result, other households get pushed down on the waiting list as new customers who are prioritized send in applications for services. WWS mentioned customers would benefit from a standalone Program funded entirely through Rocky Mountain Power as it would streamline participation requirements. **Based on the agency's feedback and the reported wait times for certain customers to receive services, Rocky Mountain Power should consider increasing funding towards the Program.**

Participants continue to be highly satisfied with the Program, as suggested by all surveyed participants noting that they would recommend it to family and friends. Seven out of eight surveyed participants reported moderate to high levels of satisfaction with the Program and half of those surveyed noted that their electric bills were lower after receiving services. In most cases, Program implementers provide energy conservation recommendations that allows customers to go beyond measure savings with behavior savings as well, such as turning off lights when not in use and turning down the temperature settings on thermostats. Most surveyed participants recall this education and find it helpful (5 out of 8). **Though not a formal part of the Program, this education may lead customers to save energy beyond the savings from the installed weatherization measures and should continue.**

Rocky Mountain Power has tried to increase awareness about its funding of the program, given that the utility provides at least 50% of the costs of measures installed in participants' homes. However, based on feedback from surveyed customers, none identified Rocky Mountain Power as a funding source. In fact, approximately half of those surveyed believe LIEAP serves as the sole source of funding for the weatherization services they received. In 2015, Rocky Mountain Power started to send letters and magnets to participants to thank customers for participating and to increase awareness of the utilities' role in the program. The effect of these outreach efforts may be seen in the next evaluation period. **If it is a priority for Rocky Mountain Power to make sure they are recognized for their sponsorship of the Program, Rocky Mountain Power might also consider branding the agency staff who conduct the audits and installation services by wearing shirts that note the Program's affiliation with Rocky Mountain Power.**

¹⁵ Two sub-grantee agencies are contracted with Rocky Mountain Power to deliver weatherization services on its behalf (CCS and WWS), but CCS completed no low income weatherization projects for the utility.

Agency staff noted that they sometimes have difficulty getting a hold of customers to arrange for weatherization services when their names come up on the waitlist. This could occur for numerous reasons such as customers relocating to a different home, incorrect or illegible information provided on the application, or customers no longer wanting to receive services and therefore do not return calls to the agency. **To ensure accurate contact information, we recommend the agency confirm customer addresses and phone numbers with Rocky Mountain Power when staff has difficulty contacting customers to arrange for weatherization services.**

Given the small number of program participants, we conducted a deemed savings review to estimate the energy savings from the Program. The result shows that the average annual net energy savings per participant for the 2014-2015 program years is 2,997 kWh. Overall, the Program achieved 114% of its ex-ante gross savings for the evaluation period. We did not have insight into all ex-ante savings assumptions and therefore cannot identify the exact reasons behind the ex-ante and ex-post differences. However, approximately 70% of the ex-post savings come from duct sealing and insulation measures. **We do believe that the ex-post values used in the impact analysis better improve upon the ex-ante values and therefore recommend using the unit energy savings (UES) values for individual measures for this program based on the deemed values provided in Appendix A.**

The ex-post impact evaluation relied on many high-level engineering assumptions to estimate impacts because participant- or program-specific data was not available. For example, information on square footages of insulation installed per home, R-values of pre- and post-insulation, and type of heating and cooling equipment in participant homes was not available so we relied on state-wide averages and other sources to make estimates for these and other parameters. We understand that this is a small program with a desire to minimize burden on agencies in collecting these data, but collecting and providing this type of information can greatly improve the accuracy of ex-post savings estimates. **We recommend collecting and providing these data to the evaluator moving forward to improve the accuracy of ex-post savings estimates.**

Appendix A.

A.1 Insulation

Table 17 documents the inputs and methodology for estimating insulation savings.

Table 17. Algorithms and Inputs for Insulation

Algorithms Used		
kWh (cooling)	$= CDD * 24 * DUA / SEER / 1,000 * (1/R_{existing} - 1/R_{new}) * ADJ_{cool} * ISR * Area$	
kWh heating (heat pump)	$= HDD * 24 / 1,000 / HSPF * (1/R_{existing} - 1/R_{new}) * ADJ_{heat} * ISR * Area$	
kWh heating (electric resistance)	$= HDD * 24 / 3,412 * (1/R_{existing} - 1/R_{new}) * ADJ_{heat} * ISR * Area$	
Source of Algorithm: Pennsylvania TRM. PA PUC. June 2016 with adjustments based on IL TRM V5. Vol 3. Page 293.		
Parameter	Value	Source/Notes
CDD	412	ASHRAE Fundamentals 2017 for Wyoming.
HDD	7,182	
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.
SEER	13	Assume 13 SEER based on several TRMs. Assume equipment installed after 2006.
HSPF	7.7	Per the IL TRM, the average SEER/HSPF ratio for AHRI directory data is 0.596. Applied this ratio to the assumed SEER value.
%AC	68.2%	From RECS 2015 data for Wyoming (Mountain North).
%heat pump	0.29	
% resistance	0.71	
ADJcool	80%	IL TRM. Adjustment for cooling savings from insulation to account for engineering algorithms over claiming savings. As demonstrated in two years of metering evaluation by Opinion Dynamics for homes in Illinois. From Memo: "Results for AIC PY6 HPwES Billing Analysis", dated February 20, 2015.
ADJheat	60%	
Rexisting	See Error! Reference source not found.	Actual R-values per home were not provided. Assumed values vary based on installation location and type of insulation.
Rnew	See Error! Reference source not found.	
Area (Attic/Ceiling)	797	Actual square footages of insulation per home were not provided. In the absence of these data, we applied average square footages per home of insulation for a similar low-income weatherization program for a confidential client. We reduced the assumed areas by 25% to be conservative and avoid potential overlap of savings with related measures.
Area (Floor)	627	
Area (Wall)	622	
ISR	100%	Assumed in-service rate.

Table 18 provides the new R-value assumptions based on location and type of insulation installed.

Table 18. Existing and New Assumed R-values for Insulation Measures

Insulation Type	R-Existing	R-New	Source/Notes
Attic/Ceiling Insulation	20	38	For R-Existing, we assume some attics/ceilings will already have some insulation in place and therefore assume an existing R-value of R-20 for attic/ceiling insulation, and R-5 for floor and wall insulation to account for existing insulation already in place and the R-value of existing framing materials. For R-New, we rely on the following three sources to estimate average R-values: 1. WY Low Income Weatherization Analysis, Quantec 2006. 2. ENERGY STAR recommended insulation levels by climate zone ¹⁶ 3. Excel spreadsheet provided by program: WY LIW TRL.xlsx 4. Energy codes for Wyoming (no existing code): https://www.energycodes.gov/adoption/states/wyoming
Floor Insulation	5	15	
Wall Insulation	5	13	

Table 19 provides the deemed savings for insulation, using the assumptions from Table 17 and Table 18.

Table 19. Insulation Deemed Savings

Metric	kWh Savings/square foot	Total kWh/home
Attic/Ceiling Insulation	0.6	506.1
Floor Insulation	3.6	2,240.5
Wall Insulation	3.3	2,053.0

A.2 Duct Sealing

Table 20 documents the inputs and methodology for estimating duct sealing savings.

Table 20. Algorithms and Inputs for Duct Sealing

Algorithms Used		
kWh (cooling)	= (DEafter - DEbefore)/(DEafter)*FLHcool*Btuhcool/SEER/1000*%AC*ISR	
kWh (heating)	= (DEafter - DEbefore)/(DEafter)*FLHheat*Btuhheat/nheat/3412*ISR	
Source of Algorithm: Indiana TRM. July 2015. Version 2.2. Page 54.		
Parameter	Value	Source/Notes
DEafter	85%	From duct distribution efficiency table. Assume average of all conditioned space possibilities for ducts sealed with mastic and no observable leaks.
DEbefore	81%	From duct distribution efficiency table. Assume average of all conditioned space possibilities for all non-sealed duct possibilities., except for the most extreme possibilities as they skew savings too high.
FLHcool	409	EPA Calculator. Assume average between cities in Wyoming.
Btuhcool	34,800	Capacity not available for Wyoming customers. Assume average capacity based on installed capacity through a similar program for a confidential utility (n=992).

¹⁶ https://www.energystar.gov/index.cfm?c=home_sealing.hm_improvement_insulation_table

SEER	13	Assume 13 SEER based on several TRMs. Assume equipment installed after 2006.
%AC	57.1%	From RECS 2015 data for Wyoming (Mountain North).
FLHheat	2,588	EPA Calculator. Assume average between cities in Wyoming.
Btuhheat	52,080	Assume average capacity (35 Btu/sf) based on two sources: 1. 1.50 Btu/sf required based on climate zone data ¹⁷ 2. 20 Btu/sf ¹⁸ For average square footage, assume 1,488 sf. This comes from RECS 2009 data for Wyoming and is the average of heated and cooled space.
nheat	1.28	Weighted average based on RECS 2015 data.
% resistance	78%	From RECS 2015 data for Wyoming (Mountain North).
COP heat pump	2.26	Mid-Atlantic TRM.
%heat pump	22%	From RECS 2015 data for Wyoming (Mountain North). Value is too small to register in data. Assume non-resistance heaters are heat pump to be conservative.
COP electric resistance	1.00	Mid-Atlantic TRM.
EER	11.18	Conversion from SEER.
ISR	100%	Assumed in-service rate.

Table 21 provides the deemed savings for duct sealing using the assumptions from Table 20. We provide the deemed savings per system.

Table 21. Duct Sealing Deemed Savings

Metric	Deemed Savings per Participant
kWh per system	1,540

A.3 Refrigerator Replacement

Table 22 documents the inputs and methodology for estimating ENERGY STAR refrigerator savings.

Table 22. Algorithms and Inputs for ENERGY STAR Refrigerators

Algorithms Used		
kWh	= (Baseline Energy - ENERGY STAR)*ISR	
Source of Algorithm: Federal standards and ENERGY STAR requirements.		
Parameter	Value	Source/Notes
Baseline Energy Consumption (kWh/year)	1,654	Average participant level test result metered data provided by similar program for another client (n=87).

¹⁷ <https://energy.ces.ncsu.edu/hvac-heating-and-cooling-systems/>

¹⁸ based on: <http://www.nrel.gov/docs/fy12osti/52991.pdf>

ENERGY STAR Energy Consumption	425 (15 ft ³) 448 (18 ft³) 472 (21 ft ³)	ENERGY STAR Standards requiring 10% reduction in current federal standard. ¹⁹ The size of refrigerator installed through the program is unknown, so we assume 18 ft ³ because it is the middle value.
ISR	100%	Assumed in-service rate.

Table 23 provides the deemed savings for refrigerators, using the assumptions from Table 22.

Table 23. Refrigerator Deemed Savings

Metric	18 ft ³
Annual kWh per refrigerator	1,206

A.4 Compact Fluorescent Lamps

Table 24 documents the inputs and methodology for estimating CFL savings.

Table 24. Algorithms and Inputs for CFLs

Algorithms Used		
kWh Savings	= (Baseline Watts - CFL Watts)/1,000*Hours*WHFe*ISR	
Source of Algorithm: Standard lighting savings equation.		
Parameter	Value	Source/Notes
Baseline Watts (14W CFL)	43	Halogen baseline based on ENERGY STAR website. ²⁰
Baseline Watts (23W CFL)	72	Halogen baseline based on ENERGY STAR website. ⁴
CFL Watts (14W CFL)	14	Assumed wattage of CFLs. Actual wattage of CFLs unknown, so we assume a mix between 14W CFLs and 23W CFLs as these are the two wattages indicated through email communication with the Utah program manager and we apply them to Wyoming to stay consistent. We assume a mix of 75% 14W and 25% 23W as 14W are more common.
CFL Watts (23W CFL)	23	
Hours of use/year	913	Assume 2.5 hours per day (365 days/year). The program requires at least 2 hours per day and most residential lighting studies find operating hours in this range.
WHFe	1.06	From IL TRMv6.
ISR	0.725	Wyoming participant study.

Table 25 provides the deemed savings CFLs, based on the assumptions from Table 24.

¹⁹ https://www.energystar.gov/products/appliances/refrigerators/key_product_criteria

²⁰ http://www.energystar.gov/ia/products/lighting/cfls/downloads/EISA_Backgrounder_FINAL_4-11_EPA.pdf

Table 25. CFL Deemed Savings

Metric	14W	23W	Gross kWh (Weighted)
kWh per CFL	20.3	34.4	23.8

A.5 Windows

Table 26 documents the inputs and methodology for estimating window savings.

Table 26. Algorithms and Inputs for Windows

Algorithms Used		
Source of Algorithm: Used RESFEN5 (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	Casper, WY	Input for RESFEN5
House Type	2 Story Existing Masonry	Input for RESFEN5
HVAC System	Electric Heat Pump	Input for RESFEN5
Window Area	9 ft ²	Input for RESFEN5
U-Factor Base	0.84	Input for RESFEN5
U-Factor New	0.35	Input for RESFEN5
SHGC Base	0.63	Input for RESFEN5
SHGC New	0.44	Input for RESFEN5
%AC	57.1%	From RECS 2015 data for Wyoming (Mountain).

Table 27 provides the deemed savings for windows, using the assumptions from Table 26.

Table 27. Window Deemed Savings

Metric	kWh Savings
Total kWh	86.4

A.6 Weather Stripping

Table 28 documents the inputs and methodology for estimating weather stripping savings.

Table 28. Algorithms and Inputs for Weather Stripping

Algorithms Used		
kWh Savings	$\text{Cooling Savings} = (\text{CFM50Exist} - \text{CFM50New}) / \text{N-factor} * 60 * 24 * \text{CDD} * \text{DUA} * 0.018 / 1000 / \text{SEER} * \text{LM} * \% \text{AC} * \text{ISR}$ $\text{Heating Savings} = (\text{CFM50Exist} - \text{CFM50New}) / \text{N-factor} * 60 * 24 * \text{HDD} * 0.018 / 3,412 / \text{nHeat} * \% \text{electric heat} * \text{ISR}$ $\text{Total Savings} = \text{Cooling Savings} + \text{Heating Savings}$	
Source of Algorithm: Common to most TRMs. Used IL TRM and adjusted based on Wyoming-specific data as available.		
Parameter	Value	Source/Notes
ACH50base	17.4	

ACH50upgrade	17.2	ENERGY STAR savings analysis assumptions for Wyoming (Use Climate Zone 6 as it covers the majority of the state). Assume air sealing for "Windows, Doors, and Walls", but assume only 1/2 of the reduction since this measure is only weather stripping and it is not known how much it covers per home. ²¹
Home volume (ft3)	11,904	For average square footage, assume 1,488 sf. This comes from RECS 2009 data for Wyoming and is the average of heated and cooled space. Assume ceiling height of 8 ft.
Baseline CFM50	3,452	Converts ACH50 to CFM50 (=ACH50*Volume/60 minutes). ²²
Upgrade CFM50	3,412	
N-factor	15.8	LBNL Study ²³ Wyoming is mix of zone 1 and 2. Assume average of 1, 1.5, and 2 stories across these two climate zones as these are low income customers.
Conversion	1,440	Converts ft ³ /min to ft ³ /day.
CDD	412	ASHRAE Fundamentals 2017 for Wyoming.
HDD	7,182	
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.
Heat capacity	0.018	Volumetric heat capacity of air
SEER	13	Assume 13 SEER based on several TRMs. Assume equipment installed after 2006.
% AC	57.1%	From RECS 2015 data for Wyoming (Mountain North).
nHeat	1.28	Weighted average based on RECS 2015 data for Wyoming (Mountain North).
Cooling kWh savings	0.9	Calculated using equation above.
Latent multiplier (LM)	1.0	Latent multiplier to account for latent cooling demand (consistent with most TRMs). This is used to convert the sensible cooling savings to a value representing both sensible and latent cooling loads. The value is derived from Harriman et al "Dehumidification and Cooling Loads from Ventilation Air", ASHRAE Journal, November 1997. There are no latent values for Wyoming, so when calculating the latent multiplier, it is 1. We calculate the multiplier by adding the latent (0) and sensible (range from 0.3 to 0.5) and dividing by the sensible.
%electric heat	1.00	Program requires electric heat for participants and this is confirmed through the participant survey although the sample is small (n=8).
%heat pump	0.22	From RECS 2015 data for Wyoming (Mountain North). Value is too small to register in data. Assume non-electric resistance heaters are heat pump to be conservative.
% resistance	0.78	From RECS 2015 data for Wyoming (Mountain North).
COP heat pump	2.26	Mid-Atlantic TRM.
COP electric resistance	1.00	Mid-Atlantic TRM.
Heating kWh savings	107	Calculated
ISR	100%	Assumed in-service rate.

²¹ https://www.energystar.gov/ia/home_improvement/home_sealing/Measure_Upgrade_Assumptions.pdf?945a-eddc

²² http://www.pureenergyaudits.com/docs/Blower_Door_Handout_ACI_Baltimore.pdf

²³http://www.waptac.org/data/files/Website_docs/Technical_Tools/Building%20Tightness%20Limits.pdf

Table 29 provides the deemed savings for weather stripping, based on the assumptions from Table 28.

Table 29. Weather Stripping Deemed Savings

Metric	Deemed Savings
kWh per Home	108

A.7 Low-Flow Showerheads

Table 30 documents the inputs and methodology for estimating low-flow showerhead savings.

Table 30. Algorithms and Inputs for Low-Flow Showerheads

Algorithms Used		
kWh Savings	$= (\text{Base GPM} - \text{low flow GPM}) * (\text{Mins/shower}) * (\text{Showers/person}) * (\text{People/household}) / (\text{Showerheads/household}) * 365 * (\text{Tmix-Tinlet}) * 8.33 / 3,412 / \text{RE} * \% \text{Elec} * \text{ISR}$	
Source of Algorithm: Indiana TRM. July 2015. Version 2.2. Page 74.		
Parameter	Value	Source/Notes
Base GPM	2.67	Illinois TRM v6.
Low flow GPM	2.0	Based on email exchange with program manager, shower head wands are rated at 2.0 GPM.
Minutes/shower	7.8	Michigan Evaluation Working Group Showerhead and Faucet Aerator Meter Study. June 2013.
Showers/person	0.6	Michigan Evaluation Working Group Showerhead and Faucet Aerator Meter Study. June 2013.
People/household	2.4	From Wyoming participant survey, but we note that sample size is small (n=8).
Showerheads/household	1.5	From Wyoming participant survey, but we note that sample size is small (n=4). However, this compares to the value of 1.6 from the Michigan Evaluation Working Group Showerhead and Faucet Aerator Meter Study. June 2013.
Days/year	365	Conversion
Tinlet	51.9	From NREL Domestic Hot Water Event Generator - Wyoming.
Tmix	101	Michigan Evaluation Working Group Showerhead and Faucet Aerator Meter Study. June 2013.
Specific heat of water (Btu/gallon °F)	8.33	Standard conversion
kWh/Btu conversion (Btu/kWh)	3,412	Standard conversion
Recovery efficiency (RE) of water heater	0.98	Typical recovery efficiency for electric resistance heaters (IL TRM, IN TRM, ARK TRM).
%Elec	100%	Program targets homes with electric hot water heaters. Confirmed by the participant survey even though sample size was small (n=8).
ISR	100%	Assumed in-service rate.

Table 31 provides the deemed savings for low-flow showerheads, using the assumptions from Table 30.

Table 31. Low-Flow Showerhead Deemed Savings

Metric	Deemed Savings
kWh per showerhead	222

A.8 Domestic Water Heater Pipe Insulation

Table 32 documents the inputs and methodology for estimating domestic water heater pipe insulation savings.

Table 32. Algorithms and Inputs for DWH Pipe Insulation

Algorithms Used		
kWh Savings	$= (1/R_{exist} - 1/R_{new}) * L * C * \Delta T * 8,766 / nDHW / 3,412 * \%Elec * ISR$	
Source of Algorithm: Illinois TRM v5.0. Volume 3. Page 161.		
Parameter	Value	Source/Notes
Rexist	1	IL TRM. Navigant Consulting Inc., April 2009; "Measures and Assumptions for Demand Side Management (DSM) Planning"
Rnew	3	ASHRAE Fundamentals Chapter 23 - Table 2: 1. For a fluid design operating temp range of 105-140 °F, the insulation conductivity is 0.22 - 0.28 Btu*in/h*ft ² * °F. Assume midpoint (0.25). 2. To determine R-value, we need to divide the thickness of the insulation by the insulation conductivity (R value = insulation thickness (inches) / thermal conductivity (Btu*in/h*ft ² * °F)). 3. Assume 0.5 inch insulation based on standard pipe insulation thickness 4. R Value = 0.5 inch thickness / 0.25 Btu*in/h*ft ² * °F = R-2. 5. This R-value is added to the existing (R-1) to get the total new R-value (R-3).
Length of pipe insulation (L) in feet	6	Assume 6 feet per participant based on email exchange with program manager.
Circumference of pipe (C.) in feet	0.196	Assume 0.75" diameter pipe, = pi*diameter
ΔT (°F)	60	IL TRM. Assumes 125 °F water leaving the hot water tank and average temperature of basement of 65 °F.
Hours/year	8766	Conversion
nDHW	0.98	Recovery efficiency of electric hot water heater (IL TRM)
kWh/Btu conversion (Btu/kWh)	3412	Standard conversion
%Elec	100%	Program targets homes with electric hot water heaters. Confirmed by the participant survey even though sample size was small (n=8).
ISR	100%	Assumed in-service rate.

Table 33 provides the deemed savings for domestic water heater pipe insulation, using the assumptions from Table 32.

Table 33. Domestic Water Heater Pipe Insulation Deemed Savings

Metric	Deemed Savings
kWh per 6 feet	124

A.9 Doors

Table 34 documents the inputs and methodology for estimating door savings.

Table 34. Algorithms and Inputs for Doors

Algorithms Used		
kWh (cooling)	$= ((1/R_{existing} - 1/R_{new}) * Area * CDD * 24 * DUA) / (1,000 * SEER) * \%AC$	
kWh (heating)	$= ((1/R_{existing} - 1/R_{new}) * Area * HDD * 24) / (1,000 * nHeat) * \%AC$	
Source of Algorithm: Iowa TRM January 2017, v 2.0 (2.6.5)		
Parameter	Value	Source/Notes
U-value	0.26	ASHRAE 2017 Fundamentals sec 15.12, Table 6 assuming double glazing, insulated steel slab, 25% glazing.
Rnew	3.846	Calculated as 1/U
Rexisting	3.125	Iowa TRM v2.0 (2.6.5)
Area	20.25	Standard entry door: 6.75 ft x 3 ft
CDD	412	ASHRAE Fundamentals 2017 for Wyoming.
HDD	7182	
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.
%AC	57.1%	From RECS 2015 data for Wyoming (Mountain North).
SEER	13	Assume 13 SEER based on several TRMs. Assume equipment installed after 2006.
nHeat	1.36	Weighted average based on RECS 2015 data.
ISR	100%	Assumed in-service rate.

Table 35 provides the deemed savings for doors, based on the assumptions from Table 34.

Table 35. Door Deemed Savings

Metric	Deemed Savings
kWh per Door	123

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