

***Final Evaluation Report for PacifiCorp Residential wattsmart  
Homes Program in Utah***

Final Evaluation Report, Program Years 2017-2018

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Prepared for:  
***Rocky Mountain Power***

*October 25, 2019*

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# 1 Executive Summary

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This report provides results of the ADM Associates, Inc. (ADM) impact and process evaluation of the PacifiCorp 2017-2018 wattsmart Homes Program in Utah. The wattsmart Homes Program in the state of Utah provides incentives for PacifiCorp (also referred to as Rocky Mountain Power in this report) residential customers who purchase various eligible products or services.

During the 2017 and 2018 program years, the wattsmart Homes Program claimed gross energy savings of 138,672,872 kWh. The wattsmart Homes Program provided incentives for the following measure categories:

- **Appliances:** clothes washers and freezers (2017 only)
- **Building Shell:** air sealing (2018 only), insulation and windows (2018 only)
- **Energy Kits:** mailed energy kits containing combinations of LEDs, bathroom and kitchen faucet aerators, and showerheads
- **Heating, ventilation, and air conditioning (HVAC):** controls and thermostats, central air conditioning, evaporative coolers, room air conditioning, duct sealing, heat pumps and ventilation
- **Lighting:** LED bulbs and fixtures
- **Multifamily:** retrofit and new construction projects
- **New Homes:** HVAC and whole homes projects
- **Water Heating:** heat pump water heaters

For the impact evaluation, ADM determined the ex-post verified energy (kWh) savings that are achieved through Rocky Mountain Power's 2017-2018 wattsmart Homes Program in Utah. Rocky Mountain Power contracted with Navigant to assess program cost-effectiveness. The results of the cost-effectiveness assessment are also included in this report. For the process evaluation, ADM attempted to gain an in-depth understanding of program operations, challenges and evaluation needs through Rocky Mountain Power and implementation contractor key staff interviews, complemented with program documentation review and program participant surveys.

## 1.1 Evaluation Results

### 1.1.1 Impact Evaluation Results

Table 1-1 and Figure 1-1 present the impact evaluation results, including the claimed savings, evaluated gross savings, realization rates, evaluated net savings and net-to-gross (NTG) values for each measure category across both program years, 2017 and 2018. Table 1-2 and Table 1-3 present this information for each year 2017 and 2018 individually.

Table 1-1: Utah wattsmart Homes Program Claimed and Evaluated Savings by Measure Category, 2017-2018

Year	Measure Category	Claimed Savings (kWh)	Evaluated Gross Savings (kWh/yr)	Realization Rate	Evaluated Net Savings (kWh/yr)	Net to Gross
2017-2018	Appliances	147,420	147,420	100.0%	110,306	74.8%
	Building Shell	644,874	679,827	105.4%	649,598	95.6%
	Energy Kits	1,647,808	1,707,227	103.6%	1,522,334	89.2%
	HVAC	19,455,860	10,184,667	52.3%	9,759,308	95.8%
	Lighting	110,043,849	95,368,175	86.7%	70,964,280	74.4%
	New Homes	2,354,521	2,354,521	100.0%	1,402,824	59.6%
	Water Heating	16,830	16,830	100.0%	12,690	75.4%
	Whole Building Multifamily	4,361,710	4,304,662	98.7%	4,107,132	95.4%
<b>2017-2018 TOTAL</b>		<b>138,672,872</b>	<b>114,763,328</b>	<b>82.8%</b>	<b>88,528,472</b>	<b>77.1%</b>

Figure 1-1: Utah wattsmart Home Program Energy Savings, 2017-2018

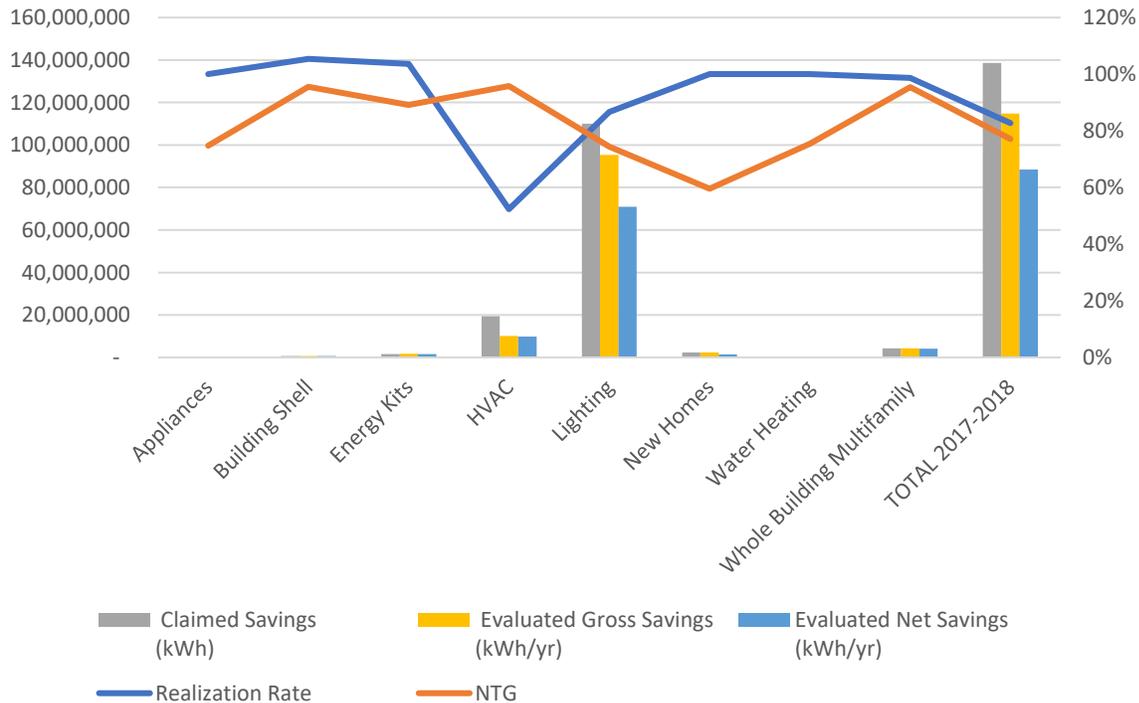


Table 1-2: Utah wattsmart Homes Program Claimed and Evaluated Savings by Measure Category, 2017

Year	Measure Category	Claimed Savings (kWh)	Evaluated Gross Savings (kWh/yr)	Realization Rate	Evaluated Net Savings (kWh/yr)	Net to Gross
2017	Appliances	147,420	147,420	100.0%	110,306	74.8%
	Building Shell	448,222	470,077	104.9%	439,848	93.6%
	Energy Kits	1,057,331	1,095,263	103.6%	976,646	89.2%
	HVAC	9,867,797	5,127,194	52.0%	4,868,361	95.0%
	Lighting	66,428,271	56,712,615	85.4%	42,030,674	74.1%
	New Homes	1,148,880	1,148,860	100.0%	684,491	59.6%
	Water Heating	9,226	9,226	100.0%	6,903	74.8%
	Whole Building Multifamily	-	-	-	-	-
<b>2017 TOTAL</b>		<b>79,107,147</b>	<b>64,710,676</b>	<b>81.8%</b>	<b>49,117,241</b>	<b>75.9%</b>

Table 1-3: Utah wattsmart Homes Program Claimed and Evaluated Savings by Measure Category, 2018

Year	Measure Category	Claimed Savings (kWh)	Evaluated Gross Savings (kWh/yr)	Realization Rate	Evaluated Net Savings (kWh/yr)	Net to Gross
2018	Appliances	-	-	-	-	-
	Building Shell	196,652	209,749	106.7%	209,749	100.0%
	Energy Kits	590,477	611,964	103.6%	545,688	89.2%
	HVAC	9,588,063	5,057,473	52.7%	4,890,948	96.7%
	Lighting	43,615,579	38,655,560	88.6%	28,933,606	74.8%
	New Homes	1,205,641	1,205,641	100.0%	718,321	59.6%
	Water Heating	7,604	7,604	100.0%	5,787	76.1%
	Whole Building Multifamily	4,361,710	4,304,662	98.7%	4,107,132	95.4%
<b>2018 TOTAL</b>		<b>59,565,726</b>	<b>50,052,652</b>	<b>84.0%</b>	<b>39,411,231</b>	<b>78.7%</b>

### 1.1.2 Process Evaluation Results

Key process evaluation results include the following:

- Program participants satisfied with Rocky Mountain Power as their electricity provider.** The large majority of program participant survey respondents reported being either “very satisfied” or “satisfied” with Rocky Mountain Power (RMP) as their electricity service provider, with approximately 81% of General Population Survey respondents, 77% of Energy Kits Survey respondents and 83% of HVAC Survey respondents reporting that they were either “very satisfied” or “satisfied”.
- Website and bill inserts were the top ways participants learned of RMP programs or incentives.** Program participant survey respondents mostly reported learning about the programs or being aware of incentives through Rocky Mountain Power’s website or bill inserts. For General Population Survey respondents, 34%

reported the website and 16% reported bill inserts as sources of program awareness. For Energy Kits Survey respondents, 37% reported bill inserts and 35% reported the website and for HVAC Survey respondents, 25% reported the website and 22% reported bill inserts as the sources of program awareness.

- **Price and lifetime of bulbs were important to customers.** General population survey respondents reported that the most important characteristics considered when purchasing light bulbs were energy efficiency (74%), price (74%), length of the bulb's life (65%) and brightness of the bulb (60%).
- **Saving money on utility bills was important to customers.** Over two thirds (65%) of Energy Kits Survey respondents reported that "saving money on utility bills" was the most important reason for requesting an energy kit. Additionally, 13% of survey respondents reported that "concern for the environment" was the most important reason for requesting an energy kit and 35% reported this as the second most important reason.
- **Reducing energy costs is the most important benefit to new homes buyers interested in energy efficiency.** New Home Builder Interview respondents conveyed what they believe are the primary benefits to new homes buyers who are interested in purchasing a new home that is energy efficient, with 92% pointing to reducing energy costs and 50% pointing to concern about the environment.
- **Most New Homes builders do not believe there are significant barriers to participation in Rocky Mountain Power's program.** Two thirds of the New Home Builder Interview respondents did not believe there were any barriers to participation, while the other one third indicated that there are some barriers that may discourage them or others from participating. The barriers cited by builders included costs, not having an established relationship with a Home Energy Rating System (HERS) rater, lack of understanding and knowledge among builders, and the incentive being less than the cost of the program-qualifying equipment.
- **Current New Home builders plan to participate in Rocky Mountain Power's program again.** All New Home Builder Interview respondents indicated that they planned to participate in the new construction program in 2019, with half believing they would build 100% of the homes to the program standards and 33% indicating they would build between 75% and 95% of the homes to the program standards.

### **1.1.3 Cost-Effectiveness Results**

The Utah wattsmart Homes Program was cost-effective during the 2017-2018 evaluation period, across all cost-effectiveness tests except for the Ratepayer Impact Measure (RIM) test. Table 1-4 below shows the results for the overall program for the combination of

program years 2017 and 2018, based on evaluated net savings. The overall program achieved a 2.13 benefit/cost ratio for the combined years using the Utility Cost Test (UCT).

*Table 1-4: 2017-2018 wattsmart Homes Program Level Cost-Effectiveness Results*

<b>Cost-Effectiveness Test</b>	<b>Levelized \$/kWh</b>	<b>Costs</b>	<b>Benefits</b>	<b>Net Benefits</b>	<b>Benefit/Cost Ratio</b>
PacifiCorp Total Resource Cost Test (PTRC) + Conservation Adder	\$0.0541	\$45,174,969	\$53,726,896	\$8,551,927	1.19
Total Resource Cost Test (TRC) No Adder	\$0.0541	\$45,174,969	\$48,842,633	\$3,667,664	1.08
Utility Cost Test (UCT)	\$0.0275	\$22,963,053	\$48,842,633	\$25,879,580	2.13
Rate Impact Test (RIM)		\$120,936,968	\$48,842,633	(\$72,094,335)	0.4
Participant Cost Test (PCT)		\$45,235,175	\$142,132,604	\$96,897,429	3.14
Lifecycle Revenue Impacts (\$/kWh)					\$0.00001010
Discounted Participant Payback (years)					4.35

Table 1-5 and Table 1-6 below show the Utah wattsmart Homes Program cost-effectiveness results for the 2017 and 2018 years individually, based on evaluated savings. The Utah wattsmart Homes Program was cost-effective using the UCT in 2018. The Utah wattsmart Homes Program was cost-effective across all cost-effectiveness tests except for the RIM test in 2017.

*Table 1-5: 2017 wattsmart Homes Program Level Cost-Effectiveness Results*

<b>Cost-Effectiveness Test</b>	<b>Levelized \$/kWh</b>	<b>Costs</b>	<b>Benefits</b>	<b>Net Benefits</b>	<b>Benefit/Cost Ratio</b>
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.0427	\$19,344,888	\$34,596,385	\$15,251,497	1.79
Total Resource Cost Test (TRC) No Adder	\$0.0427	\$19,344,888	\$31,451,259	\$12,106,371	1.63
Utility Cost Test (UCT)	\$0.0261	\$11,837,537	\$31,451,259	\$19,613,721	2.66
Rate Impact Test (RIM)		\$66,161,286	\$31,451,259	(\$34,710,027)	0.48
Participant Cost Test (PCT)		\$19,367,933	\$79,493,365	\$60,125,432	4.1
Lifecycle Revenue Impacts (\$/kWh)					\$0.00001018
Discounted Participant Payback (years)					2.09

Table 1-6: 2018 wattsmart Homes Program Level Cost-Effectiveness Results

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.0678	\$25,830,081	\$19,130,511	(\$6,699,570)	0.74
Total Resource Cost Test (TRC) No Adder	\$0.0678	\$25,830,081	\$17,391,374	(\$8,438,707)	0.67
Utility Cost Test (UCT)	\$0.0292	\$11,125,516	\$17,391,374	\$6,265,858	1.56
Rate Impact Test (RIM)		\$54,775,682	\$17,391,374	(\$37,384,308)	0.32
Participant Cost Test (PCT)		\$25,867,242	\$62,639,239	\$36,771,997	2.42
Lifecycle Revenue Impacts (\$/kWh)					\$0.00001003
Discounted Participant Payback (years)					4.65

## 1.2 Conclusions and Recommendations

ADM provides the following conclusions and recommendations to improve the program and the evaluation of the program in future years.

- **Lighting Measure Category:**

Conclusion: ADM’s calculation of an 8% leakage rate for lighting in Utah is on the low end of leakage rates for lighting and is likely due to the relatively large and connected Rocky Mountain Power territory in Utah and the effective or strategic placement of participating retailer locations. The implementation contractor has indicated that the Retail Sales Allocation Tool (RSAT) may be a predictor of bulb leakage in Rocky Mountain Power territories and is used to determine allocations of bulbs to participating stores.

Recommendation: To understand further how the RSAT tool accounts for leakage and how the store allocations relate to the Program Tracking Data, ADM recommends that the next evaluation of subsequent program years includes a full life-cycle review of the lighting contracts, including the participation agreements with the implementation contractor and a sample of all associated invoices. This would allow the evaluation to follow the life-cycle of the bulbs from the original agreement to final installation.

- **Energy Kits Measure Category:**

Conclusion: The showerhead energy kits component had the lowest overall ISR of all energy kit components. This was driven by a 56% ISR for the second showerhead in the Best Kit – 2 Bathroom Energy Kits compared to an 85% ISR for the first showerhead.

Recommendation: ADM recommends that Rocky Mountain Power consider including only one showerhead in the Best Kit – 2 Bathroom Energy Kits, which could increase the overall ISR for showerheads.

- **HVAC Measure Category:**

HVAC Conclusion #1: The evaporative cooler HVAC measure had the lowest net realization rate in the evaluation, which is likely due to the SEER 13 baseline assumption that is used in the source of the claimed savings value. Through the billing analysis, ADM found that the treatment group for evaporative coolers appear to have already drastically reduced consumption relative to the control group, indicating that the majority of participants who installed evaporative coolers didn't have an air conditioning unit previously and thus the use of a SEER 13 baseline assumption in this evaluation would require additional information on participant baseline data.

HVAC Recommendation #1: In future evaluation cycles, ADM recommends further data collection on evaporative cooler baseline conditions and purchase decisions. Given the move to a midstream measure, ADM recommends working with distributors to either collaborate on a methodology to reach program participants through gathering contact information at the purchase point or interviewing distributors directly as a proxy to understand program participants purchase decisions and baseline conditions.

HVAC Conclusion #2: ADM was limited to a deemed savings review for the heat pump measure category due to the low participant numbers and too low of a sample size to use the results of the billing analysis for this group.

HVAC Recommendation #2: ADM recommends that during the next evaluation cycle, savings are calculated for heat pump measures using an engineering desk review approach in addition to the deemed savings review. In order to do this, ADM would need baseline equipment type and specifications (e.g. make and model) and the post installation equipment specifications (e.g. capacity, HSPF, SEER, number of indoor units).

- **Whole Building Multifamily Measure Category:**

Multifamily Conclusion #1: ADM reviewed the modeling files associated with the claimed savings values for five of the 19 multifamily project sites. The provided documentation was insufficient for verification purposes, but ADM determined that the energy savings claimed for each project were reasonable.

Multifamily Recommendation #1: In order to sufficiently verify the whole building multifamily projects, ADM recommends that more detailed documentation be collected by the program implementer in subsequent program years. Ideal documentation would include as-built drawings, any available compliance documentation (e.g. COMcheck reports, approved building plans), and any calculations done outside of the modeling software. ADM recommends that any additional compliance documentation that is collected is done so in a way that minimizes the burden on program participants. Rocky Mountain Power staff indicated that asking for further compliance information could defer contractors from participating in the program. To address this concern, ADM recommends that all parties work together to ensure that any additional burden is minimized.

Multifamily Conclusion #2: ADM reached out to all 20 of the building managers for multifamily retrofit projects to attempt to conduct interviews regarding NTG inputs and process evaluation specific to multifamily projects. ADM was able to complete six interviews but did not apply the resulting multifamily NTG value because of the limited sample size.

Multifamily Recommendation #2: Because the whole building multifamily measures were newly incentivized in 2018 and represented approximately 7.3% of overall claimed savings in 2018, ADM recommends that the next evaluation cycle includes increased rigor of the evaluation for this measure. This would include case studies and in-depth interviews with building managers and decision makers at both market-rate and low-income multifamily projects. The interviews conducted during the 2017-2018 evaluation cycle will inform the refinement of the survey tool for the subsequent evaluation cycle.

- **New Homes Measure Category:**

Conclusion: ADM completed 12 interviews with new homes builders that represent approximately 58% of total claimed savings and 47% of all homes for new homes measures in 2017 and 2018. While this represents a significant sample of new homes in the program, it would be advantageous to reach additional builders in the program to expand the sample during the next evaluation cycle.

Recommendation: In order to reach more new homes builders, ADM recommends that during the next evaluation cycle, interviews focus on two points of contact (e.g. production and purchasing) for each site.

## 2 Introduction and Purpose of Study

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ADM Associates, Inc. (ADM) is under contract with Rocky Mountain Power to perform evaluation, measurement and verification (EM&V) services to determine the ex-post verified energy (kWh) savings that are achieved through Rocky Mountain Power's 2017-2018 Home Energy Savings Program in the states of California and Washington; and wattsmart Homes Program in Idaho, Utah and Wyoming.

This document is the Final Evaluation Report for the 2017-2018 wattsmart Homes Program in Utah. Henceforth in this document, ADM may refer to the Utah wattsmart Homes Program as "the Program." Program year 2017 (PY 2017) and program year 2018 (PY 2018) coincide with the respective calendar years. The purpose of this report is to present the results of the impact evaluation effort undertaken by ADM to verify the energy savings and peak demand reductions that resulted from the Program, as further described in subsequent sections. Additionally, this report presents the results of the process evaluation of the Program completed by ADM focusing on participant and program staff perspectives regarding the Program's implementation.

### 2.1 Description of the Programs

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The Program in the state of Utah provides incentives for Rocky Mountain Power residential customers who purchase various eligible products or measures. Measures include energy-efficient appliances, lighting such as ENERGY STAR® light emitting diodes (LEDs), appliances, building shell measures, energy kits, heating, ventilation, and air conditioning (HVAC) equipment, heat pump water heaters and new homes measures.

The Program is promoted by Rocky Mountain Power's marketing team and cross-promoted with participating retailers and trade allies. There is also significant effort to provide information and educational opportunities to customers and participating market partners. The Program leverages relationships with manufacturers, distributors, and retailers to ensure effective program implementation and optimize participation.

Program incentives are provided to Rocky Mountain Power customers either at the point-of-sale as an instant incentive, or as a mail-in incentive application that upon approval is paid post-purchase. Point-of-sale incentives are also known as upstream or midstream incentives. A typical upstream incentive or 'upstream distribution method' is the instant incentive that the program provides for ENERGY STAR LEDs (this is also called an upstream measure). The LED incentive is provided to the LED manufacturer. Consumers benefit from upstream incentives by buying LEDs at discounted prices made possible by the incentive that was funded upstream. A point-of-sale incentive usually does not require the consumer to use a coupon or provide an incentive form. This is an efficient and cost-

effective means to provide consumers instant incentives for relatively high-volume, low-cost measures such as LEDs.

A typical midstream incentive or ‘midstream distribution method’ is a point-of-sale incentive provided through an equipment distributor, such as an HVAC equipment incentive funded at the HVAC distributor, who subsequently discounts energy-efficient equipment prices to reflect the program incentive.

The ‘downstream distribution method’ pays the specified incentive amount per energy-efficiency measure directly to the Rocky Mountain Power customer after the customer completes an application form for an eligible measure. The application form is usually completed online or mailed in. Typical downstream measures include energy-efficient appliances and relatively high-cost HVAC equipment and services.

## **2.2 Distribution Methods and Measure Categories**

An overview of measure categories and measure types in the 2017-2018 Programs is shown in Table 2-1. For each measure type, the distribution method is indicated: upstream, midstream, or downstream.

*Table 2-1: 2017-2018 Utah Measure Categories and Distribution Methods*

Measure Category and Measure Type	Distribution Method	
	Upstream or Midstream	Downstream
<b>Appliances</b>		
Clothes Washers		Yes
Freezers		Yes
<b>Building Shell</b>		
Air Sealing		Yes
Insulation		Yes
Windows		Yes
<b>Energy Kits</b>		
Lighting		Yes
Lighting and Plumbing		Yes
<b>HVAC</b>		
Controls (smart thermostats)		Yes
Cooling	Yes	Yes
Deep Retrofit		Yes
Ducting		Yes
Heat Pump		Yes
Ventilation		Yes
<b>Lighting</b>		
General Service Fixtures	Yes	
General Service Lamps	Yes	
Specialty Lamps	Yes	
<b>Multifamily</b>		

Measure Category and Measure Type	Distribution Method	
	Upstream or Midstream	Downstream
New Construction		Yes
Retrofit		Yes
<b>New Homes</b>		
HVAC		Yes
Whole Home		Yes
<b>Water Heating</b>		
Heat Pump Water Heater		Yes

## 2.3 Program Participation

During the 2017-2018 program years, Rocky Mountain Power provided incentives to residential customers that resulted in the quantity of measures shown in Table 2-2 and Table 2-3. Rocky Mountain Power also provided upstream discounts for 103,320 lighting fixtures and 1,945,384 lighting bulbs in 2017 and 63,866 lighting fixtures and 2,903,860 lighting bulbs in 2018. Table 2-2 and Table 2-3 also show the associated claimed savings for each measure during 2017 and 2018.

Table 2-2: 2017 Claimed Program Quantity and Savings by Measure

Measure Category	Measure Type	Claimed Quantity	Quantity Type	Claimed kWh Savings
Appliances	Clothes Washer	1,026	Measures	140,766
	Freezer	100	Measures	6,654
Building Shell	Air Sealing	2,906	Square Feet	1,685
	Insulation	1,258,895	Square Feet	326,467
	Windows	108,899	Square Feet	120,070
Energy Kits	Lighting	2,901	Kits	242,523
	Lighting and Plumbing	1,305	Kits	814,808
HVAC	Controls and Thermostats	7,165	Measures	1,233,327
	Cooling	8,880	Measures	6,727,020
	Ducting	598	Measures	182,055
	Heat Pump	133	Measures	573,419
	Ventilation	2,371	Measures	1,151,976
Lighting	General Service Fixtures	63,866	Fixtures	1,858,501
	General Service Lamps	2,015,113	Bulbs	35,112,026
	Specialty Lamps	888,747	Bulbs	29,457,744
New Homes	HVAC	256	Measures	60,997
	Whole Homes	3,609	Measures	1,087,883
Water Heating	Water Heater	6	Measures	9,226
<b>2017 TOTAL</b>				<b>79,107,147</b>

Table 2-3: 2018 Claimed Program Quantity and Savings by Measure

Measure Category	Measure Type	Claimed Quantity	Quantity Type	Claimed kWh Savings
Building Shell	Insulation	1,315,100	Square Feet	196,652
Energy Kits	Lighting	1,801	Kits	149,915
	Lighting and Plumbing	684	Kits	440,562
HVAC	Controls and Thermostats	11,036	Measures	2,151,964
	Cooling	7,619	Measures	6,428,694
	Heat Pump	62	Measures	100,507
	Ventilation	1,969	Measures	906,898
Lighting	General Service Fixtures	103,320	Fixtures	3,006,612
	General Service Lamps	1,240,111	Bulbs	21,209,346
	Specialty Lamps	705,273	Bulbs	19,399,621
New Homes	Whole Homes	3,314	Measures	1,205,641
Water Heating	Water Heater	5	Measures	7,604
Whole Building	Custom	18	Measures	2,373,061
	Whole Building	45	Measures	1,988,649
<b>2018 TOTAL</b>				<b>59,565,726</b>

## 2.4 Impact Evaluation Objectives

The primary objective of the impact evaluation is to determine ex-post verified gross energy (kWh) savings and net kWh savings. ADM executed the following steps to determine ex-post verified gross and net kWh savings.

- Review and reconcile program tracking data to the claimed participation counts and ex-ante savings in the 2017 and 2018 annual reports.
- Administer participant surveys to determine actual installation rates at the measure level. Surveys were administered online-only in Utah.
- Determine gross unit energy savings (“UES”), which incorporate verified measure installation rates and employ engineering analyses for lighting and energy kits; or employ billing analysis (regression analysis) for some HVAC and building shell measures; or employ deemed savings review for some appliance, HVAC, building shell, multifamily and new homes measures.
- Determine net savings by applying survey results and by also employing demand elasticity modeling for the upstream lighting measure category. Note that no net savings adjustments are needed for measures for which billing analyses are utilized to determine ex-post verified savings.
  - Net-to-gross and realization values used to determine net savings by measure category and program level.
- Achieve a minimum precision of  $\pm 10\%$  with 90% statistical confidence (“90/10 precision”) for gross realized savings estimates by program.
- Provide comprehensive documentation and transparency for all evaluation tasks.

- Estimate leakage impacts utilizing geospatial analysis (i.e., ArcGIS or similar).
- Provide inputs for cost benefit analyses.
- Provide ongoing technical reviews and guidance throughout the evaluation cycle.
- There was no on-site verification or equipment monitoring.

## **2.5 Process Evaluation Objectives**

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The overarching approach to process evaluation is the following.

- To gain an in-depth understanding of program operations and the challenges and evaluation needs through Rocky Mountain Power and implementation contractor key staff interviews, complemented with program documentation review and program participant surveys.

Specifically, the process evaluation was designed to answer the following research questions.

- How well did Rocky Mountain Power staff, implementation staff, participants, and trade allies work together?
- How do participants learn about the program? What percentage is contacted directly by Rocky Mountain Power or implementation staff? What percentage hears about the program through another avenue and then contacts Rocky Mountain Power?
- Were program participants satisfied with their experiences? What was the level of satisfaction with the work performed, the scheduling/application process, and other aspects of program participation? What are the perceived energy and non-energy benefits associated with the program?
- What are key barriers and drivers to program success within Rocky Mountain Power's service territories? How can those be addressed to improve program operations in the future

### 3 Impact Evaluation

This chapter presents the findings of the impact evaluation for the Utah wattsmart Homes Program. Table 3-1 and Figure 3-1 present the impact evaluation results, including the claimed savings, evaluated gross savings, realization rates, evaluated net savings and net-to-gross (NTG) values for each measure category across both program years, 2017 and 2018. Table 3-2 presents the same information for each individual year, 2017 and 2018.

*Table 3-1: wattsmart Homes Program Claimed and Evaluated Savings for 2017-2018*

Year	Measure Category	Measure Type	Claimed Savings (kWh)	Evaluated Gross Savings (kWh/yr)	Realization Rate	Evaluated Net Savings (kWh/yr)	NTG
2017-2018	Appliances	Clothes Washers	140,766	140,766	100.0%	105,327	74.8%
		Freezers	6,654	6,654	100.0%	4,979	74.8%
	Building Shell	Air Sealing	1,685	1,798	106.7%	1,798	100.0%
		Insulation	523,119	557,959	106.7%	557,959	100.0%
		Windows	120,070	120,070	100.0%	89,841	74.8%
	Energy Kits	LED Only	392,438	429,575	109.5%	383,052	89.2%
		Best Kit - 1 Bathroom	193,476	209,212	108.1%	186,555	89.2%
		Best Kit - 2 Bathroom	1,061,894	1,068,440	100.6%	952,728	89.2%
	HVAC	Controls and Thermostats	3,385,291	3,385,291	100.0%	3,210,610	94.8%
		Cooling	13,155,714	4,722,169	35.9%	4,639,876	98.3%
		Ducting	182,055	204,193	112.2%	204,193	100.0%
		Heat Pump	673,926	673,926	100.0%	505,541	75.0%
		Ventilation	2,058,874	1,199,088	58.2%	1,199,088	100.0%
	Lighting	General Service Fixtures	4,865,113	4,642,164	95.4%	4,226,226	91.0%
		General Service Lamps	56,321,372	48,868,268	86.8%	35,947,498	73.6%
		Specialty Lamps	48,857,365	41,857,743	85.7%	30,790,556	73.6%
	New Homes	HVAC	60,997	60,997	100.0%	36,342	59.6%
		Whole Homes	2,293,524	2,293,524	100.0%	1,366,482	59.6%
	Water Heating	Water Heater	16,830	16,830	100.0%	12,690	75.4%
	Whole Building	Retrofit	2,153,977	2,096,929	97.4%	2,000,706	95.4%
New Construction		2,207,733	2,207,733	100.0%	2,106,426	95.4%	
<b>2017-2018 TOTAL</b>			<b>138,672,872</b>	<b>114,763,328</b>	<b>82.8%</b>	<b>88,528,472</b>	<b>77.1%</b>

Figure 3-1: 2017-2018 wattsmart Home Program Energy Savings



Table 3-2: wattsmart Homes Program Claimed and Evaluated Savings for 2017 and 2018

Year	Measure Category	Measure Type	Claimed Savings (kWh)	Evaluated Gross Savings (kWh/yr)	Realization Rate	Evaluated Net Savings (kWh/yr)	NTG
2017	Appliances	Clothes Washers	140,766	140,766	100.0%	105,327	74.8%
		Freezers	6,654	6,654	100.0%	4,979	74.8%
	Building Shell	Air Sealing	1,685	1,798	106.7%	1,798	100.0%
		Insulation	326,467	348,210	106.7%	348,210	100.0%
		Windows	120,070	120,070	100.0%	89,841	74.8%
	Energy Kits	LED Only	242,523	265,035	109.3%	236,332	89.2%
		Best Kit - 1 Bathroom	139,124	150,440	108.1%	134,147	89.2%
		Best Kit - 2 Bathroom	675,684	679,788	100.6%	606,167	89.2%
	HVAC	Controls and Thermostats	1,233,327	1,233,327	100.0%	1,169,687	94.8%
		Cooling	6,727,020	2,445,344	36.4%	2,394,514	97.9%
		Ducting	182,055	204,193	112.2%	204,193	100.0%
		Heat Pump	573,419	573,419	100.0%	429,055	74.8%
		Ventilation	1,151,976	670,911	58.2%	670,911	100.0%
	Lighting	General Service Fixtures	1,858,501	1,789,898	96.3%	1,629,523	91.0%
		General Service Lamps	35,112,026	30,194,609	86.0%	22,211,154	73.6%
		Specialty Lamps	29,457,744	24,728,109	83.9%	18,189,997	73.6%
	New Homes	HVAC	60,997	60,997	100.0%	36,342	59.6%
		Whole Homes	1,087,883	1,087,883	100.0%	648,161	59.6%
	Water Heating	Water Heater	9,226	9,226	100.0%	6,903	74.8%
	<b>2017 TOTAL</b>			<b>79,107,146</b>	<b>64,710,675</b>	<b>81.8%</b>	<b>49,117,240</b>
2018	Building Shell	Insulation	196,652	209,749	106.7%	209,749	100.0%
	Energy Kits	LED Only	149,915	164,539	109.8%	146,720	89.2%
		Best Kit - 1 Bathroom	54,352	58,772	108.1%	52,407	89.2%
		Best Kit - 2 Bathroom	386,210	388,652	100.6%	346,561	89.2%
	HVAC	Controls and Thermostats	2,151,964	2,151,964	100.0%	2,040,923	94.8%
		Cooling	6,428,694	2,276,824	35.4%	2,245,362	98.6%
		Heat Pump	100,507	100,507	100.0%	76,486	76.1%
		Ventilation	906,898	528,177	58.2%	528,177	100.0%
	Lighting	General Service Fixtures	3,006,612	2,852,266	94.9%	2,596,703	91.0%
		General Service Lamps	21,209,346	18,673,659	88.0%	13,736,344	73.6%
		Specialty Lamps	19,399,621	17,129,634	88.3%	12,600,559	73.6%
	New Homes	Whole Homes	1,205,641	1,205,641	100.0%	718,321	59.6%
	Water Heating	Water Heater	7,604	7,604	100.0%	5,787	76.1%
	Whole Building	Retrofit	2,153,977	2,096,929	97.4%	2,000,706	95.4%
		New Construction	2,207,733	2,207,733	100.0%	2,106,426	95.4%
<b>2018 TOTAL</b>			<b>59,565,726</b>	<b>50,052,652</b>	<b>84.0%</b>	<b>39,411,231</b>	<b>78.7%</b>

### **3.1 Impact Evaluation Approach**

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#### **3.1.1 Data Collection and Measure Verification**

During the period of this evaluation, ADM reviewed and reconciled program tracking data to the participation counts and ex-ante savings indicated in the 2017 and 2018 annual reports. ADM reviewed a census of program tracking data. In concert with tracking data reviews, ADM also reviewed the savings values and measure savings assumptions and calculations contained in the Technical Resource Library (TRL) files provided by Rocky Mountain Power. ADM issued data requests as needed to ensure that all data was collected that could be reasonably expected or required for this evaluation.

ADM conducted surveys to verify measure installation and collected additional primary data from program participants, including data related to purchasing decisions which was utilized in the freeridership and spillover analyses. ADM surveyed a representative sample of known participants and employed a general population survey for unknown participants (those who purchased upstream measures).

The following provides additional detail regarding data collection and measure verification activities.

- **Review of the program tracking database** is an essential first step for verifying data integrity. ADM assessed the program data management system DSMC – which facilitates data collection and organization. ADM reviewed a census of program tracking data contained in DSMC. Each program year’s dataset was reviewed for completeness, consistency, and compliance with the provided TRL files.
- **Review of measure savings assumptions and calculations** occurred concurrent with the DSMC data reviews mentioned above. Savings values are maintained in the Technical Reference Library (TRL). The TRL files sometimes include measure savings assumptions, calculations, source papers or files (e.g. RTF versions), and additional documentation that together comprise the generally accepted rules and guidance for evaluating the Programs. ADM reviewed all TRL documentation and included in this report any errors, omissions, or inconsistencies identified during ADM’s review.
- **Data requests** related to EM&V activities occurred throughout the period of this evaluation. ADM provided Rocky Mountain Power various data requests for DSMC and TRL data pulls and reports, and other program data and verification, as necessary.

- **Online surveys were developed/administered** to verify measure installation and collect additional primary data from program participants. ADM surveyed a representative sample of known participants, i.e., customers who implemented midstream or downstream measures, for which incentives are provided to specific Rocky Mountain Power customers. ADM also employed a general population survey for Rocky Mountain Power customers to survey the unknown upstream customers. A general population survey is an effective tool to identify the upstream participants. Surveys were online-only for Utah.

### **3.1.2 Sample Design**

A representative participant sample was developed for each of the following measure categories in Utah: appliances, energy kits, HVAC, lighting, new homes. ADM achieved a sampling precision of  $\pm 10\%$  with 90% statistical confidence – or “90/10 precision” – for gross realized savings estimates at the measure category level for all significant measures. (Notably, 90/10 precision can be difficult to achieve for a very small population of participants for a given measure category.)

For measure categories for which program participants are known – i.e., midstream and downstream measures – the sampling frame is the population of participants for a given measure category/state.

Midstream participants in the 2017-2018 Programs aren’t always known. The subset of unknown midstream participants were evaluated essentially the same as if they were upstream participants (see following paragraph).

For upstream measure categories – for which participants are not known – the Utah sampling frame is the population of Rocky Mountain Power residential customers excluding these residential customers: known participants in 2017-2018 Programs and known participants in other energy efficiency programs that Rocky Mountain Power is implementing in 2017 or 2018.

Actual sample sizes were dependent on participant counts and specific measures installed. For the evaluation activities listed below, ADM utilized the following sample sizes.

- Census review for all measures listed in the DSMC program tracking database to ensure appropriate use of deemed savings values (described in detail above).
- Review of a stratified sample of 51 lighting invoices associated with upstream lighting measures. The sampling precision was 6.16% at the 90% confidence interval.

- A sample of known program participants were surveyed for measure installation rates, net-to-gross (NTG) analyses, and process evaluation questions regarding the specific measures they implemented according to DSMC datasets. A sample of all other residential customers will be surveyed using a general population survey. Survey sample sizes per measure category are provided in the following Table 3-3.

*Table 3-3: Impact Evaluation Survey Sample Size*

Survey	Number of Survey Invites Sent	Number of Completed Surveys	Response Rate	Impact Evaluation Survey Sample (n)
General Population Survey	3,600	365	10%	236
Energy Kits Survey	3,182	221	7%	221
HVAC Survey	751	75	10%	72
New Homes Builders Survey	40	12	30%	12

### 3.1.3 Impact Evaluation Approach by Measure Category

Table 3-4 shows the methodology approach for each gross and net savings evaluation step for each measure. For the measure types with no adjustment made to the gross evaluated savings, ADM performed a review of the deemed savings values, savings assumptions and calculations, modeling files, and other information contained in the applicable TRL files and sources of savings values. Through this review, ADM did not find any reasons to adjust the claimed savings for these measures. For the measures in which ADM did not have a unique NTG value or did not have net savings results from a billing analysis, ADM applied the program level NTG values for each year. The program level NTG values are representative of approximately 72% of overall gross program savings and thus are used as an approximation for a value for the measures that did not have a unique NTG value. This approach results in a more conservative net savings value than using an assumed NTG value of 1. The program level NTG values applied to these measures do not include the new homes or whole building measures or the measures for which ADM conducted a billing analysis. Additionally, for measures in which ADM conducted a billing analysis, the evaluated results are net results. Thus, there was no additional NTG value applied to the evaluated savings for those measures.

*Table 3-4: 2017-2018 Impact Evaluation Methodology Approach by Measure*

Measure Category	Measure Type	Impact Evaluation Methodologies	Inputs to Gross Evaluated Savings	Inputs to NTG
Appliances	Clothes Washer	Deemed Savings Review	No adjustment	Program-level NTG
	Freezer	Deemed Savings Review	No adjustment	Program-level NTG
Building Shell	Air Sealing and Insulation	Billing Analysis	Billing Analysis	N/A
	Windows	Deemed Savings Review	No adjustment	Program-level NTG
Energy Kits	Lighting, and Lighting and Plumbing	Engineering Analysis / Energy Kits Survey	Energy Kits Survey	Energy Kits Survey

<b>Measure Category</b>	<b>Measure Type</b>	<b>Impact Evaluation Methodologies</b>	<b>Inputs to Gross Evaluated Savings</b>	<b>Inputs to NTG</b>
HVAC	Controls and Thermostats	HVAC Survey	HVAC Survey	HVAC Survey
	Central Air Conditioning, Ducting and Ventilation	Billing Analysis	Billing Analysis	N/A
	Evaporative Cooler	Billing Analysis	Billing Analysis	N/A
	Heat Pump	Deemed Savings Review	No adjustment	Program-level NTG
Lighting	General Service Lamps and Fixtures	Engineering Analysis / General Population Survey	General Population Survey	General Population Survey
	Specialty Lamps	Engineering Analysis / General Population Survey	General Population Survey	General Population Survey
New Homes	HVAC	Site specific	No adjustment	Builders Survey
	Whole Homes	Desk Review of Modeling Files	No adjustment	Builders Survey
Water Heating	Water Heater	Deemed Savings Review	No adjustment	Program-level NTG
Whole Building	Retrofit	Site specific	Site specific	Site specific
	New Construction	Desk Review of Modeling Files	No adjustment	Whole Building Retrofit NTG

### **3.2 Evaluated Savings**

ADM determined gross unit energy savings (“UES”) and evaluated net energy savings by incorporating verified measure installation rates, including installation rates by room, freeridership scores, and spillover from participant surveys together with engineering analyses for lighting and energy kits; billing analyses (regression analyses) for most HVAC and building shell measures; and deemed savings reviews for appliance, some HVAC and building shell measures, and multifamily and new homes measures. The deemed savings reviews for some HVAC measures as well as multifamily and new homes measures were supplemented with participant surveys or other methodologies to determine net savings values.

ADM’s estimation of verified UES per measure takes into consideration Utah’s deemed savings values and the measure savings assumptions and calculations contained in the provided TRL files. Utah protocols frequently refer to the Regional Technical Forum (RTF), which maintains a library of UES measures. The UES values in Utah may be adjusted to reflect specific, generally accepted evaluation requirements in Utah.

#### **3.2.1 Lighting**

For lighting measure categories, Rocky Mountain Power claimed the following gross energy savings detailed in Table 3-5 for Utah in 2017 and 2018.

*Table 3-5: 2017-2018 Utah Claimed Gross Energy Savings for Lighting Measures*

<b>Measure Category</b>	<b>Measure Type</b>	<b>2017 Quantity</b>	<b>2017 Savings (kWh)</b>	<b>2018 Quantity</b>	<b>2018 Savings (kWh)</b>
Lighting	General Service Fixtures	63,866	1,858,501	103,320	3,006,612
	General Service Lamps	2,015,113	35,112,026	1,240,111	21,209,346
	Specialty Lamps	888,747	29,457,744	705,273	19,399,621

### 3.2.1.1 Database Review

For all lighting measures in Utah in 2017 and 2018, ADM reviewed and reconciled the program tracking data to the claimed participation counts and ex-ante savings in the 2017 and 2018 annual reports. Further, ADM conducted the review activities detailed below for lighting measures.

#### 3.2.1.1.1 General Service Lamps and Specialty Lamps (ENERGY STAR®LEDs)

ADM conducted an ex-ante review of the Program’s 2017 and 2018 Lighting data for General Service Lamps and Specialty Lamps. In this review, the following activities were performed:

- Verification of measure incentive requirements (e.g. ENERGY STAR® qualified status)
- Review of a sample of retailer and distributor invoices
- Verification that the program tracking dataset does not include duplicate or erroneous data entries
- Confirmed data entries in the program tracking dataset include all necessary fields for savings calculations (e.g. program tracking data model numbers were cross checked with verified watts per lamp and baseline wattages)
- Verification that all energy savings are claimed in accordance with the applicable TRL documents and calculations

ADM reviewed each of the 36 individual Lighting measures for 2017 and 38 individual Lighting measures for 2018, including both general service lamps and specialty lamps. ADM verified for all lighting measures that the claimed savings per measure were supported by the applicable TRL documents. Overall, the total claimed savings by Rocky Mountain Power for all lighting measures is equal to the ADM reviewed ex-ante savings.

The TRL values for Lighting measures in Utah were updated on December 12, 2016 and thus ADM’s review utilized one TRL source document for measures with an effective date before December 12, 2016 and another TRL source document for measures with an effective date after December 12, 2016. The updated UES values in the TRL source

document for measures with an effective date after December 12, 2016 were lower than those in the previous version, primarily driven by a lower input for hours of use (HOU).

### 3.2.1.1.2 General Service Fixtures

ADM conducted an ex-ante review of the Program's 2017 and 2018 Lighting data for General Service Fixtures. In the 2017-2018 Programs, the measure category "general service fixtures" is comprised of ENERGY STAR® LED fixtures. In this review, the following activities were performed:

- Verification of measure incentive requirements (e.g. ENERGY STAR® qualified status)
- Verification that the program tracking dataset does not include duplicate or erroneous data entries
- Confirmed data entries in the program tracking dataset include all necessary fields for savings calculations (e.g. program tracking data model numbers were cross checked with verified watts per fixture and baseline wattages)
- Verification that all energy savings are claimed in accordance with the applicable TRL documents and calculations

The Rocky Mountain Power claimed UES value for LED ENERGY STAR® Fixtures in both 2017 and 2018 is 29.1 kWh/yr per the program tracking database. ADM verified that the claimed savings are based on Utah deemed savings values and measure savings assumptions and calculations in the TRL. Using the deemed value in conjunction with the total number of measures incentivized as provided in the program tracking database results in the claimed program energy savings.

#### *3.2.1.2 Verified Inputs to Savings Calculation*

ADM acquired information from the General Population survey in order to calculate an ex-post installation rate (ISR) factor and hours-of-use (HOU) value to generate the evaluated gross lighting program energy savings for both lamps and fixtures. The resulting ISR factor of 85.41% for lamps and 95.5% for fixtures and the daily HOU value of 1.97 for lamps and 2.11 for fixtures are shown in Table 3-6 below. The HOU values are based on results derived from the General Population survey regarding installation percentage by room type and HOU values by room type contained in a KEMA Study on Residential Lighting End-Use Consumption.<sup>1</sup> Because ADM collected installation percentages by room type through the General Population survey, a study that includes

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<sup>1</sup> Residential Lighting End-Use Consumption Study: Estimation Framework and Initial Estimates; DNV KEMA Energy and Sustainability, Pacific Northwest National Laboratory; December 2012.

HOU values by room type is appropriate to use in this case. Additionally, this is the most recent lighting study of its magnitude. The overall HOU values in the study are within the range of other HOU values and studies reviewed by ADM.

Table 3-6: Ex-post ISR factor and HOU value for Utah

Measure Type	Evaluated ISR	Evaluated Daily HOU
Lamps	85.4%	1.97
Fixtures	95.5%	2.11

ADM also determined the fraction of lighting measures that are installed in commercial premises or other non-residential premises (e.g., small medical or dental offices or schools, houses of worship, etc.). Although the Programs are designed to encourage residential customers to purchase discounted LEDs in participating retail outlets, a fraction of residential customers may purchase an additional quantity for a small office or school or various non-residential premises. The fraction of upstream lighting measures installed in non-residential premises is also called “cross-sector sales.” ADM determined the fraction of cross-sector sales in Utah in the 2017-2018 Programs as 2.5% for lamps and 6.9% for fixtures.

### 3.2.1.3 Leakage Analysis

Leakage refers to cross-territory sales that occur when program discounted bulbs are installed outside of Rocky Mountain Power’s service territory. When this occurs, the energy and demand impacts from the discounted bulbs are not being realized within the territory that paid for and claimed the savings. Leakage was estimated for each of the retailers in the program. Table 3-7 shows the number of stores in Utah by retail channel that were included in the leakage analysis. Discount stores would include stores like Dollar Tree and True Value, while Do-it-yourself stores include stores like Ace Hardware or Home Depot. Lastly, Mass Merchant would include stores like Walmart and Lowe’s.

Table 3-7: Participating Utah Stores by Channel

Retail Channel	Number of Stores
Discount	17
DIY	43
Mass Merchant	82
<b>TOTAL</b>	<b>142</b>

Estimates of leakage were assessed using an approach that combined online survey responses with Geo-mapping. The leakage analysis centered on the following approach:

- First, ADM developed a mapping of concentric circles (drive times) surrounding each participating retailer. The initial modeling assumed the “reach” of a retailer is a 60-minute drive. If drive times overlap between one or more retailer locations,

the drive times are split between the stores with the assumption that customers will drive to the nearest store.

- Second, ADM used 2010 Census block data from Environmental System Research Institute (ESRI) to determine the proportion of the population that falls within each drive time circle (from Step 1), as well as the proportion of the population that falls within the Rocky Mountain Power territory and within the state of the participating retailer. Thus, for each drive time circle for each retail location, the Evaluators determined the proportion of the population within the Rocky Mountain Power territory and within state, outside of Rocky Mountain Power territory and within state, and outside of the state of the participating retailer. ADM utilized a shapefile (a format commonly used in GIS that geographically displays the underlying tabular data) showing the service areas of Rocky Mountain Power in the analyzed states from Platts/McGraw-Hill.<sup>2</sup>
- Third, ADM used an online survey to assess the shopping habits of customers within the radius of participating retailers. This was used to assess the total and maximum drive time that consumers accepted when shopping for products incentivized by the retail channel. This was used in modifying the initial 60-minute drive assumption established in Step 1. An online survey was performed for Rocky Mountain Power in 2019 and the results of this survey are shown in Table 3-8. This approach uses a log transformation of the drive times to smooth the data and estimates the cumulative percent via a second order polynomial regression. The log transformation takes the log of the drive time and uses that as the independent variable in the regression. A log transformation is common when the relationship between the variables is logarithmic and linear regression is being used, since linear regression assumes the data are linearly related.
- Lastly, ADM calculated the percentage of bulbs that leaked out of Rocky Mountain Power territory (but still within state) and the percent of bulbs that leaked out of state.

*Table 3-8: Online Survey Drive Time Estimates in Utah*

<b>Channel/ Drive time (minutes)</b>	<b>0-4</b>	<b>5-9</b>	<b>10-14</b>	<b>15-19</b>	<b>20-24</b>	<b>25-29</b>	<b>30-39</b>	<b>40-49</b>	<b>50+</b>	<b>N</b>
DIY	1%	18%	31%	25%	16%	2%	6%	0%	1%	289
Discount	6%	15%	46%	19%	9%	1%	4%	0%	0%	246
Mass Merchant	5%	19%	39%	21%	10%	1%	4%	0%	1%	286
<b>TOTAL</b>	<b>4%</b>	<b>17%</b>	<b>38%</b>	<b>22%</b>	<b>12%</b>	<b>1%</b>	<b>5%</b>	<b>0%</b>	<b>1%</b>	<b>289</b>

<sup>2</sup> Source: [http://www.platts.com/IM.Platts.Content/ProductsServices/Products/gismetadata/iou\\_terr.pdf](http://www.platts.com/IM.Platts.Content/ProductsServices/Products/gismetadata/iou_terr.pdf).

Table 3-9 shows the leakage estimate of 8% for Utah overall across all retailer channels and Table 3-10 provides leakage estimates by retail channel.

Table 3-9: Leakage Estimate in Utah

Quantity Sold	Leakage Quantity	Leakage Rate
2,044,415	173,265	8.5%

Table 3-10: Leakage Estimate by Retailer Type in Utah

Retailer Type	Quantity Sold	Leakage Quantity	Leakage Rate
Discount	13,461	1,377	10.2%
DIY	653,737	31,103	4.8%
Mass Merchant	1,377,217	140,785	10.2%
<b>TOTAL</b>	<b>2,044,415</b>	<b>173,426</b>	<b>8.5%</b>

Table 3-11 provides a benchmark comparison of the estimated Utah leakage rates with other leakage estimates for utilities ADM has evaluated in the past couple of years. The leakage estimates for these other states vary from a low of 10% overall leakage for OG&E Arkansas to a high of 50% for SWEPCO Arkansas. Rocky Mountain Power’s leakage rate of 8% in Utah is on the low end and is due to the relatively large and connected Rocky Mountain Power territory and effective or strategic placement of participating retailer locations.

Table 3-11: Leakage Benchmarking

Utility	State	Year	Leakage (Overall)	Leakage (Discount)	Leakage (DIY)	Leakage (Mass Merchant)
SWEPCO	AR	2018	50%	41%	65%	48%
Cleco	LA	2018	33%	33%	-	-
OG&E	OK	2017	23%	30%	19%	23%
OG&E	AR	2018	10%	28%	0%	10%
RMP	UT	2018	8%	10%	5%	10%

### 3.2.1.4 Gross Unit Energy Savings Review

#### 3.2.1.4.1 Engineering Calculation for Lighting Measure

For ENERGY STAR® LEDs, the following formula is used to calculate annual energy (kWh) savings per measure:

Formula 3.1 Energy Savings for LEDs

$$LED\ kWh\ savings = \left( \frac{\Delta Watts}{1000} \right) * ISR * Hours * IEF_E$$

Where:

$$\Delta Watts = Watts, baseline bulb - Watts, LED$$

*ISR* = “In Service Rate” or installation rate for LEDs purchased in 2017-2018 were determined from ADM’s analysis of Rocky Mountain Power customers’ responses to lighting-related questions in the general population survey (online survey); specifically, the general population survey contains various questions related to LED installation, including removals (if any) and burnouts (if any); *ISR is net of removals and burnouts*

*Hours* = deemed hours of use per year; or the product of 365.25 days per year and the deemed average daily hours of use for LEDs or efficient residential lamps

*IEF<sub>E</sub>* = Interactive Effects Factor to account for cooling energy savings and heating energy penalties (a deemed value)

Source of deemed values in Utah are the RTF or recent state-specific deemed values.

*Example Calculation for Lighting Measure:*

The following is an example of a general purpose 13-watt type A LED lamp. The updated TRL source document for this measure indicates a retail UES of 18.92 kWh/yr. The TRL document specifies an hours of use value of 1.92, a removal rate of 9.1%, and a heat exchange factor of 1.005%. Inserting these values into the equation above verifies the 18.92 kWh/yr savings. ADM verified the UES values for each individual lighting measure in 2017 and 2018.

*Example 3.1 Energy Savings for LEDs*

$$18.92 \text{ kWh} = \left( \frac{(43 - 13)}{1000} \right) * (1 - .091) * (1.92 * 365.25) * (1 - .01005)$$

Using deemed UES values in conjunction with the total quantity of measures incentivized as provided in the program tracking database will result in the ex-ante program energy savings. For this example of a general purpose 13-watt type A LED lamp measure, the program tracking data indicates that this measure was incentivized 35 times in 2017 and 2,060 times in 2018. This results in ex-ante energy savings of 662.20 kWh/Yr for 2017 and 38,975.20 kWh/Yr for 2018. Appendix Table 7-1 shows the input values and UES savings for all 2018 lighting measures.

3.2.1.4.2 Evaluated Gross Lighting Savings

Table 3-12 below shows the claimed and evaluated gross savings by lighting measure category in addition to the realization rates. Appendix Table 7-2, Table 7-3 and Table 7-4 provide the claimed and evaluated gross savings for each individual lighting measure in addition to the realization rates. The realization rates were lower for 2017 measures with

effective dates prior to December 12, 2016 due to the relatively higher UES values for those measures from the applicable TRL document. Again, these higher claimed UES values were driven by a higher HOU input. The evaluated lighting savings also include the impact of the leakage analysis that showed an 8% overall leakage rate in Utah.

*Table 3-12: 2017-2018 Claimed and Evaluated Utah wattsmart Homes Program Gross Lighting Savings*

Measure Category	Year	Measure Type	Claimed Savings (kWh)	Evaluated Gross Savings (kWh/yr)	Realization Rate
Lighting	2017	General Service Fixtures	1,858,501	1,789,898	96.3%
		General Service Lamps	35,112,026	30,194,609	86.0%
		Specialty Lamps	29,457,744	24,728,109	83.9%
	2018	General Service Fixtures	3,006,612	2,852,266	94.9%
		General Service Lamps	21,209,346	18,673,659	88.0%
		Specialty Lamps	19,399,621	17,129,634	88.3%
<b>2017-2018 TOTAL</b>			<b>110,043,850</b>	<b>95,368,175</b>	<b>86.7%</b>

### 3.2.1.5 Net Savings

#### 3.2.1.5.1 Free Ridership and Spillover Survey Results

ADM calculated freeridership and spillover from the General Population survey results to arrive at the net program energy savings and the overall net-to-gross ratio presented in this section. Table 3-13 shows the freeridership and spillover results for lighting measures in 2017 and 2018. Table 3-14 shows the net savings evaluation results, including the evaluated gross savings, evaluated net savings and the NTG for each lighting measure category in 2017 and 2018. The same information for each individual lighting measure in 2017 and 2018 is included in Appendix Table 7-5 and Table 7-6. The methodology for calculating NTG for Lighting measures is discussed in Appendix C.

*Table 3-13: 2017-2018 Lighting Freeridership and Spillover*

Measure Type	Free Ridership	Spillover	NTG
Lamps	27.2%	0.8%	73.6%
Fixtures	9.8%	0.8%	91.0%

Table 3-14: 2017-2018 Utah wattsmart Homes Program Net Lighting Savings and NTG

Measure Category	Year	Measure Type	Evaluated Gross Savings (kWh/yr)	Evaluated Net Savings (kWh/yr)	NTG
Lighting	2017	General Service Fixtures	1,789,898	1,629,523	91.0%
		General Service Lamps	30,194,609	22,211,154	73.6%
		Specialty Lamps	24,728,109	18,189,997	73.6%
	2018	General Service Fixtures	2,852,266	2,596,703	91.0%
		General Service Lamps	18,673,659	13,736,344	73.6%
		Specialty Lamps	17,129,634	12,600,559	73.6%
<b>2017-2018 TOTAL</b>			<b>95,368,175</b>	<b>70,964,280</b>	<b>74.4%</b>

### 3.2.1.5.2 Demand Elasticity Modeling

To benchmark the lighting freeridership calculations, ADM developed an alternative estimate of freeridership based on demand elasticity modeling. ADM did not apply the results of its demand elasticity modeling to its evaluation results, however the modeling does provide a useful benchmark for the net lighting savings results that ADM calculated from the General Population Survey. ADM’s demand elasticity modeling estimated NTG for upstream bulbs using a price response model, wherein a regression is developed to estimate the relationship between price and quantity sold. Program sales data are, by their nature, non-negative integer values (i.e., count data). Typical ordinary least squares (OLS) estimation procedures are designed to deal with continuous dependent variables that are normally distributed. Count data dependent variables can be adapted for OLS estimation through logarithmic or square root transformations. ADM used a log-log model to account for the right-skewed relationship between prices and quantities.

The typical price elasticity model is based on the assumption that four broad factors affect bulb sales: prices, bulb models, promotional events, and seasonal trends. Promotional event data were not available for the program, and the final model used program prices and dummy variables to control for seasonal effects (month dummies) and bulb type (model number dummies). The basic equation of the price response model was structured as follows (for bulb model  $i$ , in period  $t$ ):

#### Formula 3.2 Price Response Model

$$\ln(Q_{it}) = \beta_1 + \beta_2 * \ln(P_{it}) + \sum_{\pi} \beta_{\pi} ModelNumberDummy_i + \sum_{\gamma} \beta_{\gamma} MonthDummy_t + \varepsilon_{it}$$

Where:

$\ln$  = natural logarithm

$Q$  = quantity of bulb packs,  $i$ , sold during week  $t$

$P$  = retail price (after markdown) for package of bulbs,  $i$ , during week  $t$

ModelNumberDummy = a binary variable equaling 1 for each unique model number; 0 otherwise

MonthDummy = a binary variable equaling 1 in a given month; otherwise

The  $\beta_2$  coefficient in the model represents average price elasticity of demand holding the effects of all other independent variables constant.

ADM calculated free ridership ratios for the program as follows. First, the price response model was used to estimate bulb package sales under program and non-program pricing scenarios. The non-program scenario represents pricing at original retail levels. Bulb package sales under both scenarios were multiplied by the number of bulbs per package to arrive at total bulb sales under the program and non-program scenarios. Finally, deemed savings values (gross kWh) were applied to the estimated number of bulbs sold under both scenarios. The final price response model was used to estimate a free ridership as described in the equation below:

*Formula 3.3 Freeridership*

$$\text{Free ridership ratio} = \frac{\sum_i^n (E[Bulbs_{NoProgram_i}] * kWh_i)}{\sum_i^n (E[Bulbs_{Program_i}] * kWh_i)}$$

Where:

$E[Bulbs_{NoProgram_i}]$  = the expected number of bulbs of type, i, purchased given original retail pricing (as predicted by the model).

$E[Bulbs_{Program_i}]$  = the expected number of bulbs of type, i, given program discounted pricing (as predicted by the model).

$kWh_i$  = the average gross kWh savings for bulb type, i.

The price response modeling approach is advantageous in that it is built upon actual sales data from participating retailers, however, there are a number of limitations for the approach. Most importantly, non-program sales data was unavailable for inclusion in the model. As a result, the modeling of price impacts may fit program sales data well, but it is uncertain whether those price effects apply well to prices outside of program ranges. In addition, there were likely variables that affect sales levels for LEDs that were not captured by the program tracking data; thus, presenting a risk of omitted variable bias in addition to the inherent amount of error from statistical modeling.

The model coefficients for each model and program year are shown in the tables below. ADM normally includes a variable for promotional events, but no promotional data was

provided. The effect of any promotional events is therefore absorbed by the other covariates, although its omission usually has an insignificant effect on the overall free ridership rate. Additional covariates were also unavailable to include in the model. The coefficients on program price are negative (the expected direction) and statistically significant at the 99% level. ADM also performed a literature review for spillover and estimated a spillover rate of 8% as shown in Table 3-15.<sup>3</sup>

*Table 3-15: Results of Spillover Benchmarking Study*

<b>Program Administrator</b>	<b>Year</b>	<b>Methodology</b>	<b>Spillover</b>
Progress Energy Carolinas	2012	General population survey	7%
Xcel Energy Minnesota	2012	Participant survey	10%
Public Service Company of New Mexico	2013	Participant survey	11%
Xcel Energy Colorado	2015	Lighting saturation trend analysis	8%
ComEd Illinois	2015	In-store intercepts	7%
Ameren Illinois	2015	In-store intercepts	7%
<b>Average</b>			<b>8%</b>

ADMs’ estimates of free-ridership and NTG are shown in Table 3-16 below for each program year. The NTG ratio is estimated using the following formula:  $NTG = 1 - \text{Free Ridership} + \text{Spillover}$ . The overall NTG rate in 2018 is 69% while the NTG rate in 2017 is 84% using the price response model. Differences in free ridership rates are primarily due to differences in program and retail prices (i.e. average retail and program prices were lower in 2017 vs. 2018) and differences in sales volumes for lower priced bulbs (e.g. average sales in 2017 were 2.5 times higher than average sales in 2018). ADM did not apply the results of its demand elasticity modeling to its evaluation results, however the modeling does provide a useful benchmark for the net lighting savings results that ADM calculated from the General Population Survey.

*Table 3-16: Freeridership Results from Demand Elasticity Modeling*

<b>Program Year</b>	<b>Free Ridership</b>	<b>Benchmark Spillover Rate</b>	<b>NTG</b>	<b>Adjusted R2</b>
2017	24%	8%	84%	0.54
2018	39%	8%	69%	0.47

### **3.2.2 Energy Kits**

Rocky Mountain Power made wattsmart Energy Kits available to customers in Utah who requested them. Kit configurations varied according to the characteristics of customer’s homes and include ENERGY STAR® and WaterSense® certified products. All Kits

<sup>3</sup> Entergy Arkansas Evaluation Report - Program Year 2017, April 20., Table 4-30, page 229.

included four 9.5 W LED light bulbs. If the customer’s home utilized an electric water heater, kits also included energy saving faucet aerator and showerheads.

Table 3-17 details the kit configurations and Rocky Mountain Power claimed savings for each kit type offered in 2017 and 2018 and Table 3-18 shows the quantity of Energy Kits and the total Rocky Mountain Power claimed savings attributed to each kit type in 2017 and 2018.

*Table 3-17: 2017-2018 wattsmart Energy Kit Configurations and Claimed Gross Energy Savings per Unit*

Configuration	Measure	Quantity	Claimed Savings (kWh/yr)
LED Only	9.5 W LED A-Lamp	4	83.2
Best Kit - 1 Bathroom	9.5 W LED A-Lamp	4	405.6
	1.5GPM Aerator Kitchen	1	
	0.5GPM Aerator Bath	1	
	1.5GPM Showerhead	1	
Best Kit - 2 Bathroom	9.5 W LED A-Lamp	4	702.2
	1.5GPM Aerator Kitchen	1	
	0.5GPM Aerator Bath	2	
	1.5GPM Showerhead	2	

*Table 3-18: 2017-2018 wattsmart Energy Kit Quantities and Total Claimed Gross Savings*

Kit Type	2017 Quantity	2017 Total Claimed Savings (kWh/yr)	2018 Quantity	2018 Total Claimed Savings (kWh/yr)
LED Only	2,901	242,523	1,801	149,915
Best Kit – 1 Bathroom	343	139,124	134	54,352
Best Kit – 2 Bathroom	962	675,684	550	386,210

### 3.2.2.1 Database Review

ADM conducted an ex-ante review of the Program’s 2017 and 2018 Energy Kits data. In this review, the following activities were performed:

- Verification of measure incentive requirements (e.g. model numbers)
- Verification that the program tracking dataset does not include duplicate or erroneous data entries
- Confirmed data entries in the program tracking data include all necessary fields for savings calculations (e.g. program tracking data model numbers were cross checked with verified watts per lamp and baseline wattages)
- Verification that all energy savings are claimed in accordance with the applicable TRL documents and calculations

- Calculate energy savings for individual components of each Energy Kit measure

ADM reviewed each energy kit component in each energy kit measure. ADM verified that the Rocky Mountain Power claimed savings were based on the applicable source TRL documents. Using the UES values in the TRL documents in conjunction with the total number of measures incentivized as provided in the program tracking database results in the total claimed program energy savings shown in Table 3-18.

### 3.2.2.2 *Verified Inputs to Savings Calculation*

ADM acquired information from the Energy Kits survey in order to calculate an ex-post ISR factor to generate the evaluated gross program energy savings for Energy Kits. The resulting installation rates for each kit component are shown in Table 3-19 below.

*Table 3-19: 2017-2018 Ex-Post Installation Rates for Kit Components*

<b>Energy Kit Component</b>	<b>Installation Rate</b>
LED Lamps	94.4%
Showerheads	70.4%
Bathroom Aerator	92.0%
Kitchen Aerator	80.0%

### 3.2.2.3 *Gross Unit Energy Savings Review*

#### 3.2.2.3.1 Engineering Calculation for Energy Kit Measures

Energy savings can be calculated for the individual components of each measure using engineering formulas and deemed inputs from the TRL source documents. LED annual energy (kWh) savings per lamp are calculated using the same formulas as provided above for ENERGY STAR® LEDs, although there will be unique input values for ISR as well as hours of use.

Faucet aerator annual energy (kWh) savings are calculated using the following formula:

#### *Formula 3.4 Energy Savings for Aerators*

$$\text{Savings (kWh)} = \text{ISR} \times (\text{F}_B - \text{F}_P) \times \text{T}_{\text{Person-Day}} \times \text{N}_{\text{Persons}} \times 365.25 \times \Delta T_L \times U_H \times U_E \times \text{WHE} \div \text{Eff} \div (\text{F/home})$$

Where:

*ISR* = In-Service Rate determined from Energy Kits surveys

*F<sub>B</sub>* = Average Baseline Flow Rate of aerator, (gallons per minute)

*F<sub>P</sub>* = Average Post Measure Flow Rate, (gallons per minute)

*T<sub>Person-Day</sub>* = Average time of hot water usage per person per day (minutes)

*N<sub>Persons</sub>* = Average number of persons per household (state-specific values)

$\Delta T$  = Average temperature differential between hot and cold water (°F)

$U_H$  = Unit Conversion: 8.33BTU/(Gallons-°F)

$U_E$  = Unit Conversion: 1 kWh/3413 BTU

$WH_E$  = Fraction of Homes with Electric Water Heaters

Eff = Efficiency of Electric Water Heater

F/home = Average number of faucets in the home

Showerhead annual energy (kWh) savings are calculated using the following formula:

*Formula 3.5 Energy Savings for Showerheads*

$$\text{Savings (kWh)} = \text{ISR} \times [(\text{F}_B - \text{F}_P) \div \text{F}_B] \times \text{G}_{\text{Shower}} \times \text{N}_{\text{Persons}} \times 365 \times \Delta T \times U_H \times U_E \div \text{Eff} \div S$$

Where:

ISR	= In-Service Rate determined from Energy Kits surveys
$F_B$	= Average Baseline Flow Rate, (gallons per minute)
$F_P$	= Average Post Measure Flow Rate, (gallons per minute)
$G_{\text{Shower}}$	= Average gallons of hot water used per person per shower per day
$N_{\text{Persons}}$	= Average number of persons per household (state-specific values)
$\Delta T$	= Average temperature differential between hot and cold water (°F)
$U_H$	= Unit Conversion: 8.33BTU/(Gallons-°F)
$U_E$	= Unit Conversion: 1 kWh/3413 BTU
Eff	= Efficiency of Electric Water Heater
S	= Average number of showers in the home

*Example Ex-Ante Calculation for Energy Kits Measures:*

The following example demonstrates the energy savings calculations for a 'Best Kit – 1 Bathroom' wattsmart Energy Kit that includes four 9.5 W LED A-Lamps, one 1.5 GPM Kitchen Aerator, one 0.5 GPM Bathroom Aerator, and one 1.5 GPM Showerhead. ADM's calculations are based on inputs obtained from the applicable TRL and RTF source documents. ADM did not locate a TRL source document for a 9.5 W LED A Lamp and thus used the TRL source document for a 10 W LED A Lamp.

*LED Energy Savings in Best Kit – 1 Bathroom wattsmart Energy Kit:*

$$20.81 \text{ kWh (per bulb)} = \left( \frac{(43 - 10)}{1000} \right) * (1 - .091) * (1.92 * 365.25) * (1 - .01005)$$

$$83.24 \text{ kWh (per kit)} = 20.81 * 4$$

*Aerator Energy Savings in Best Kit – 1 Bathroom wattsmart Energy Kit:*

$$54.44 \text{ kWh (kitchen)} = .55 * (2.2 - 1.5) * 1.8 * 2.59 * 365.25 * (128 - 53) * 8.345 * \left( \frac{1}{3413.14} \right) * .49 \div 1 \div 1.08$$

and

$$39.93 \text{ kWh (bathroom)} = .55 * (2.2 - 0.5) * 1.3 * 2.59 * 365.25 * (128 - 53) * 8.345 * \left( \frac{1}{3413.14} \right) * .49 \div 1 \div 2.56$$

*Showerhead Energy Savings in Best Kit – 1 Bathroom wattsmart Energy Kit:*

$$236.26 \text{ kWh} = .76 * [(2.3-1.35)/2.3] * 8.51 * 2.35 * 365.25 * (128 - 53) * 8.345 * \left( \frac{1}{3413.14} \right) \div 1 \div 1.78$$

*Total Energy Savings in Best Kit – 1 Bathroom wattsmart Energy Kit:*

$$413.87 \text{ kWh} = 83.24 + 54.44 + 39.93 + 236.26$$

ADM’s calculated ex-ante savings values for each individual energy kit component were not exactly matched to the deemed UES values found in the Energy Kits source TRL documents. Specifically, ADM was not able to reverse engineer the values for kitchen and bathroom aerators contained in the TRL documents. ADM calculated values of 54.44 kWh/yr for kitchen aerators and 39.93 kWh/yr for bathroom aerators compared to the deemed UES values of 25.77 kWh/yr for kitchen aerators and 62.59 kWh/yr for bathroom aerators. The deemed UES values for these energy kit components are based on a hardcoded value in the implementation contractor’s savings calculation that ADM was not able to trace back to its source, and thus was not able to determine with certainty what is driving the difference in savings values. The difference may be partially attributed to the temperature differential utilized in the engineering calculation. For the example of the ‘Best Kit – 1 Bathroom’ Energy Kit calculated above, the ADM calculated ex-ante savings of 413.87 kWh/Yr does not match the Energy Kits TRL UES value and the Rocky Mountain Power claimed savings value of 405.61 kWh/Yr. Appendix B include tables that list the TRL and RTF source documents used to calculate savings for each individual component of the Energy Kits.

**3.2.2.3.2 Evaluated Gross Energy Kits Savings**

Table 3-20 below shows claimed and evaluated gross savings as well as realization rates for each Energy Kits component. Table 3-21 shows claimed and evaluated gross savings

for all Energy Kits in 2017 and 2018, as well as realization rates on the Energy Kit level. To calculate ex-post evaluated gross savings, ADM incorporated the verified ISR obtained through the Energy Kits surveys.

The main driver of realization rates for each Energy Kit component is the ISR. For each component other than showerheads, the ISR values that ADM obtained through the Energy Kits surveys are higher than the ISR values contained in the TRL and its RTF source documents. The overall ISR for showerheads was driven down by a lower ISR for the second showerhead (56%) compared to the ISR for the first showerhead (85%) in the Best Kit – 2 Bathroom kits, and therefore was lower than the ISR value in the RTF source document. The kitchen aerator had the highest realization rate at 307.3%, driven by a higher evaluated ISR and the difference in ex-ante calculated savings.

*Table 3-20: 2017-2018 Energy Kits Claimed and Evaluated Per-Component Gross Savings and Realization Rates*

Energy Kit Component	Claimed Gross Savings Per Unit (kWh)	Evaluated Gross Savings Per Unit (kWh)	Realization Rate
LED Lamps	20.8	22.8	109.8%
Showerheads	234.0	201.3	86.0%
Bathroom Aerator	62.6	66.8	106.7%
Kitchen Aerator	25.8	79.2	307.3%

*Table 3-21: 2017-2018 Energy Kits Claimed and Evaluated Gross Savings and Realization Rates*

Year	Configuration	Claimed Gross Savings (kWh)	Evaluated Gross Savings (kWh/yr)	Realization Rate
2017	LED Only	242,523	265,035	109.3%
	Best Kit - 1 Bathroom	139,124	150,440	108.1%
	Best Kit - 2 Bathroom	675,684	679,788	100.6%
2018	LED Only	149,915	164,539	109.8%
	Best Kit - 1 Bathroom	54,352	58,772	108.1%
	Best Kit - 2 Bathroom	386,210	388,652	100.6%
<b>2017-2018 TOTAL</b>		<b>1,647,808</b>	<b>1,707,227</b>	<b>103.6%</b>

#### 3.2.2.4 Net Savings

ADM calculated freeridership and spillover from the Energy Kits survey results to arrive at the net program energy savings and the overall net-to-gross ratio presented in this section. Table 3-22 shows the freeridership, spillover and NTG results for Energy Kits measures and

Table 3-23 shows the net savings evaluation results, including the evaluated gross savings, evaluated net savings and NTG for each Energy Kits configuration. The methodology for calculating NTG for Energy Kits measures is discussed in Appendix C.

Table 3-22: 2017-2018 Freeridership, Spillover and NTG for Energy Kits

Measure Category	Free Ridership	Spillover	Non-Participant Spillover	NTG
Energy Kits	13.0%	1.3%	0.8%	89.2%

Table 3-23: 2017-2018 Energy Kits Evaluated Net Energy Savings and NTG

Year	Configuration	Evaluated Gross Savings (kWh/yr)	Evaluated Net Savings (kWh/yr)	NTG
2017	LED Only	265,035	236,332	89.2%
	Best Kit - 1 Bathroom	150,440	134,147	89.2%
	Best Kit - 2 Bathroom	679,788	606,167	89.2%
2018	LED Only	164,539	146,720	89.2%
	Best Kit - 1 Bathroom	58,772	52,407	89.2%
	Best Kit - 2 Bathroom	388,652	346,561	89.2%
<b>2017-2018 TOTAL</b>		<b>1,707,227</b>	<b>1,522,334</b>	<b>89.2%</b>

### 3.2.3 Appliances

Under the appliances measure category, Rocky Mountain Power offered incentives for high-efficiency clothes washers and freezers in Utah in 2017 only. Table 3-24 below shows the quantity of appliances and the total Rocky Mountain Power claimed savings attributed to each appliance in 2017.

Table 3-24: 2017 Appliance Measure Quantities and Total Claimed Savings

Measure Type	2017 Quantity	2017 Claimed Savings (kWh)
Clothes Washers	1,026	140,766
Freezers	100	6,654

#### 3.2.3.1 Database Review

Appliance incentives only pertain to the program year 2017. ADM conducted an ex-ante review of the Program's 2017 appliances data. Appliances receiving incentives through the 2017 Program include high-efficiency freezers and clothes washers.

ADM conducted an ex-ante review of the Program's 2017 and 2018 Appliances data. In this review, the following activities were performed:

- Verification of measure incentive requirements for a sample of appliances (e.g. model numbers)
- Verification that the program tracking dataset does not include duplicate or erroneous data entries

- Confirmed data entries in the program tracking dataset include all necessary fields for savings calculations
- Verification that all energy savings are claimed in accordance with the applicable TRL document

For each of the five individual Appliance measures in 2017, ADM verified that the UES values claimed by Rocky Mountain Power were supported by the applicable TRL documents. Further, ADM verified that the total claimed savings for each measure accurately reflected the quantity of that measure installed.

### *3.2.3.2 Verified Inputs to Savings Calculation*

The appliance measures represented 0.2% of overall Utah Program savings in 2017. Thus, ADM did not survey these program participants separately to calculate an ISR. ADM assumes a 100% ISR for the appliances measure category, consistent with the 99% ISR that was calculated in the previous evaluation cycle and consistent with other large appliance categories.<sup>4</sup> ADM surveying of the Utah general population produced an average of 281.32 load of laundry per year, which is an increase of 9.5% over the average loads per year value from the Clothes Washer RTF version 4.0.

### *3.2.3.3 Gross Unit Energy Savings Review*

#### *3.2.3.3.1 Clothes Washers*

The savings values for clothes washers in the program tracking data are from the Clothes Washer RTF version 4.0. The clothes washer units must comply with Energy Star specifications and have a Modified Energy Factor (MEF) of 3.2 or higher and a Water Factor (WF) of 2.9 or lower. The baseline MEF is 1.72. The main driver of the savings differentials between individual appliance measures is whether the domestic hot water (DHW) fuel and dryer fuel are electric or gas. For instance, a clothes washer paired with an electric water heater and electric dryer offered higher savings than a clothes washer paired with a gas water heater and gas dryer. The largest source of savings for Clothes Washer measures in Utah in 2017 were Clothes Washers paired with gas DHW and electric dryers, representing 64% of the quantity installed and 72% of the savings for the Clothes Washers measure. The RTF indicated an average of 257 loads of laundry per year. ADM reviewed these results compared to our surveying of the Utah general population which indicated an average of 281 loads of laundry per year. ADM made no

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<sup>4</sup> Cadmus, 2015-2016 Report: Utah Home Energy Savings Program Evaluation, December 21, 2017, p.26.

adjustments to the gross savings values for clothes washers because the claimed gross savings values are reasonable and ADM did not find any reasons to adjust the savings.

### 3.2.3.3.2 Freezers

The savings values for freezers in the program tracking data are sourced from the Residential Refrigerator and Freezer RTF version 4.3. The UES baseline and measure energy values are both calculated by multiplying the federal standard maximum kWh/yr by (1 – average percent below federal standard consumption). The space heat interaction factor is multiplied by these values to determine final savings. The baseline source is the weighted average of the percentage below federal standard consumption, weighted by the percentage of the market that is Energy Star and Non-Energy Star. This is intended to represent the weighted average market baseline, which is more efficient than the federal standard maximum. The efficient case source is the weighted average of the percentage below federal standard consumption for each Freezer Type/Defrost combination and Tier that meets Energy Star (with estimations made for categories where the data was unavailable). The primary parameter/adjustment factor is the: average percent below federal standard consumption. The ENERGY STAR criteria for freezers, per the September 15, 2014 update, is the following: 10% less measured energy use than the minimum federal efficiency standards.

### 3.2.3.4 Net Savings

Due to the low level of savings for the appliance measures, ADM did not conduct surveys directed at these program participants to obtain measure specific NTG values. ADM applied the 2017 program-level NTG value (74.8%) for clothes washers and freezers. The program-level NTG values applied to the appliance measures do not include new homes or multifamily measures or measures that ADM evaluated through a billing analysis. Table 3-25 below shows the NTG and evaluated net savings for each appliance measure type.

*Table 3-25: 2017 Appliance Measure Net Savings and NTG*

Measure	Evaluated Gross Savings (kWh/yr)	Evaluated Net Savings (kWh/yr)	NTG
Clothes Washers	140,766	105,327	74.8%
Freezers	6,654	4,979	74.8%
<b>2017 TOTAL</b>	<b>147,420</b>	<b>110,306</b>	<b>74.8%</b>

## 3.2.4 Building Shell

The building shell measure category included air sealing, insulation and windows measures across the Program years 2017 and 2018. The following Table 3-26 shows the

quantity of building shell measures installed and the claimed savings attributed to each building shell measure in 2017 and 2018.

*Table 3-26: Building Shell Measure Quantities and Claimed Savings, 2017-2018*

<b>Measure Type</b>	<b>2017 Quantity (sq. ft.)</b>	<b>2017 Claimed Savings (kWh)</b>	<b>2018 Quantity (sq. ft.)</b>	<b>2018 Claimed Savings (kWh)</b>
Air Sealing	2,906	1,685	-	-
Insulation	1,258,895	326,467	1,315,100	196,652
Windows	108,899	120,070	-	-

#### *3.2.4.1 Database Review*

ADM conducted an ex-ante review of the Program’s 2017 and 2018 Building Shell data. In this review, the following activities were performed:

- Verification that the program tracking dataset does not include duplicate or erroneous data entries
- Confirmed data entries in the program tracking dataset include all necessary fields for savings calculations
- Verification that all energy savings are claimed in accordance with the applicable TRL document

ADM reviewed each of the 22 individual building shell measures incentivized in 2017 and the four individual building shell measures incentivized in 2018. ADM verified that the UES values claimed by Rocky Mountain Power were supported by the applicable TRL documents. Further, ADM verified that the total claimed savings for each measure accurately reflected the quantity of that measure installed in 2017 and 2018.

#### *3.2.4.2 Verified Inputs to Savings Calculation*

The building shell measures represented 0.6% of overall Utah Program savings in 2017 and 0.3% of overall Utah Program savings in 2018. Thus, ADM did not survey these program participants separately to calculate an ISR. ADM assumes a 100% ISR for the building shell measure category, consistent with the 100% ISR in the previous evaluation cycle.<sup>5</sup>

#### *3.2.4.3 Evaluated Gross and Net Savings*

For the air sealing and insulation measures, ADM conducted billing analyses to determine net energy savings. For the windows measures, ADM performed a deemed savings review of the claimed gross savings and applied a program level NTG value to estimate

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<sup>5</sup> Cadmus, 2015-2016 Report: Utah Home Energy Savings Program Evaluation, December 21, 2017, p.26.

net savings. Table 3-27 shows the evaluation results for the building shell measures in 2017 and 2018.

Table 3-27: 2017-2018 Building Shell Measure Gross and Net Evaluation Results

Year	Measure	Claimed Savings (kWh)	Evaluated Gross Savings (kWh/yr)	Realization Rate	Evaluated Net Savings (kWh/yr)	NTG
2017	Air Sealing	1,685	1,798	106.7%	1,798	100.0%
	Insulation	326,467	348,210	106.7%	348,210	100.0%
	Windows	120,070	120,070	100.0%	89,841	74.8%
2018	Air Sealing	-	-	-	-	-
	Insulation	196,652	209,749	106.7%	209,749	100.0%
	Windows	-	-	-	-	-
<b>2017-2018 TOTAL</b>		<b>644,874</b>	<b>679,827</b>	<b>105.4%</b>	<b>649,598</b>	<b>95.6%</b>

### 3.2.4.3.1 Air Sealing and Insulation

Through a billing analysis of air sealing and insulation program participants and a control group, ADM estimated average annual net savings of approximately 0.28 kWh per square foot of installed air sealing and insulation measures. The billing analysis included the following three steps and is discussed in more detail in Appendix D.

1. Data cleaning: Clean billing and Program Tracking Data to develop a streamlined, simple format for the analysis.
2. Incorporate weather data: Zip codes in the billing data were used to match line items with the nearest weather stations and an optimizing algorithm applied on integer sets of possible cooling degree day (CDD) and heating degree day (HDD) base conditions was used on the billing data and associated weather data.
3. Regression analysis: Control groups were developed using “Late Installs”, or program participants who had a measure installed too late (after June 1, 2018) to be considered in the regression analysis due to not yet having sufficient post period data for analysis. The June 1, 2018 date was selected based on a determination of acquiring a sufficient number of potential control group homes to be able to have a reasonably high probability of acquiring a representative control population. Both the control group and treatment group for the air sealing and insulation billing analysis consisted of 366 participants.

The evaluated average annual net savings of approximately 0.28 kWh per square foot of installed air sealing and insulation measures represents a net realization rate of 106.7% over the claimed average annual savings of approximately 0.26 kWh per square foot of the air sealing and insulation measures that were evaluated in the billing analysis. Table 3-27 above shows the net realization rate and evaluated net savings for air sealing and insulation measures in 2017 and 2018.

### 3.2.4.3.2 Windows

Savings from the windows measures represented approximately 0.15% of total program savings and the windows measures were discontinued in 2018. Because of the relatively low savings amounts and because the measure was discontinued in 2018, ADM performed a deemed savings review for the windows measures. The deemed Unit Energy Savings (UES) values for windows measures in Utah are included in the TRL file '3-10-2014\_UT\_HES\_Windows\_Brief'. The TRL UES values are derived from EnergyGauge modeling. Savings values are differentiated by tier (qualifying by a U-factor of either 0.30 or lower or 0.22 or lower, with each tier containing values for electrically heated and electrically cooled homes or only electrically cooled homes. Based on ADM's deemed savings review of the Utah windows TRL file, the UES values are reasonable. Therefore, ADM did not adjust the claimed gross savings values for windows measures, resulting in a realization rate of 100% for windows measures.

To determine net savings, ADM applied the 2017 program-level NTG value (74.8%) for windows measures. The program-level NTG value applied to the windows measures does not include new homes or multifamily measures or measures that ADM evaluated through a billing analysis. *Table 3-27* above shows the NTG and evaluated net savings for windows measures in 2017.

### 3.2.5 HVAC

The HVAC measure category included controls and thermostats, cooling, heating, ducting, heat pump, motors, and ventilation measures across the Program years 2017 and 2018. The heating and motors HVAC measure categories did not have any savings in the Program Tracking Data. The following *Table 3-28* shows the quantity of HVAC measures installed and the claimed savings attributed to each HVAC measure in 2017 and 2018. The cooling and ventilation measure types included midstream measures. The cooling midstream measures made up 95% of total cooling measure savings in 2017 and 90% of total cooling measure savings in 2018. The ventilation midstream measures made up 75% of total ventilation measure savings in 2017 and 62% of total ventilation measure savings in 2018.

*Table 3-28: HVAC Measure Quantities and Claimed Savings, 2017-2018*

Measure Type	2017 Quantity	2017 Claimed Savings (kWh)	2018 Quantity	2018 Claimed Savings (kWh)
Controls and Thermostats	7,165	1,233,327	10,994	2,151,964
Cooling	8,880	6,727,020	7,534	6,428,694
Duct Sealing	598	182,055	-	-
Heat Pump	133	573,419	51	100,507
Ventilation	2,371	1,151,976	1,969	906,898

### *3.2.5.1 Database Review*

ADM conducted an ex-ante review of the Program's 2017 and 2018 HVAC data. In this review, the following activities were performed:

- Verification of measure incentive requirements for a sample of HVAC measure items (e.g. AHRI numbers and model numbers)
- Verification that the program tracking dataset does not include duplicate or erroneous data entries
- Confirmed data entries in the program tracking dataset include all necessary fields for savings calculations
- Verification that all energy savings are claimed in accordance with the applicable TRL document

ADM reviewed all 54 individual HVAC measures in 2017 and all 24 individual HVAC measures in 2018. ADM verified for 52 of the 54 HVAC measures in 2017 and all 24 HVAC measures in 2018 that the UES values claimed by Rocky Mountain Power were supported by the applicable TRL documents. Further, ADM verified that the total claimed savings for each of these measures accurately reflected the quantity of that measure installed in 2017 and 2018. There were two HVAC measures in 2017 and five HVAC measures in 2018 that ADM was not able to verify the UES values claimed by Rocky Mountain Power in the program tracking database. For both the 'Manufactured Home Duct Sealing – Direct Install – Electric Heat – Test, Crossover Replacement, Seal and Insulate – UT' and the 'Manufactured Home Duct Sealing – Direct Install – Electric Heat – Test, Seal and Insulate – UT' measures in 2017, Rocky Mountain Power claimed UES values of 1,010 kWh/Yr. Based on ADM's review of the source TRL documents, the UES value for each measure is 1,543 kWh/Yr. Using the quantity of each measure installed in 2017, this results in a total increase in reviewed ex-ante savings of 3,198 kWh/Yr for 2017 compared to what Rocky Mountain Power claimed.

### *3.2.5.2 Verified Inputs to Savings Calculation*

ADM assumes a 100% ISR for the HVAC measure category, consistent with the 100% ISR in the previous evaluation cycle.<sup>6</sup> The 100% ISR was confirmed for controls and thermostats through the surveying of these program participants.

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<sup>6</sup> Cadmus, 2015-2016 Report: Utah Home Energy Savings Program Evaluation, December 21, 2017, p.26.

**3.2.5.3 Evaluated Gross and Net Savings**

ADM conducted billing analyses to determine net energy savings associated with most HVAC measures. Similar to the billing analysis completed for building shell measures, the billing analysis for HVAC measures included the following three steps and is discussed in more detail in Appendix D.

1. Data cleaning: Clean billing and Program Tracking Data to develop a streamlined, simple format for the analysis.
2. Incorporate weather data: Zip codes in the billing data were used to match line items with the nearest weather stations and an optimizing algorithm applied on integer sets of possible cooling degree day (CDD) and heating degree day (HDD) base conditions was used on the billing data and associated weather data.
3. Regression analysis: Control groups were developed using “Late Installs”, or program participants who had a measure installed too late (after June 1, 2018) to be considered in the regression analysis due to not yet having sufficient post period data for analysis. The June 1, 2018 date was selected based on a determination of acquiring a sufficient number of potential control group homes to be able to have a reasonably high probability of acquiring a representative control population. The size of the control groups and the treatment groups for each HVAC measure billing analysis is shown in Table 3-29.

*Table 3-29: Control Group and Treatment Group Size for HVAC Measure Billing Analyses*

<b>HVAC Billing Analysis Group</b>	<b>Control and Treatment Group Size</b>
Central Air Conditioning	309
Duct Sealing	214
Evaporative Cooler	133
Ventilation	423

For the controls and thermostats measure type, ADM acquired information from the HVAC survey in order to calculate a NTG value and generate the evaluated net savings. For the room air conditioning and heat pump measures, ADM performed a deemed savings review of the claimed gross savings and applied program level NTG values to estimate net savings. Table 3-30 below shows the evaluation results for HVAC measure in 2017 and 2018.

Table 3-30: 2017-2018 HVAC Measure Gross and Net Evaluation Results

Year	Measure	Claimed Savings (kWh)	Evaluated Gross Savings (kWh/yr)	Realization Rate	Evaluated Net Savings (kWh/yr)	NTG
2017	Controls and Thermostats	1,233,327	1,233,327	100.0%	1,169,687	94.8%
	Central Air Conditioning	909,229	1,011,881	111.3%	1,011,881	100.0%
	Evaporative Cooler	5,615,893	1,231,565	21.9%	1,231,565	100.0%
	Room Air Conditioning	201,898	201,898	100.0%	151,068	74.8%
	Duct Sealing	182,055	204,193	112.3%	204,193	100.0%
	Heat Pump	573,419	73,419	100.0%	429,055	74.8%
	Ventilation	1,151,976	670,911	58.2%	670,911	100.0%
2018	Controls and Thermostats	2,151,964	2,151,964	100.0%	2,040,923	94.8%
	Central Air Conditioning	855,236	951,792	111.3%	951,792	100.0%
	Evaporative Cooler	5,441,816	1,193,390	21.9%	1,193,390	100.0%
	Room Air Conditioning	131,642	131,642	100.0%	100,180	76.1%
	Heat Pump	100,507	100,507	100.0%	76,486	76.1%
	Ventilation	906,898	528,177	58.2%	528,177	100.0%
<b>2017-2018 TOTAL</b>		<b>19,455,860</b>	<b>10,184,667</b>	<b>52.3%</b>	<b>9,759,308</b>	<b>95.8%</b>

### 3.2.5.3.1 Controls and Thermostats

ADM calculated freeridership and spillover from the HVAC survey results to arrive at the net program energy savings and the overall net-to-gross ratio presented in this section. Table 3-31 shows the freeridership, spillover and NTG results for the controls and thermostats measure type. The methodology for calculating NTG for HVAC measures is discussed in Appendix C. Table 3-30 shows the NTG and evaluated net savings for controls and thermostat measures in 2017 and 2018.

Table 3-31: 2017-2018 Freeridership, Spillover and NTG for Controls and Thermostats Measure Type

Measure Type	Free Ridership	Spillover	Non-Participant Spillover	NTG
Controls and Thermostats	8.7%	2.7%	0.8%	94.8%

### 3.2.5.3.2 Cooling

Through a billing analysis of HVAC cooling measure program participants and a control group, ADM estimated average annual net savings of approximately 446 kWh per central air conditioning measure and 331 kWh per evaporative cooler measure. ADM performed a deemed savings review of savings values for room air conditioners and did not adjust the claimed gross savings attributed to this measure, resulting in gross evaluated savings of 86.95 kWh per year per room air conditioner measure.

Table 3-30 shows the net realization rate and evaluated net savings for the HVAC cooling measures in 2017 and 2018. The evaluated average annual net savings of approximately 446 kWh per central air conditioning measure represents a net realization rate of 111.3%

over the claimed average annual savings of approximately 401 kWh per central air conditioning measure that was evaluated in the billing analysis.

The net realization rate for evaporative coolers was significantly lower, with the evaluated average annual net savings of approximately 331 kWh per evaporative cooler measure representing a net realization rate of approximately 21.9% of the claimed average annual savings of approximately 1,508.6 kWh per evaporative cooler measure that was evaluated in the billing analysis. It is likely that a main driver of the low realization rate is the SEER 13 baseline assumption used in the source of the claimed savings value. Through the billing analysis, ADM found that the treatment group for evaporative coolers appear to have already lower consumption relative to the control group, indicating that the majority of participants who installed evaporative coolers didn't have an air conditioning unit previously and thus the use of a SEER 13 baseline assumption in this evaluation would require additional information on participant baseline data.

ADM verified the baseline conditions of the evaporative cooler program participants' households that were evaluated in the billing analysis by referencing multiple secondary sources, including Google Maps, real estate websites such as Zillow and Redfin, and other county assessment records. ADM looked at 351 of the total evaporative cooler participants' households and was able to verify 204 of the households. ADM found that approximately 73% of these households appear not to have central AC systems, either because they have swamp coolers (67.6%), window AC units (2.9%), or the secondary sources indicate they do not have central AC (2.5%). In future evaluation cycles, ADM recommends further data collection on evaporative cooler baseline conditions and purchase decisions. Given the move to a midstream measure, ADM recommends working with distributors to either collaborate on a methodology to reach program participants through gathering contact information at the purchase point or interviewing distributors directly as a proxy to understand program participants purchase decisions and baseline conditions.

For the room air conditioning measures, claimed savings represented 0.24% of the overall program savings in 2017 and 2018. Based on ADM's deemed savings review of the room air conditioning measure, the UES values are reasonable. Therefore, ADM did not adjust the claimed gross savings values for room air conditioning measures, resulting in a realization rate of 100% for these cooling measures.

To determine net savings, ADM applied the 2017 program-level NTG value (74.8%) for 2017 room air conditioner measures and the 2018 program-level NTG value (76.1%) for 2018 room air conditioner measures. The program-level NTG value applied to the room air conditioner measures does not include new homes or multifamily measures or measures that ADM evaluated through a billing analysis.

### 3.2.5.3.3 Duct Sealing

The evaluated average annual net savings of approximately 334 kWh per duct sealing measure represents a net realization rate of 112.3% over the claimed average annual savings of approximately 298 kWh per duct sealing measure that was evaluated in the billing analysis. Table 3-30 shows the net realization rate and evaluated net savings for the duct sealing measures in 2018.

### 3.2.5.3.4 Heat Pump

The heat pump measure group did not have a sample size large enough to calculate savings through a billing analysis. Additionally, this measure group only represented approximately 0.49% of the overall program savings in 2017 and 2018. Therefore, ADM conducted a deemed savings review of the heat pump measure claimed savings values, including the TRL file provided and the RTF file “ResDHPonFAF\_v2\_0”. ADM concludes that the UES values in the TRL are within the bounds of reasonable estimates. The TRL document states a baseline of electric resistance heat, whereas the RTF file is based on the replacement of a forced-air electric furnace with a ductless heat pump. Both baselines are comparable with a COP of close to one. Additionally, TRL savings are estimated using assumptions of 1.5 tons for the single head unit and 3.5 tons for the multihead unit, with both simulations assuming a 9.5 HSPF. The RTF file requires the installed units to be at least 9.0 HSPF and at least 0.75 tons. ADM recommends that during the next evaluation cycle, we calculate savings for heat pump measures using an engineering desk review approach in addition to the deemed savings review. In order to do this, ADM would need baseline equipment type and specifications (e.g. make and model) and the post installation equipment specifications (e.g. capacity, HSPF, SEER, number of indoor units). Table 3-30 above shows the net realization rate and evaluated net savings for the heat pump measures in 2018.

### 3.2.5.3.5 Ventilation

ADM estimated average annual savings of approximately 284 kWh per ventilation measure. This represents a net realization rate of 58.2% of the claimed average annual savings of approximately 487 kWh per ventilation measure that was evaluated in the billing analysis. Table 3-30 shows the net realization rate and evaluated net savings for the ventilation measures in 2018.

## **3.2.6 Water Heating**

The water heating measure category consisted of six heat pump water heater measures incentivized in 2017 for a total of 9,226 kWh of savings and five heat pump water heater measures in 2018 for a total of 7,604 kWh of savings. Water heating measures

represented only 0.012% of overall program savings in 2017 and 0.013% of overall program savings in 2018.

### 3.2.6.1 Database Review

ADM conducted an ex-ante review of the Program’s 2017 and 2018 Water Heating data. In this review, the following activities were performed:

- Verification that the program tracking dataset does not include duplicate or erroneous data entries
- Confirmed data entries in the program tracking dataset include all necessary fields for savings calculations
- Verification that all energy savings are claimed in accordance with the applicable TRL document

ADM reviewed all six of the individual water heating measures in 2017 and four individual water heating measures in 2018. ADM verified that the UES values claimed by Rocky Mountain Power were supported by the applicable TRL documents. Further, ADM verified that the total claimed savings for each measure accurately reflected the quantity of that measure installed in 2017 and 2018.

### 3.2.6.2 Verified Inputs to Savings Calculation

Due to the low savings attributed to water heating measures, ADM did not survey these program participants separately to calculate an ISR. ADM assumes a 100% ISR for the water heating measure category.

### 3.2.6.3 Gross Unit Energy Savings Review

Due to the low savings attributed to water heating measures, ADM did not adjust the claimed gross energy savings and assumed a realization rate of 100% for water heaters under the program. Table 3-32 shows the evaluated gross energy savings and realization rate for water heating measures in 2017 and 2018.

*Table 3-32: Evaluated Energy Savings and Realization Rates for Water Heating Measures*

Measure Category	Claimed Gross Savings (kWh)	Evaluated Gross Savings (kWh)	Realization Rate
2017 Water Heating Measures	9,226	9,226	100%
2018 Water Heating Measures	7,604	7,604	100%
<b>2017-2018 TOTAL</b>	<b>16,830</b>	<b>16,830</b>	<b>100%</b>

### 3.2.6.4 Net Savings

Due to the low level of savings for the water heating measures, ADM did not conduct surveys directed at these program participants to obtain a measure specific NTG value. ADM applied the 2018 program-level NTG value (76.1%) and 2017 program-level NTG value (74.8%) for water heating measures. The program-level NTG values applied to the water heating measures do not include new homes or multifamily measures or measures that ADM evaluated through a billing analysis. Table 3-33 shows the NTG and evaluated net savings for the water heating measures.

Table 3-33: Net Energy Savings and NTG for Water Heating Measures

Measure Category	Evaluated Gross Savings (kWh)	Evaluated Net Savings (kWh)	NTG
2017 Water Heating Measures	9,226	6,903	74.8%
2018 Water Heating Measures	7,604	5,787	76.1%
<b>2017-2018 TOTAL</b>	<b>16,830</b>	<b>12,690</b>	<b>75.4%</b>

### 3.2.7 Whole Building Multifamily Measures

The whole building measure category includes multifamily retrofit and multifamily new construction measure types in 2018. The following Table 3-34 shows the quantity of whole building measures installed and the claimed savings attributed to each whole building measure in 2018.

The Program Tracking Data appeared to have two New Construction measure type projects that were labeled as Retrofit measure types. The supporting documentation that ADM reviewed for these two whole building multifamily projects supported this assessment and thus ADM adjusted the Program Tracking Data to correctly represent the measure type quantities and savings. These adjusted quantities and savings for the whole building multifamily measure category are shown below in Table 3-34.

Table 3-34: Whole Building Multifamily Measure Quantities and Claimed Savings, 2018

Measure Type	2018 Quantity	2018 Savings (kWh)
Retrofit	18	2,153,977
New Construction	45	2,207,733

#### 3.2.7.1 Database Review

ADM conducted an ex-ante review of the Program's 2018 whole building data. In this review, the following activities were performed:

- Review of site specific documents from ICAST, including all incentive requests and TRL uploads from all multifamily retrofit and new construction projects and

the REM/Rate or eQuest modeling files associated with five of the 19 new construction projects

- Verification that program tracking dataset does not include duplicate or erroneous data entries
- Confirmed data entries in the program tracking dataset include all necessary fields for savings calculations

#### *3.2.7.2 Verified Inputs to Savings Calculation*

For whole building retrofit lighting measures, ADM used a multifamily-specific value of 1.8 HOU/day obtained from the same Residential Lighting End-Use Consumption Study use in the lighting measure evaluation.<sup>7</sup> Because the study includes a multifamily-specific HOU value it is appropriate to use in this case. Additionally, this is the most recent lighting study of its magnitude. ADM used a 100% ISR for all lighting and non-lighting retrofit measures. For the whole building new construction measures, ADM used a 100% ISR for all lighting and non-lighting measures.

#### *3.2.7.3 Gross Unit Energy Savings Review*

*Table 3-35* shows the claimed and evaluated gross savings and realization rates for whole building multifamily measures. To evaluate the energy savings values for the whole building multifamily retrofit measure type, ADM used a multifamily-specific value for lighting measures of 1.8 HOU/day, resulting in a realization rate of 93.8% for lighting measures. This realization rate does not include the leakage value attributed to the other non-whole building lighting measures in the program. All other measure types in the retrofit measure category had a realization rate of 100%, leading to an overall gross realization rate of 97.4% for all multifamily retrofit measures.

ADM did not apply any adjustments to the claimed savings associated with the new construction multifamily measures, resulting in a realization rate of 100% for these measures. ADM reviewed the project documentation associated with all 19 of the new construction project sites and the REM/Rate and eQuest modeling files associated with five of the project sites. While the provided documentation was insufficient for full verification purposes, the energy savings claims for each project were determined to be reasonable. ADM recommends that more detailed documentation be collected by the program implementer in subsequent program years.

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<sup>7</sup> Residential Lighting End-Use Consumption Study: Estimation Framework and Initial Estimates; DNV KEMA Energy and Sustainability, Pacific Northwest National Laboratory; December 2012.

Table 3-35: Evaluated Energy Savings and Realization Rates for Whole Building Multifamily Measures, 2018

Measure Type	Ex-ante Claimed Savings (kWh)	Ex-post Evaluated Savings (kWh)	Realization Rate
Retrofit	2,153,977	2,096,929	97.4%
New Construction	2,207,733	2,207,733	100.0%
<b>2018 TOTAL</b>	<b>4,361,710</b>	<b>4,304,662</b>	<b>98.7%</b>

#### 3.2.7.4 Net Savings

Table 3-36 shows the evaluated net savings and NTG for whole building multifamily measures. To obtain a NTG value for multifamily projects, ADM contacted all 20 building managers that implemented retrofit measures at their properties in order to conduct interviews regarding NTG inputs. ADM was only able to complete six interviews and thus did not apply the NTG value obtained from those interviews due to the incidence of interview completion. Therefore, for the market-rate multifamily retrofit measures, ADM used the measure specific NTG values obtained through our evaluation efforts, including surveys, billing analyses and deemed savings engineering reviews. For the low-income multifamily retrofit measures, ADM applied a NTG value of 100%, consistent with its evaluation of other low-income projects. This resulted in an overall NTG value of 95.4% for the multifamily retrofit measures. ADM applied this NTG value of 95.4% to the new construction measures as well. ADM recommends that because whole building multifamily measures were newly incentivized in 2018 and represented approximately 7.3% of overall claimed savings in 2018, ADM will increase the rigor of the evaluation for this measure in the next evaluation cycle, including case studies and in-depth interviews with building managers and decision makers at both market-rate and low-income multifamily projects. The interviews conducted during the 2017-2018 evaluation cycle will inform the refinement of the survey tool for the subsequent evaluation cycle. Table 3-36 shows the evaluated gross and net savings and NTG for whole building multifamily measures. For the market-rate multifamily retrofit measures, ADM used the measure specific NTG values obtained through our evaluation efforts, including surveys, billing analyses and deemed savings engineering reviews. ADM used a NTG value of 100% for low-income multifamily retrofit measures.

Table 3-36: Net Energy Savings and NTG for Whole Building Multifamily Measures, 2018

Measure Type	Evaluated Gross Savings (kWh/yr)	Evaluated Net Savings (kWh/yr)	NTG
Retrofit	2,096,929	2,000,706	95.4%
New Construction	2,207,733	2,106,426	95.4%
<b>2018 TOTAL</b>	<b>4,304,662</b>	<b>4,107,132</b>	<b>95.4%</b>

### 3.2.8 New Homes

The new homes measure category includes three HVAC measures and eight whole homes measures in 2017 and nine whole homes measures in 2018. The following Table 3-37 shows the quantity of new homes measures installed and the claimed savings attributed to each new homes measure type in 2017 and 2018.

Table 3-37: New Homes Quantities and Claimed Savings

Measure Type	2017 Quantity	2017 Savings (kWh)	2018 Quantity	2018 Savings (kWh)
HVAC: Cooling	72	11,501	-	-
HVAC: Ventilation	184	49,496	-	-
Whole Homes	3,609	1,087,883	3,314	1,205,641

#### 3.2.8.1 Database Review

ADM conducted an ex-ante review of the Program’s 2017 and 2018 new homes data. In this review, the following activities were performed:

- Verification of HERS Certificates associated with a sample of new homes projects
- Verification that the program tracking dataset does not include duplicate or erroneous data entries
- Confirmed data entries in the program tracking dataset include all necessary fields for savings calculations
- Verification that all energy savings are claimed in accordance with the applicable TRL document

ADM reviewed each of the 11 new homes measures in 2017 and 9 new homes measures in 2018. ADM verified that the UES values claimed by Rocky Mountain Power were supported by the applicable TRL documents. Further, ADM verified that the total claimed savings for each measure accurately reflected the quantity of that measure installed in 2017 and 2018.

#### 3.2.8.2 Verified Inputs to Savings Calculation

ADM assumes a 100% ISR for the new homes measure category.

#### 3.2.8.3 Gross Unit Energy Savings Review

ADM assumes a 100% realization rate for all of the new homes measures, resulting in the evaluated savings shown in Table 3-38.

Table 3-38: Evaluated Energy Savings and Realization Rates for New Homes Measures

Measure Category	Ex-ante Claimed Savings (kWh)	Ex-ante Evaluated Savings (kWh)	Realization Rate
2017 New Homes	1,148,880	1,148,880	100%
2018 New Homes	1,205,641	1,205,641	100%
<b>2017-2018 TOTAL</b>	<b>2,354,521</b>	<b>2,354,521</b>	<b>100%</b>

#### 3.2.8.4 Net Savings

ADM conducted interviews with new homes builders in Utah in order to calculate a NTG value for the new homes measures. ADM contacted 40 new homes builders in Utah, utilizing phone calls and email, and attempting each builder at least three times. ADM was able to complete 12 interviews with new homes builders, representing approximately 58% (1,376,436 kWh) of total claimed savings for all new homes measures in 2017 and 2018. In order to reach more new homes builders, ADM recommends that during the next evaluation cycle, interviews focus on two points of contact (e.g. production and purchasing) for each site. ADM calculated an overall NTG rate of 60% for new homes measures in Utah based on the free ridership scoring that is explained in Appendix C. Table 3-39 shows the net savings evaluation results, including the evaluated gross savings, evaluated net savings and NTG for new homes measures.

Table 3-39: Net Energy Savings and NTG for New Homes Measures

Measure Category	Evaluated Gross Savings (kWh)	Evaluated Net Savings (kWh)	NTG
2017 New Homes	1,148,860	684,491	59.6%
2018 New Homes	1,205,641	718,321	59.6%
<b>2017-2018 TOTAL</b>	<b>2,354,501</b>	<b>1,402,812</b>	<b>59.6%</b>

## 4 Process Evaluation

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This chapter presents the findings of the process evaluation for the Utah wattsmart Homes Program. ADM's process evaluation included a review of the program materials, in-depth interviews with program staff, and general population and participant surveys.

### **4.1 Review of Program Materials and In-depth Interviews with Program Staff**

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#### **4.1.1 Roles and Responsibilities**

ADM evaluators interviewed the wattsmart Homes program manager from Rocky Mountain Power (RMP) for the purposes of gaining insight into program design, identifying program objectives, and assessing the extent to which there are future opportunities for program improvement. The wattsmart Homes program manager is responsible for overseeing the program in Utah, Wyoming, and Idaho, which includes managing the vendors, cost-effectiveness testing, filing tariffs with state regulators, and maintaining the website.

ADM evaluators also interviewed the president and program manager from ICAST (International Center for Appropriate and Sustainable Technology), the program administrator and program manager from Nexant, and the senior account manager and marketing account manager from CLEAResult. The Utah programs are implemented by ICAST, Nexant and CLEAResult. ICAST managed and implemented the multifamily and multifamily new construction programs, CLEAResult implemented the residential and new construction programs, and Nexant was responsible for a residential midstream HVAC program.

#### **4.1.2 Program Design and Goals**

The program savings goals and spend targets vary for channel (lighting and non-lighting). Each implementer has individual goals for each channel. The programs in Utah were described as complex with a larger service territory.

The residential midstream HVAC and the custom multifamily programs are operated in Utah solely. The wattsmart incentives include clothes washers, central air conditioners, duct sealing and insulation (manufactured homes included), ductless heat pumps, evaporative coolers, gas furnaces, ground source heat pumps, heat pumps, room air conditioners, smart thermostats, whole home upgrades, advanced power strips, light bulbs and fixtures, multifamily attic insulation, multifamily duct sealing and insulation, new homes, heat pump water heaters, and weatherization (insulation and windows).

The wattsmart Homes program operations and changes:

- In 2017, Rocky Mountain Power introduced a portal for instant incentives. Customers can see if they qualify for a smart thermostat and if they do, the site generates a coupon that can be used at the point of sale.
- In April 2017, an evaporative cooler mid-market program was developed.
- The Rocky Mountain Power website (<https://www.wattsmarthomes.com/state/UT>) was enhanced in 2018 and there will be further improvements in 2019.
- CFLs were eliminated from the program in 2017, with staff indicating that LEDs have demonstrated savings and strong participation.
- CLEAResult staff believed there is a need for additional customer education about LEDs and their benefits, with additional focus in rural areas.
- CLEAResult staff indicated there were changes to the participating lighting retailers between 2017 and 2018. They also stated they may try to recruit online retailers (e.g., Amazon) since all possible brick and mortar stores have an agreement.
- RMP staff indicated that overall participation in 2017 and 2018 remained consistent from past program years but there is some variability among specific measures and states. CLEAResult staff indicated that customer satisfaction is high.
- CLEAResult staff indicated having multiple implementers in multiple markets (i.e. new construction) can create some challenges to the program.
- CLEAResult staff indicated they are continuing to move away from paper applications and towards self-validation tools at the point of purchase.

The custom multifamily program operations and changes:

- The Custom Multifamily program was launched in 2017 and primarily works with developers and property managers. The program was described as a “deep retrofit” program, which focuses on entire properties. Multifamily projects are only offered in the Utah territory for single locations with three or more units under one ownership.
- ICAST program staff indicated participation has increased in the multifamily program since its launch and expressed satisfaction with the first year of program implementation. ICAST staff also indicated they have built relationships with the larger developers in the state to complete more projects (both new and retrofits).
- The current process for recruiting property owners and managers includes a review of the portfolio of multifamily companies; identifying properties that are good candidates for retrofit projects.

- The program offered high incentives for low income properties (defined as 80% or less of Area Median Income) and also leveraged weatherization programs to reduce costs. Over half of the projects completed in the multifamily program were low income.
- ICAST staff provides technical assistance to builders in the form of design assistance.
- Lack of capital and/or budget, lack of knowledge, regulatory hurdles, or not being interested were listed as reasons that property owners might not participate. Primary cost or lack of knowledge was listed as a reason that builders might not participate. ICAST indicated that moving to a HERS system did create some barriers for builders to participate but now that there is a system of raters in place, the program has seen traction.
- ICAST staff indicated they spent a lot of time on market transformation by increasing the adoption of high efficiency heat pumps in colder climates. Convincing developers to adopt highly efficient heat pumps was described as a major hurdle.
- ICAST has discussed increasing their goals with RMP. ICAST expressed the desire to obtain more information (usage, demand, all-electric properties, and if they are multifamily) from RMP on larger accounts.
- There were no concerns raised about program design during the interviews and no anticipated challenges to meet program goals in the future were discussed.

The residential midstream HVAC program operations and changes:

- In 2017 and 2018, a newly-developed midstream HVAC incentive program was offered exclusively in the Utah territory.
- This program was originally a downstream model which was converted to a midstream approach to be more cost-effective. There was already a midstream model on the commercial side.
- RMP and Nexant staff discussed challenges and obstacles with moving to a midstream model. Some of those challenges included customer validation and verifying equipment installations. Initial conversations with the distributors revealed the challenge of obtaining information and their concerns over the administrative burden of collecting data from customers. National distributors can have complicated databases and it took some time to get each new distributor onboard and to get data in the format needed.
- In 2017, there were not any distributors onboard and as a result, program staff reduced some of the requirements. By 2018, the program continued to move towards distribution with additional distributors coming on over the summer.

Nexant staff indicated they have continued to work closely with distributors, with some casually participating. Nexant staff indicated that the goal is to move the program solely to distributors in 2019.

- Nexant developed and designed a webtool for contractors to use to verify customer eligibility at the point of sale. Staff indicated they provided education to contractors on how to use the tool and the difference between a downstream and midstream model.
- Online applications were added to the portal for downstream programs with simple measures, while HVAC and building shell are still relying on paper applications.
- Nexant staff discussed the concern over customer attribution (recognition that the incentive originated from utility) and engagement.
- RMP staff discussed the future challenges to the wattsmart Home program, such as reduced savings from lighting measures, with the concern that non-lighting measures are more expensive and difficult to get customers to install.

#### **4.1.3 Trade Allies and Other Program Partners**

For most of the program, there is an established trade ally network, which was described as “good and ample” by implementation staff. There are account managers who will recruit local contractors but there is not much active recruiting currently.

For the multifamily program, the trade ally network is informal and open. ICAST indicated that any contractor who completes projects is qualified to participate and can apply for an incentive. Program staff is continuously seeking to recruit new trade allies and partners. Staff indicated that rural areas can be pose a challenge to have a choice in trade allies and quality.

ICAST staff reported they do outreach to builders for the new homes program. There are email campaigns, in-person meetings, panel presentations, and trainings. ICAST meets with builders to help maximize their incentives.

For the residential HVAC midstream program there are different tiers of contractors. The first tier are those who are very engaged with the program and are actively marketing and selling the program to customers. The second tier are those who offer the program to customers if interest is expressed. The third tier are those who are not actively engaged and are mostly performing emergency replacements with cost-sensitive customers.

#### **4.1.4 Tracking and Reporting**

The residential program is currently tracking the following data indicators:

Wattsmart homes data indicators:

- Application processing time
- Energy savings targets
- Field activities
- Outreach and marketing
- Customer escalations
- Customer satisfaction
- Invoices

Multifamily data indicators:

- Budget
- kWh goals
- Other savings (therms, water per gallon, environmental savings, carbon emissions)
- Economic impact (e.g., number of jobs created)
- Dollar savings
- Conversion rates (number of assessments in relation to signed contracts)
- Money spent per unit
- Savings per unit
- Demographics

RMP staff indicated that they are collecting all the necessary information and that the information is kept current enough to effectively manage the program. No significant improvements were suggested. One staff member stated they would like to collect email addresses from customers.

#### **4.1.5 Communication**

RMP staff have regularly scheduled weekly conference calls with implementation staff. Topics include program status and performance, field operations, changes to the website, program enhancements, marketing and outreach activities, customer issues, barriers to participation, and program enhancements. There are also monthly meetings where program staff discuss forecasts, budgets, and future program adjustments to hit targets. ICAST staff indicated they have in-person meetings about once a month or once every other month.

There were no concerns raised about the current communication structure. One staff member noted that it would be beneficial to have an internal messaging capability, such as instant messenger.

#### **4.1.6 Quality Assurances and Quality Controls (QA/QC)**

For the wattsmart Homes program, there is a QC team with a few inspectors. The primary inspections are completed by contractors, with the use of standardized forms. There are no inspections of clothes washers. There are pre-inspections for weatherization measures.

For the multifamily program, there are not formal QA/QC procedures for the program nor post-inspections of projects. ICAST staff stated they manage all the projects to ensure the correct equipment is installed and functioning correctly. When there are projects that are not overseen by ICAST, they perform a sample inspection.

For the residential HVAC midstream program, each new contractor that completes a project has the first three projects inspected by state inspectors. The site inspections are typically conducted at the time of installation. There is then a 5% inspection rate and if problems are discovered the percent of projects inspected increases incrementally. There are QA procedures performed at both the contractor and distributor level to examine paperwork and invoices and staff ensure there is a line item for the incentive. There is also an inspection at the homeowner's residence. It is common for homeowners to be "nervous" about an inspection because they may not understand or be aware of RMP's involvement.

#### **4.1.7 Marketing and Outreach**

RMP works directly with CLEARResult's marketing team, who presents a marketing and outreach proposal. CLEARResult does all the design work and submits to RMP for approval. RMP manages social media posts and CLEARResult provides content.

Marketing activities for lighting and non-lighting for 2017 and 2018 included:

- Bill inserts and postal mailers
- Email campaigns
- Social media (Facebook, Instagram, and Twitter)
- Program website
- Mass media advertisement
- Monthly newsletters (print or electronic)
- Cross promotion
- Outreach events (e.g., home shows)
- Policy interactions/referrals with relevant agencies
- Point-of-purchase signage

ICAST staff indicated that they are responsible for marketing and outreach of the multifamily program. The activities for multifamily included all the above except for point-of-purchase signage and traditional media advertising. ICAST staff indicated that trade allies play a large role in program outreach and are a good referral source. When email campaigns are used to promote the program, staff track open rates and how much business was generated from the marketing activities. Staff also believes that referrals are the most effective marketing approach for multifamily.

Nexant staff indicated that most of the customer marketing of the residential midstream HVAC program has been through the website. Customers can find a list of participating vendors and the incentive amount on the website. There are outreach activities with contractors and distributors, which are usually “lunch-and-learn” events where attendees can receive information about the program. There were also mass mailers in selected areas, which distributors favor. Nexant staff assess marketing efforts by comparing sales history with contractors yearly. Nexant staff indicated they would like to see an increase in point-of-purchase marketing.

Program staff did not express any immediate concerns about marketing. There are no planned changes to the marketing approach for the upcoming program year, but staff would like to see an increase in activities in 2019.

## **4.2 General Population Survey Results**

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This section presents key findings from surveys administered online by ADM evaluators between April and May 2019. The surveys were completed by 396 Rocky Mountain Power customers in Utah. The surveys gathered information regarding these customers’ energy efficient lighting purchases, incentive program awareness, measures installed and in-service rates, decision making and overall satisfaction.

### **4.2.1 Customer LED Purchases**

Survey respondents provided their insights into their LED purchases. Eighty-four percent of survey respondents indicated that they or someone in their household purchased LED light bulbs in 2017 or 2018. Twenty-six percent of respondents indicated that they or a member of their household purchased a LED fixture in 2017 or 2018. The remaining respondents (13%) reported that no one in their household purchased LED light bulbs or LED fixtures in 2017 or 2018 or they did not recall whether a purchase had been made. Most customers that reported purchasing a LED fixture in 2017 or 2018 also reported purchasing an LED lightbulb (2% of respondents reported purchasing LED fixture and not a LED bulb).

Less than half of survey respondents (47%) reported making their LED lighting purchase from Home Depot. About one-third of respondents (32%) reported purchasing their LED lighting at Costco. Respondents also reported purchasing LED lighting from retailers including Lowe’s, Walmart, and Amazon. Table 4-1 summarizes which retailers survey respondents reported purchasing LED lighting in 2017 or 2018.

*Table 4-1: Where did respondents purchase LED lighting?*

<b>From which of the following retail stores did you purchase your LED lighting?</b>	<b>Response</b>	<b>Percent of Responses (n = 341)</b>
	The Home Depot	47%
	Costco	32%
	Lowe’s	30%
	Walmart	24%
	Amazon	11%
	Other	8%
	Ace Hardware	6%
	Target	6%
	Sam’s Club	4%
	I do not recall	3%
	Batteries Plus	1%

Note: The sum of percentages may not be 100% because respondents could choose more than one response.

Respondents provided information regarding their decision to purchase an LED bulb or fixture. Survey respondents provided the reasons they purchased LED lighting (LED light bulbs and LED fixtures). Table 4-2 summarizes survey respondents’ reported reasons for purchasing LED lighting in 2017 or 2018. Most respondents (84%) reported that they had purchased LED lighting because they “wanted to lower energy usage”. Fifty-seven percent of respondents reported that they purchased LED lighting in 2017 or 2018 because they “replaced burned out bulbs or non-working fixtures”.

*Table 4-2: Why did respondents purchase LED lighting?*

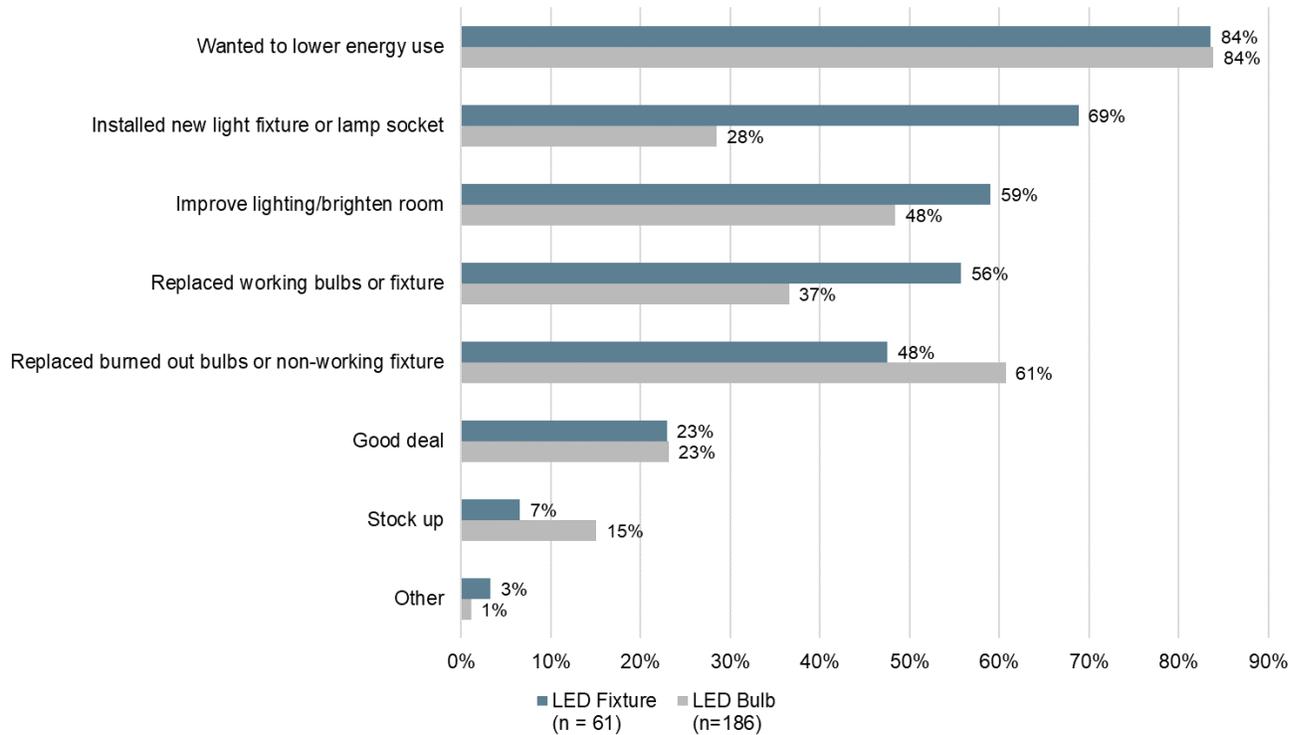
<b>Please select the reasons that best describe your decision to purchase LED lighting in 2017 or 2018.</b>	<b>Response</b>	<b>Percent of Responses (n = 247)</b>
	Wanted to lower energy use	84%
	Replaced burned out bulbs or non-working fixture	57%
	Replaced working bulbs or fixture	41%
	Installed new light fixture or lamp socket	38%
	Improve lighting/brighten room	51%
	Stock up	13%
	Good deal	23%
Other	2%	

Note: The sum of percentages is not 100% because respondents could choose more than one response.

The reasons respondents reported for buying LED fixtures differed from those they gave for purchasing LED bulbs. A higher portion of respondents that were asked about the

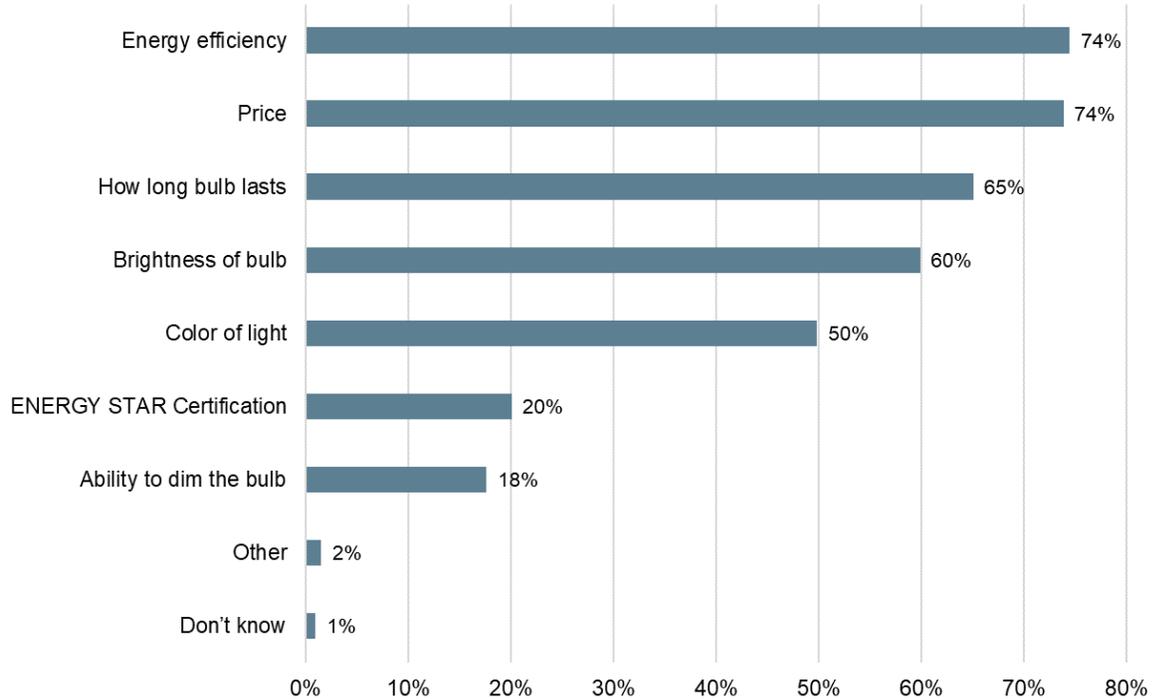
reason they purchased LED fixtures reported that they “installed a new light fixture or socket”, wanted to “improve lighting/brighten room”, or “replaced a working bulb or fixture” compared to those who purchased LED bulbs. A larger portion of respondents (61%) reported they purchased LED bulbs because they “replaced burned out bulbs or non-working fixtures” compared to LED fixtures (48%). Figure 4-1 displays the reasons respondents gave for purchasing either LED bulbs or LED fixtures.

Figure 4-1: Why did respondents purchase LED Bulbs or LED Fixtures?



Respondents reported the most important characteristics they consider when they purchase light bulbs. About three-quarters of respondents reported that energy efficiency (74%) and price (74%) were important characteristics. A significant portion of respondents also indicated that the length of the bulb’s life (65%), brightness of the bulb (60%), color of the light (50%) are important characteristics in their decision to purchase a bulb. Figure 4-2 shows the reasons survey respondents indicated were important when they purchased new light bulbs.

Figure 4-2: What are the most important characteristics when purchasing light bulbs?



n = 329

Note: The sum of percentages is not 100% because respondents could choose more than one response

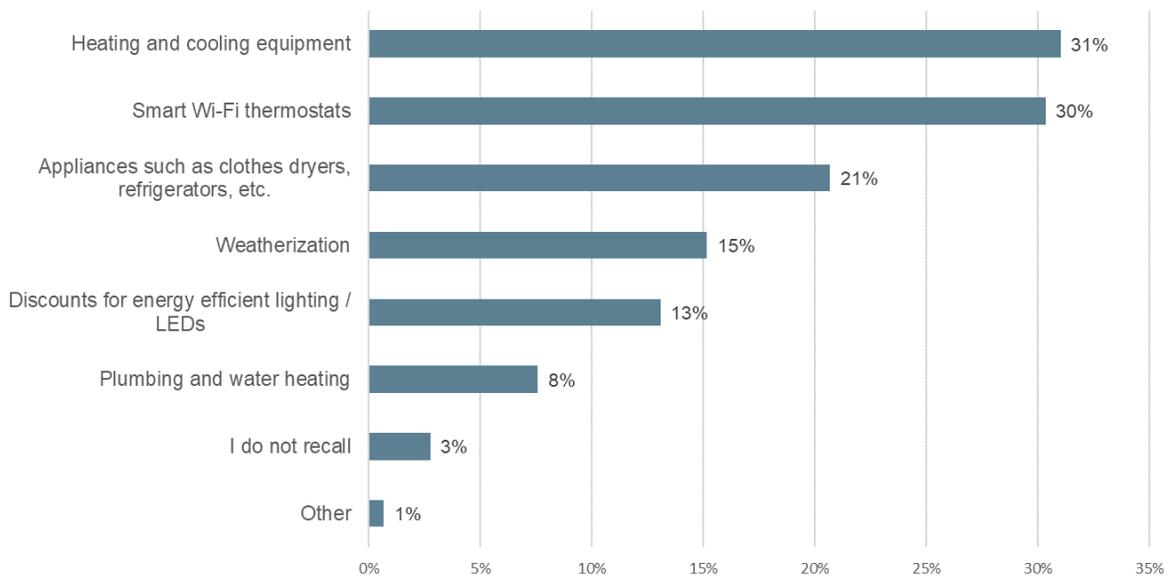
Three-quarters of respondents (75%) indicated that at least one of the new LED bulbs they purchased replaced an incandescent bulb. About half of survey respondents (53%) reported that at least one of the new LED fixtures they purchased replaced an incandescent bulb or fixture. Over one-third of respondents (36%) reported that at least one of the LED fixtures they purchased was to be “installed as a new fixture or socket”. Only 2% of respondents reported that any of the LEDs they purchased were installed in a business or commercial building.

#### 4.2.2 Customer Awareness of Incentives

Survey respondents provided feedback about their awareness of discounts and incentives for energy efficiency equipment and services. Of the 139 respondents who recalled their LED lighting purchase being discounted, respondents most frequently reported that they learned about the discount through in-store advertisements (39%) or could not recall how they learned about the discount (33%).

Survey respondents also indicated their general level of awareness of other utility sponsored discounts or incentives for energy efficient equipment and services. Seventy-three percent of respondents reported they were unaware of incentives for energy efficient equipment and home improvements or other services offered by Rocky Mountain Power. The survey respondents that reported being aware of incentives or services most frequently reported being aware of incentives for heating and cooling equipment (31%), smart wi-fi thermostats (30%), or appliances such as clothes dryers or refrigerators (21%). These respondents most frequently cited the Rocky Mountain Power website (34%), TV ads (18%), and bill inserts (16%) as their source of awareness regarding utility sponsored incentives for equipment and services. Figure 4-3 and Figure 4-4 show the results of the questions about what types of discounts or incentives respondents recall hearing about and how they learned about them.

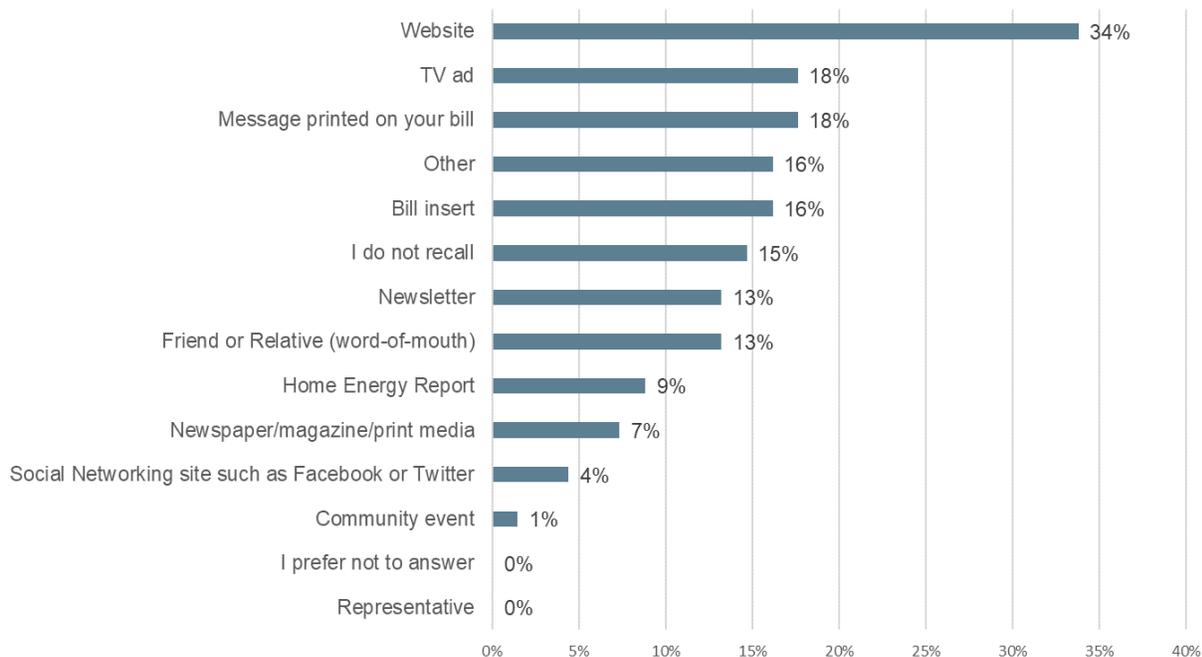
Figure 4-3: What types of discounts or incentives do respondents recall hearing about?



n = 145

Note: The sum of percentages is not 100% because respondents could choose more than one response

Figure 4-4: How did respondents learn about other Rocky Mountain Power discounts or incentives for energy efficient equipment and services?



n = 68

Note: The sum of percentages is not 100% because respondents could choose more than one response

### 4.2.3 Survey Respondent Background & Home Characteristics

ADM gathered demographic and background information from respondents. Regarding respondents' previous experience with energy efficient lighting, 52% of respondents that reported purchasing a LED bulb in 2017 or 2018 reported that they had purchased LED light bulbs prior to 2017. Additionally, 43% of respondents that reported purchasing a LED fixture in 2017 or 2018 reported they had purchased LED fixtures prior to 2017.

Survey respondents who recalled purchasing discounted light bulbs or fixtures, indicated overall satisfaction with Rocky Mountain Power, with 43% who were "satisfied" and 38% who were "very satisfied."

Participants' home characteristics are summarized in Table 4-3. Three-quarters of respondents reported living in single-family detached homes. The majority (83%) of respondents indicated that they owned their home. Respondents' reported approximate household income was equally distributed across the possible survey response options. About eighty percent of respondents indicated natural gas was their primary home and water heating fuel. The average number of members of the household approximately four people. Survey respondents reported their square footage of the home was on average about 2,560 square feet.

Table 4-3: General Population Home Characteristics

Home Characteristics	Percentage of Respondents
Single Family, detached from any other house	75%
Single Family, factory manufactured/modular	2%
Single Family, mobile home	1%
Single Family attached to one or more other houses (e.g. duplex, row house,	11%
Apartment in building with 2 or more units	10%
Other/Don't Know	3%
<b>Own or Rent</b>	
Own	83%
Rent	17%
<b>Year Built</b>	
Before 1960	14%
1960 to 1969	6%
1970 to 1979	12%
1980 to 1989	11%
1990 to 1999	15%
2000 to 2009	22%
2010 to 2018	15%
Don't know	5%
<b>What is the main fuel used for heating your home?</b>	
Electricity	20%
Natural Gas	77%
Propane/Wood Stove/No Heat	2%
Don't know	2%
<b>What fuel does your main water heater use?</b>	
Electricity	13%
Natural Gas	80%
Propane	2%
Don't know	5%
<b>What is your approximate household income?</b>	
Less than \$10,000	2%
\$10,000 to \$29,999	8%
\$30,000 to \$49,999	13%
\$50,000 to \$69,999	18%
\$70,000 to \$89,999	13%
\$90,000 to \$99,999	6%
\$100,000 to \$149,999	17%
\$150,000 or more	11%
Don't know	11%

### 4.3 Energy Kits Program Participant Survey Results

This section presents key findings from Energy Kit surveys, which were administered online by ADM. The surveys were completed by 221 customers who participated in the

Energy Kits Program in 2017 or 2018. Of these respondents, 15 reported that they had not received a kit or did not recall receiving a kit. The survey gathered information regarding program awareness, measures installed and in-service rates, decision making and overall satisfaction.

### **4.3.1 Program Awareness and Enrollment Experience**

Participants provided information and feedback regarding how they learned about the Energy Kits program and their experience enrolling in the program. Over 40% of participants reported hearing about the program through either their utility bill insert (37%) or a message printed on their bill (6%). Thirty-five percent of respondents reported learning about the program from the utility’s website. Utility newsletters (11%) and word of mouth (6%) were also mentioned as sources of program information. A summary of survey responses appears in Table 4-4.

*Table 4-4: How did respondents learn about the program?*

<b>How did you hear about these kits?</b>	<b>Percent of Responses (n = 206)</b>
Utility bill insert	37%
Utility Website	35%
Utility newsletter	11%
Message printed on your bill	6%
Word of mouth	6%
Don't know	5%
Social networking website	3%
Newspaper/magazine/print media	2%
Home Energy Report	1%
Community event	1%
TV ad	1%
Utility representative	1%
Other	1%

Note: The sum of percentages is not 100% because respondents could choose more than one response

### **4.3.2 Customer Experience and Installation of Measures**

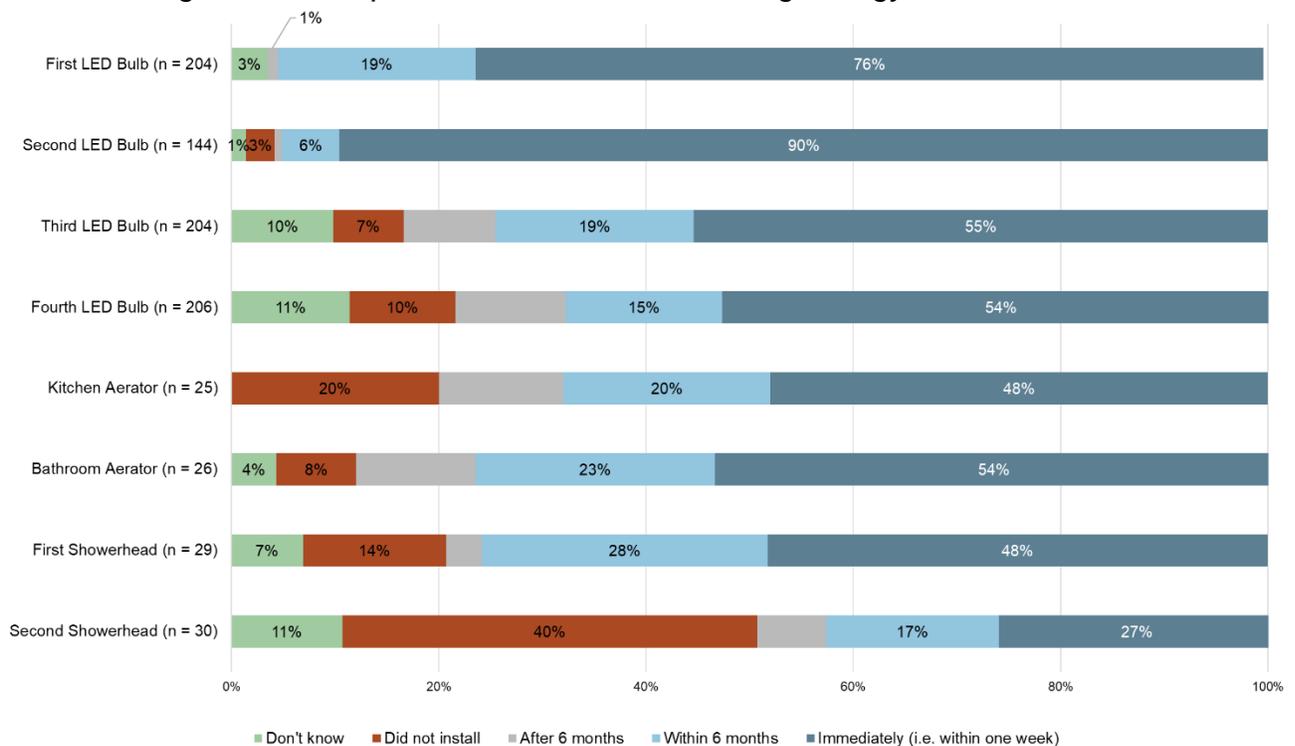
Survey respondents provided feedback regarding installing the energy kit contents. To verify the contents of each survey respondents’ energy kit, respondents indicated if their home had an electric water heat. Next, according to their response, they indicated if they had installed the various energy kit measures. For each of the measures, most respondents reported that they installed them “immediately (within one week).” The one exception was high efficiency showerhead(s). Regarding the first high efficiency showerhead, slightly less than half of respondents (48%) reported installing it immediately. Forty-three percent of survey respondents that were asked about a second

high efficiency showerhead reported that it had not been installed and 11% were not sure whether it had been installed.

Most respondents reported installing the first LED light bulb (77%) and second LED light bulb (87%) “immediately (within one week).” There were not any customers who reported that they had not installed their first LED light bulb and only a small portion of survey respondents reported that they had not installed their second LED light bulb (6%). A larger portion of respondents reported that the third and fourth LED bulbs they received were not installed or “did not know” if they were installed. About one-quarter (23%) of respondents that reported receiving kitchen aerators reported that they had not installed them. Figure 4-5 displays respondents’ timeline for installing various energy kit measures.

Among those who reported receiving an energy kit, 19% reported they had not installed one or more items they received in their energy kit. Thirteen percent of energy kit recipients stated that they could not recall whether one or more items they received had been installed.

*Figure 4-5: Respondent Timeline for Installing Energy Kit Measures*



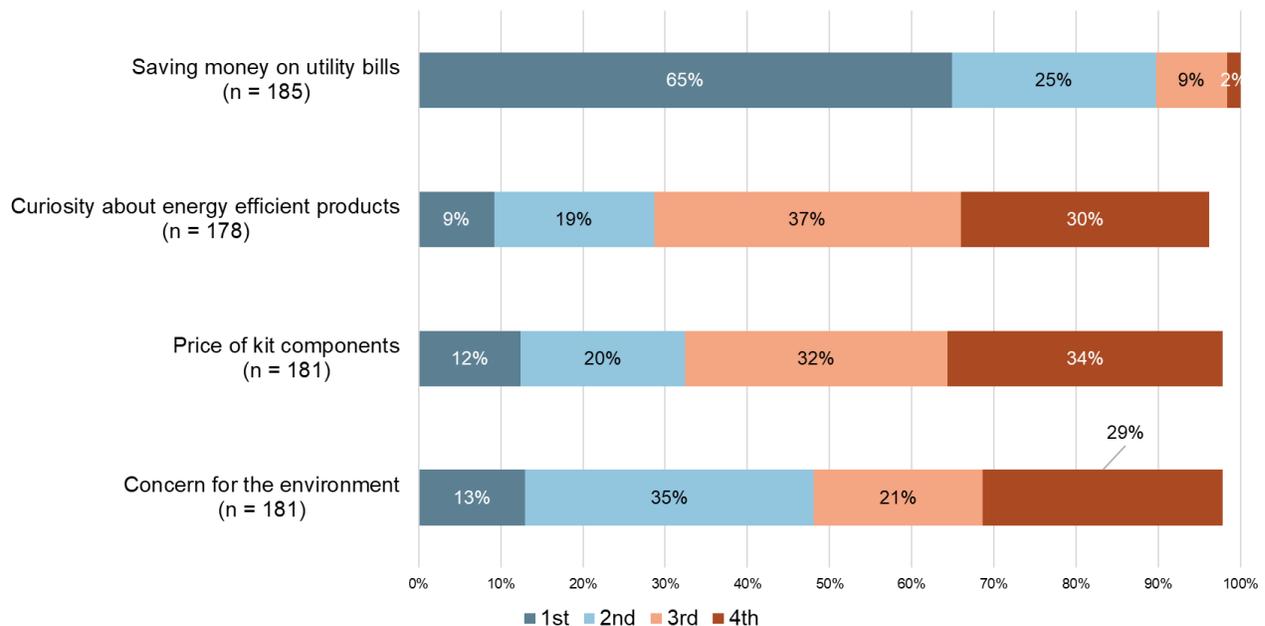
Energy kit recipients who reported that they had not installed certain measures provided the reasons that these measures were not installed. Of the respondents who reported they did not install one or more of the LED bulbs from the energy kit, 76% indicated they were “waiting for their current lights to burn out.” Fourteen percent of respondents reported that they “did not know” why one or more of the LED bulbs they received was

not installed. Regarding high efficiency showerheads that were not installed, the most frequently cited reason (35%) was the customer already had high efficiency showerheads installed throughout their house. Most respondents stated the LED bulbs (84%) and showerheads (57%) they had not installed were in storage. A small portion of survey respondents reported receiving bathroom and kitchen aerators (12% of respondents or 25 individuals). Of these respondents, six stated that they had either not installed their kitchen aerator or bathroom aerator. Two-thirds of these individuals stated they did not know why they had not installed them and half reported not knowing where the aerators were currently located.

### 4.3.3 Participant Motivations

Respondents provided feedback regarding what influenced them to request the energy kit. Energy kit survey respondents ranked the most important reasons that influenced them to participate in the program, with 65% of respondents reporting “saving money on utility bills” as the most important reason. Almost half of survey respondents reported that “concern for the environment” was either the first (13%) or second (35%) most important reason that motivated them to request an energy kit. A smaller portion of survey respondents reported that the most important reason they requested an energy kit was “curiosity about energy efficient products” (9%) or “price of energy kit components” (12%). Figure 4-6 displays respondents’ ranking of different reasons for requesting an energy kit.

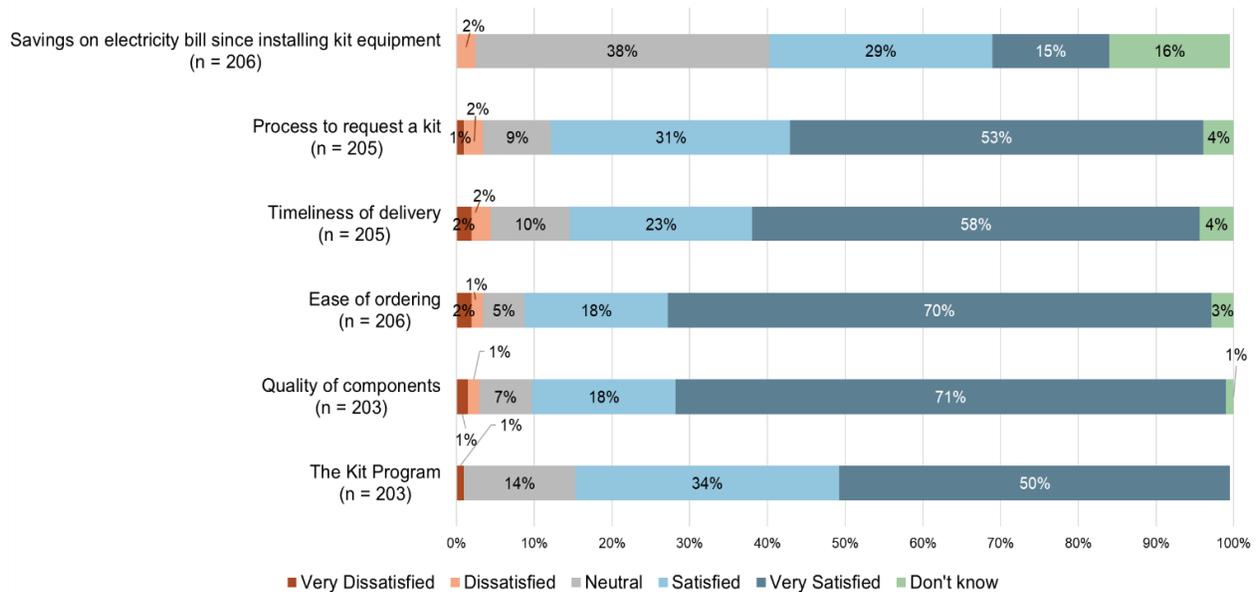
Figure 4-6: Survey respondents’ Ranking of Reasons for Requesting an Energy Kit



### 4.3.4 Customer Satisfaction

Participants provided feedback regarding their level of satisfaction with specific aspects of the program, as well as their overall experience with the energy kits component of the program. Eighty-four percent of survey respondents indicated they were either “very satisfied” (50%) or “satisfied” (34%) with the energy kit overall. Additionally, survey respondents shared positive sentiments regarding the energy kit request process and the energy kit contents. Regarding the energy kit request process, the majority of survey respondents reported being either “very satisfied” or “satisfied” with the ease of ordering (88%) and timeliness of delivery (71%). Eighty-nine percent of survey respondents reported being “very satisfied” (71%) or “satisfied” (18%) with the quality of the energy kit components. Survey respondents shared sentiments regarding the savings on their electricity bill since installing the equipment; though 44% of respondents reported being either “very satisfied” (15%) or “satisfied” (29%), over one-third of respondents (38%) indicated they were “neither satisfied nor dissatisfied” with their savings since installing the equipment. Figure 4-7 displays survey respondents’ satisfaction with the energy kit component of the program as well as their satisfaction with specific aspects of their experience with the program.

Figure 4-7: Customer Satisfaction with Energy Kit Program



Additionally, survey respondents were asked about their level of satisfaction with their electricity service provider. Seventy-seven percent of survey respondents reported being either “very satisfied” (33%) or “satisfied” (44%) with Rocky Mountain Power. Twenty percent of respondents reported having a “neutral” level of satisfaction with their electricity

service provider. The remaining respondents reported being dissatisfied (1%) or being unable to gauge their level of satisfaction (1%).

#### 4.3.5 Home Characteristics

Participants' home characteristics are summarized in Table 4-5. Over three-quarters of respondents reported living in single-family detached homes (84%). The majority (89%) of respondents indicated that they owned their home. Fifty-nine percent of respondents reported having an approximate household income of \$69,999 or less. Over eighty percent of respondents indicated natural gas was their primary home and water heating fuel. The average number of members of the household was three people and about one-third (34%) of survey respondents indicated that two people lived in their household (including themselves). Survey respondents reported their square footage of the home was on average about 2,600 square feet.

*Table 4-5: Energy Kit Participants Home Characteristics*

Home Characteristics	Percentage of Respondents
Single Family, detached from any other house	84%
Single Family, factory manufactured/modular	2%
Single Family, mobile home	1%
Single Family attached to one or more other houses (e.g. duplex, row house,	7%
Apartment in building with 2 or more units	6%
<b>Own or Rent</b>	
Own	89%
Rent	11%
<b>Year Built</b>	
Before 1960	15%
1960 to 1969	5%
1970 to 1979	10%
1980 to 1989	10%
1990 to 1999	14%
2000 to 2009	23%
2010 to 2018	19%
Don't know	5%
<b>What is the main fuel used for heating your home?</b>	
Electricity	13%
Natural Gas	85%
Propane	2%
<b>What fuel does your main water heater use?</b>	
Electricity	14%
Natural Gas	84%
Propane	2%
<b>What is your approximate household income?</b>	

Home Characteristics	Percentage of Respondents
Less than \$10,000	2%
\$10,000 to \$29,999	6%
\$30,000 to \$49,999	12%
\$50,000 to \$69,999	20%
\$70,000 to \$89,999	18%
\$90,000 to \$99,999	6%
\$100,000 to \$149,999	19%
\$150,000 or more	4%
Don't know	12%

#### 4.4 HVAC Program Participant Survey Results

This section presents key findings from HVAC program surveys administered online by ADM, completed by 72 customers who reported receiving an incentive for a smart thermostat in the 2017 or 2018 through Rocky Mountain Power's wattsmart Homes Program in Utah. The survey gathered information regarding program awareness, measures installed and in-service rates, decision making and overall satisfaction.

##### 4.4.1 Program Awareness and Enrollment Experience

Participants provided information regarding how they first learned about the incentive program as well as sources of information they utilized while they were making the decision to purchase the smart thermostat. One-quarter of survey respondents reported that they learned about the program from the utility's website. Twenty-two percent of survey respondents also indicated that bill inserts were a source of program awareness or how they learned about the program. Table 4-6 summarizes how survey respondents first learned about the program.

Table 4-6: How did respondents first learn about the program?

How did you first learn about the Program?	Percent of Responses (n = 70)
Utility's Program website	25%
Bill inserts	22%
Retailer/store	14%
Friend, neighbor, relative, or	12%
Message printed on your bill	9%
Internet advertisement	6%
Don't know	4%
Television	4%
Other	3%
Newspaper/magazine/print media	1%

Survey respondents most frequently indicated that they found information on a program website (51%) or through a retailer (42%) when deciding to purchase a smart thermostat. Word of mouth through a friend, neighbor, relative or coworker (14%) was also mentioned as sources of program information about incentives offered (see Table 4-7).

*Table 4-7: How did respondents get information about the incentive?*

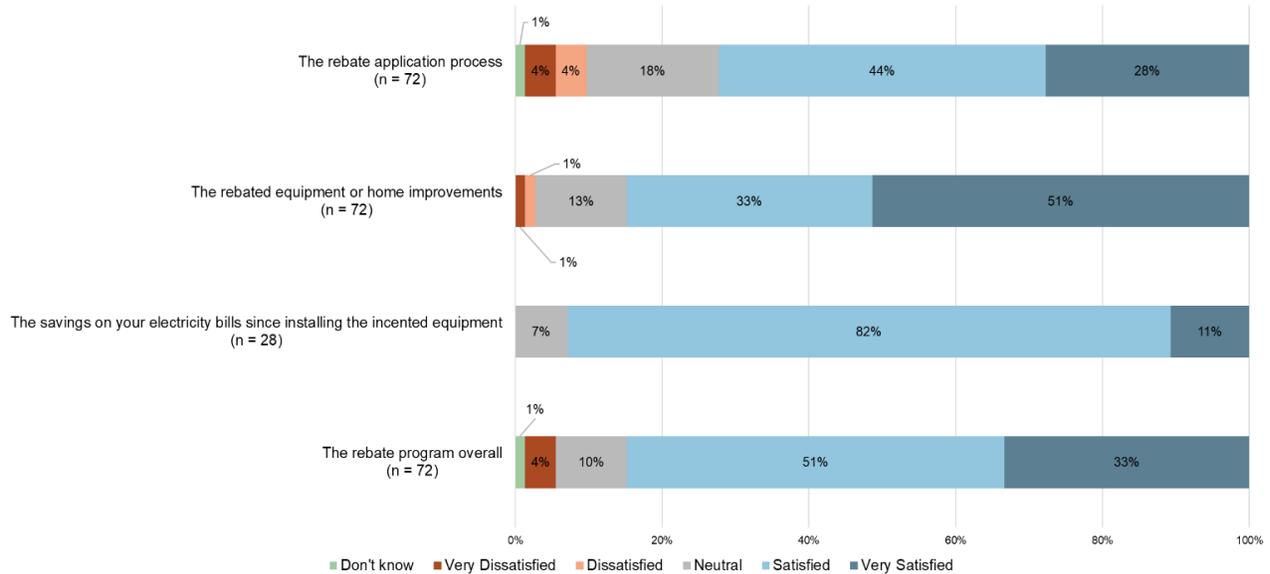
<b>When you were deciding to purchase the energy efficient thermostat, from where did you get information about the incentives offered by your Utility?</b>	<b>Percent of Responses** (n = 69)</b>
Program website	51%
Retailer	42%
Friend, neighbor, relative or co-worker	14%
Installation contractor	6%
Other	6%
Don't Know	6%
Radio	4%
Product magazine (e.g. Consumer Reports)	3%
Utility representative	1%

\*\*Total exceeds 100% because respondents could select more than one response.

#### **4.4.2 Customer Satisfaction**

Participants provided feedback regarding their level of satisfaction with specific aspects of the HVAC component of Rocky Mountain Power’s wattsmart Homes Program as well as the program overall. Over half of respondents (51%) reported being “very satisfied” with the incentivized equipment they purchased and one-third of respondents reported being “satisfied”. Nearly all of survey respondents (93%) reported being “satisfied” (82%) or “very satisfied” (11%) with the savings on their electric bill since installing their new smart thermostat. Regarding the incentive application process, 72% of survey respondents reported being either “very satisfied” (28%) or “satisfied” (44%). Eight percent of respondents indicated they were “dissatisfied” (4%) or “very dissatisfied” (4%) with the application process and 18% indicated they felt “neutral” about the process. Eighty-four percent of survey respondents indicated they were either “very satisfied” (33%) or “satisfied” (51%) with the program overall. Figure 4-8 displays survey respondents’ overall satisfaction with the HVAC component of Rocky Mountain Power’s wattsmart Homes program as well as their satisfaction with specific aspects of their experience with the program.

Figure 4-8: Customer Satisfaction with Rocky Mountain Power’s HVAC and Appliance Incentive Program



Survey respondents were asked about their level of satisfaction with Rocky Mountain Power. Eighty-three percent of survey respondents reported being either “very satisfied” (19%) or “satisfied” (64%) with their electricity service provider. Sixteen percent of respondents reported having a “neutral” level of satisfaction with their electricity service provider. Only one respondent (1% of surveyed participants) reported dissatisfaction with their electricity service provider.

#### 4.4.3 Home Characteristics

Participants’ home characteristics are summarized in Table 4-8. Nearly ninety percent of respondents reported living in a single-family detached home (89%). Almost all respondents (97%) indicated that they owned their home and ninety percent of respondents indicated natural gas was their primary home and water heating fuel. More than half of survey respondents indicated that their household’s approximate income was \$100,000 or greater. The average reported number of people per household survey respondents reported was about four people. Over two-thirds of survey respondents indicated that they had three or more people living in their household (including themselves). On average survey respondents reported their square footage of the home was about 2,950 square feet.

Table 4-8: HVAC Participant Home Characteristics

Home Characteristics	Percentage of Respondents
Single Family, detached from any other house	89%
Single Family, factory manufactured/modular	3%
Single Family, mobile home	1%
Condominium	6%
Other	1%
<b>Own or Rent</b>	
Own	97%
Rent	3%
<b>Year Built</b>	
Before 1960	7%
1960 to 1969	3%
1970 to 1979	11%
1980 to 1989	19%
1990 to 1999	11%
2000 to 2009	24%
2010 to 2018	24%
Don't know	1%
<b>What is the main fuel used for heating your</b>	
Electricity	7%
Natural Gas	90%
Other/Don't Know	3%
<b>What fuel does your main water heater use?</b>	
Electricity	7%
Natural Gas	89%
Don't know	4%
<b>What is your approximate household</b>	
\$30,000 to \$49,999	4%
\$50,000 to \$69,999	11%
\$70,000 to \$89,999	16%
\$90,000 to \$99,999	4%
\$100,000 to \$149,999	28%
\$150,000 or more	24%
Don't know	13%

## 4.5 New Homes Builder Interviews Results

### 4.5.1 Program Description

Rocky Mountain Power offers a new homes component of the wattsmart Homes Program to eligible builders who are interested in building and marketing above-code, energy-efficient new homes in Rocky Mountain Power's Utah service area. The new homes offering provides incentives for high-efficiency homes.

#### **4.5.2 Builder Interview Findings**

ADM completed interviews with program participants to collect information regarding builders' experience with the new homes component of the wattsmart Homes Program in 2017 and 2018.

ADM contacted 40 builders to participate in the interviews and a total of twelve builders participated in the interviews. Multiple efforts (emails and direct calls) were made to contact builders to solicit their participation in an interview. The interviews were conducted by telephone. ADM evaluators also interviewed HERS raters who works with approximately 77 builders in the service territory.

##### *4.5.2.1 Program Participation and Other Incentive Offerings*

The number of single-family homes completed among the interviewed builders varied from 8 to 834 homes in 2017 and 5 to 1,064 in 2018. The number of multifamily homes completed ranged from 81 to 800 units in 2017 and 179 to 800 in 2018. The reported average square footage of single family homes included in the program ranged from 1,400 to 3,500 ft<sup>2</sup> and multifamily units ranged from 1,100 to 1,600 ft<sup>2</sup>. The actual average size of a new home participating in the program is about 3,500 ft<sup>2</sup>.

Most builders interviewed (67%) built single-family homes exclusively and one third (33%) built both single-family and multifamily units. The HERS raters indicated they completed about 8,500 single-family and multifamily units in 2018 and that nearly 70% qualified for the wattsmart Homes Program. Two of survey respondents indicated they participated in 2018 and ten participated in 2017 and 2018 (see Table 4-9).

*Table 4-9: Year Company Participated*

<b>Response</b>	<b>Percentage of Respondents (n = 12)</b>
2017 only	0%
2018 only	17%
2017 and 2018	83%

Forty-two percent of builders interviewed indicated they received the federal ENERGY STAR New Homes tax credit in 2017. Among those who received the ENERGY STAR tax credit, most indicated that 100% of those homes also received the wattsmart Homes incentive as well. A large share (83%) indicated they received the Dominion Energy ThermWise Builder Rebates. No other incentive sources were identified during the interviews. Three builders indicated they participated in the EPA's "Energy Star New Homes" program, one builder participated in the NGBS Green Housing program, one

builder participated in the Environments for Life program, and one builder participated in the Department of Energy’s Builder Challenge.

*4.5.2.2 Experience with wattsmart New Homes Program*

Most builders interviewed indicated their homes are production homes, with two indicating they build custom homes. Builders who built program-qualifying homes (e.g., ENERGY STAR 3.0, HERS 62 or lower, etc.), provided feedback about how it adds value to home and the ability to sell to homebuyers. Some builders indicated these standards are important to certain types of buyers (i.e., those more interested in green building and/or energy conscience) and others indicated educated buyers are interested in HERS ratings. Builder interview participants conveyed what they believe are the primary benefits to customers who are interested in purchasing a new home that is energy efficient, with 92% pointing to reducing energy costs (see *Table 4-10*).

*Table 4-10: Perceived Interests of Buyers about the Benefits of Energy Efficient Construction*

<b>Response</b>	<b>Percentage of Respondents (n = 12)</b>
Reducing energy costs	92%
Concern about the environment	50%
Knowing they purchased a high-quality home	42%
Improving home comfort	33%
Resale value	17%
Other (Water consumption, windows, indoor air quality, homes are quieter)	33%

Note: The sum of percentages is not 100% because respondents could choose more than one response

Forty-two percent of respondents indicated they perform duct leakage testing on all their homes, another 42% indicated they perform the testing on a sample of their homes, 8% indicated none, and 8% were unsure. Sixty-seven percent perform infiltration testing on all homes, with 8% indicating a sample of homes, another 8% who indicated none of their homes, and 17% reporting they did not know.

All builders who were interviewed stated they utilize a HERS rater for their homes within Rocky Mountain Power’s service territory. Twenty-five percent of builders interviewed indicated it is most beneficial to consult HERS raters at the planning and design stage, 42% indicated it was valuable during construction, and 42% indicated the inspection and testing phase.<sup>8</sup> The interviewed HERS raters indicated it varies significantly when they are typically contacted about a potential program-qualifying home. The interviewed HERS

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<sup>8</sup> The sum is greater than 100% because some builders indicated multiple phases where a HERS rater is important.

raters stated that with multifamily homes they are typically involved in the planning stage because of HUD and ENERGY STAR requirements. Since many of the builders they work with build production homes, involvement with single-family homes can be an ongoing process and it is common for their role to be testing and inspection of homes post construction. HERS raters indicated the number of times they visit a project varies but is typically once or twice and they complete thermal bypass inspections before drywall is installed.

Builders provided feedback on how partnering with a HERS rater during the design process added value to their homes. Below are a few of their verbatim responses.

- We were already gravitating years ago to be more energy efficiency. They helped us get to the last stage. The biggest benefit we had working with a HERS rater is the third-party testing and validating. I cannot emphasize that enough. It is a tool that I use with customers, it carries a lot of weight.
- Having that and being able to tell our customers their homes are more efficient and lower bills. We have energy certificates that come with every plan and that is part of the customer's file when they build the home.
- Nice to have an expert to answer any questions that we had. Making sure we were doing the construction correctly.
- We are a production home builder; we work with them closely so most of the homes have already been through design iterations. It is integral to what we do.
- We can identify things we can improve on early on before we start building the home.
- Just getting a better understanding of what we needed to do and how it would impact the HERS rating.
- They help us along the way, they work with our contractors. They meet with them and provide tips. It helps contractors better understand what they need to do and make the home the best they can.
- I really liked working with him, he was very knowledgeable. We could use his knowledge and expertise to make our homes more efficient
- It helps reduce mistakes.
- It helped it ton with layout and setting our expectation of where we need to be. The blower tests and where we need to be in terms of building efficient homes. It is really helpful at the beginning.

#### *4.5.2.3 Training and Technical Assistance*

Forty-two percent of surveyed builders indicated they received technical training or assistance on new construction design and energy efficiency (see Table 4-11). Training

on energy codes from Nexant was cited as the type of technical training and assistance received, along with training from RMP and ThermWise. Those who received resources through the program were given an opportunity to rate the impact using a scale from 1 (no impact) to 5 (large impact). The average score was 3.3 among those who received resources which were offered through the wattsmart Homes Program. The interviewed HERS raters indicated they provide builders additional technical assistance outside of plan reviews and inspections (e.g., education on weatherization durability and energy efficiency).

*Table 4-11: Training, Technical Support and Marketing*

<b>Response</b>	<b>Percentage of Respondents (n = 12)</b>
Technical training or assistance on new construction design and energy efficiency	42%
Training on program processes and procedures	17%
Marketing support	0%
None	50%

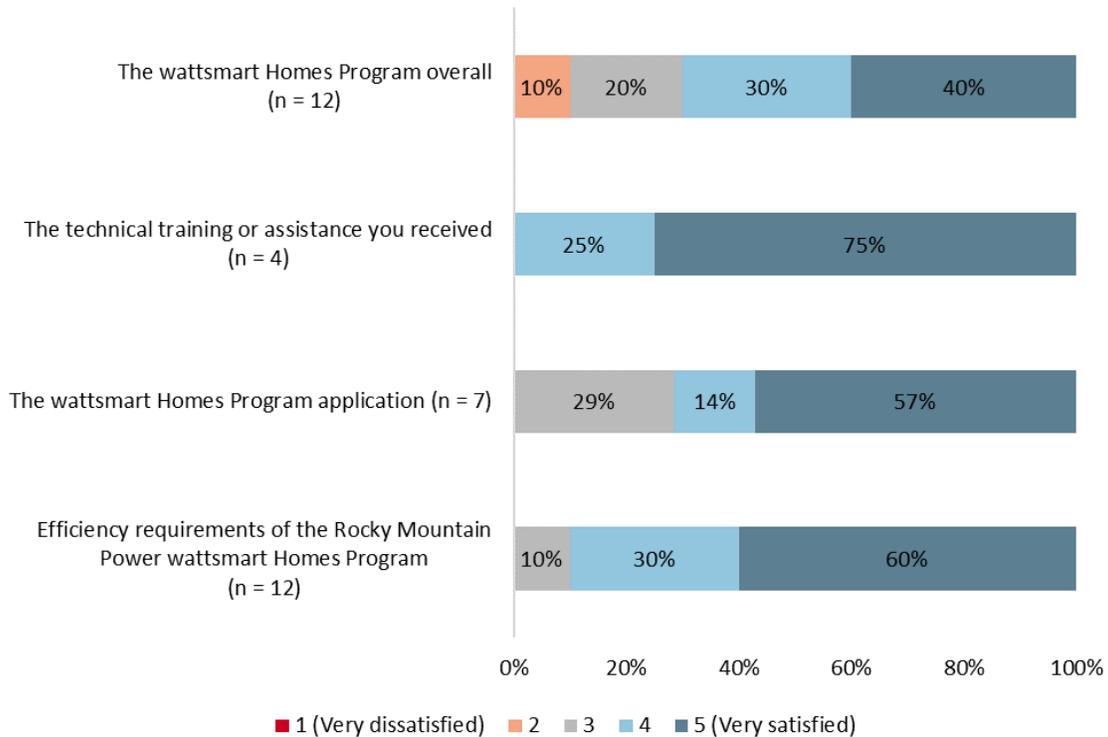
Note: The sum of percentages is not 100% because respondents could choose more than one response

Most builders did not believe there were any barriers, but four respondents indicated there are some that may discourage them or others from participation. The barriers cited by builders included costs, not having an established relationship with a HERS rater, lack of understanding and knowledge among builders, and the incentive amount being less than the cost of program-qualifying equipment. Interviewees who believed there were barriers offered suggestions to reduce the barriers to participating in the wattsmart Homes Program. They included providing education to builders who are not on board of the benefits of energy-efficient homes and the available resources.

*4.5.2.4 Satisfaction and Program Feedback*

Using a scale from 1 (very dissatisfied) to 5 (very satisfied), participants rated how satisfied or dissatisfied they were with the efficiency requirements of the program, the wattsmart Homes Program application, the technical training or assistance they may have received, and the program overall. All participants who received training or technical assistance indicated they were very or somewhat satisfied with that component of the program (see Figure 4-9). Additionally, 83% were very or somewhat satisfied with the efficiency requirement, 75% were very or somewhat satisfied with the program overall, and 71% were very or somewhat satisfied with the application.

Figure 4-9: Builders Satisfaction with Components of the wattsmart Homes Program and Overall



Builders were given an opportunity to provide feedback about the wattsmart Homes Program. Three builders interviewed cited the high cost of energy-efficiency equipment compared to the incentive amount can be challenging. The HERS raters also suggested increasing funding for the program to encourage additional participation. They also suggested to identify and engage more strategic partners in the program.

Two builders indicated they waited a long period to receive their incentive check, with one person indicating that 60 – 90 days would be an acceptable timeframe to receive the incentive. Two builders cited frustration with the application process being laborious and one builder indicated they would like to see more consistency with communication with program staff. Challenges with the application process were also echoed by the HERS raters.

All interview participants indicated they planned to participate in the new homes component of the wattsmart Homes Program in 2019. Half of builders (50%) believed they would build 100% of the homes to the standards of the program, with 33% indicating they would build between 75% and 95% of their homes to the standards of the program.

## 5 Cost-Effectiveness

Rocky Mountain Power contracted with Navigant to calculate the Program cost-effectiveness based on the evaluated savings assessed by ADM. Additionally, ADM provided the measure life and incremental cost inputs needed to calculate the cost-effectiveness of the Program. Measure life and incremental cost values were assigned on an individual measure basis and came from the TRL files provided by Rocky Mountain Power.

Table 5-1 provides the cost-effectiveness analysis inputs for each year, including evaluated energy savings, discount rate, residential line loss, residential energy rate, inflation rate, and total program costs (based on the UCT).

*Table 5-1: wattsmart Homes Program Cost-Effectiveness Inputs*

Parameter	2017	2018
Evaluated Net Savings (kWh/year)	49,117,240	39,411,231
Discount Rate	6.66%	6.57%
Residential Line Loss	9.32%	9.32%
Residential Energy Rate (\$/kWh)	\$0.1117	\$0.1069
Inflation Rate	1.90%	2.20%
Total Program Costs	\$11,837,537	\$11,125,516

Table 5-2 shows the results for the overall program for the combination of program years 2017 and 2018, based on evaluated net savings. The Utah wattsmart Homes Program was cost-effective during the 2017-2018 evaluation period, across all cost-effectiveness tests except for the Ratepayer Impact Measure (RIM) test. The overall program achieved a 2.13 benefit/cost ratio for the combined years using the Utility Cost Test (UCT).

*Table 5-2: 2017-2018 wattsmart Homes Program Level Cost-Effectiveness Results*

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.0541	\$45,174,969	\$53,726,896	\$8,551,927	1.19
Total Resource Cost Test (TRC) No Adder	\$0.0541	\$45,174,969	\$48,842,633	\$3,667,664	1.08
Utility Cost Test (UCT)	\$0.0275	\$22,963,053	\$48,842,633	\$25,879,580	2.13
Rate Impact Test (RIM)		\$120,936,968	\$48,842,633	(\$72,094,335)	0.4
Participant Cost Test (PCT)		\$45,235,175	\$142,132,604	\$96,897,429	3.14
Lifecycle Revenue Impacts (\$/kWh)					\$0.00001010
Discounted Participant Payback (years)					4.35

Table 5-3 and Table 5-4 show the Utah wattsmart Homes Program cost-effectiveness results for the 2017 and 2018 years individually, based on evaluated savings. The Program was cost-effective using the UCT in 2018. The Utah wattsmart Homes Program was cost-effective across all cost-effectiveness tests except for the RIM test in 2017.

Table 5-3: 2017 wattsmart Homes Program Level Cost-Effectiveness Results

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.0427	\$19,344,888	\$34,596,385	\$15,251,497	1.79
Total Resource Cost Test (TRC) No Adder	\$0.0427	\$19,344,888	\$31,451,259	\$12,106,371	1.63
Utility Cost Test (UCT)	\$0.0261	\$11,837,537	\$31,451,259	\$19,613,721	2.66
Rate Impact Test (RIM)		\$66,161,286	\$31,451,259	(\$34,710,027)	0.48
Participant Cost Test (PCT)		\$19,367,933	\$79,493,365	\$60,125,432	4.1
Lifecycle Revenue Impacts (\$/kWh)					\$0.00001018
Discounted Participant Payback (years)					2.09

Table 5-4: 2018 wattsmart Homes Program Level Cost-Effectiveness Results

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.0678	\$25,830,081	\$19,130,511	(\$6,699,570)	0.74
Total Resource Cost Test (TRC) No Adder	\$0.0678	\$25,830,081	\$17,391,374	(\$8,438,707)	0.67
Utility Cost Test (UCT)	\$0.0292	\$11,125,516	\$17,391,374	\$6,265,858	1.56
Rate Impact Test (RIM)		\$54,775,682	\$17,391,374	(\$37,384,308)	0.32
Participant Cost Test (PCT)		\$25,867,242	\$62,639,239	\$36,771,997	2.42
Lifecycle Revenue Impacts (\$/kWh)					\$0.00001003
Discounted Participant Payback (years)					4.65

Table 5-5 presents the benefit/cost ratio results for the Program for each cost-effectiveness test by program year.

Table 5-5: Benefit/Cost Ratios by Program Year

Program Year	PTRC	TRC	UCT	RIM	PCT
2018	0.74	0.67	1.56	0.32	2.42
2017	1.79	1.63	2.66	0.48	4.10
2017-2018	1.19	1.08	2.13	0.40	3.14

Navigant also completed cost-effectiveness tests at the measure-category level for each individual program year. The benefit/cost ratio results by measure-category are presented in Table 5-6 and Table 5-7.

Table 5-6: Benefit/Cost Ratios by Measure Category, 2017

Measure Group	PTRC	TRC	UCT	RIM	PCT
Building Shell	0.34	0.31	0.74	0.30	0.96
Energy Kits - DHW	0.61	0.55	1.84	0.56	0.96
Energy Kits - Lighting	13.77	12.52	11.30	0.47	49.91
HVAC	2.31	2.10	1.98	0.43	16.96
Lighting	0.61	0.56	0.97	0.43	1.41
Water Heating	3.41	3.10	4.24	0.49	6.93
Whole Building	0.69	0.62	0.75	0.30	2.38
New Homes	0.49	0.44	0.98	0.36	1.11
<b>Total</b>	<b>1.79</b>	<b>1.63</b>	<b>2.66</b>	<b>0.48</b>	<b>4.10</b>

Table 5-7: Benefit/Cost Ratios by Measure Category, 2018

Measure Group	PTRC	TRC	UCT	RIM	PCT
Building Shell	0.21	0.19	1.28	0.38	0.47
Energy Kits - DHW	2.91	2.64	3.14	0.30	23.74
Energy Kits - Lighting	2.73	2.48	2.35	0.31	16.65
HVAC	0.38	0.34	0.68	0.29	1.26
Lighting	1.62	1.47	2.43	0.31	5.19
Water Heating	0.50	0.45	0.51	0.21	2.61
Whole Building	0.41	0.37	1.85	0.40	0.93
New Homes	0.43	0.39	0.96	0.35	0.99
<b>Total</b>	<b>0.74</b>	<b>0.67</b>	<b>1.56</b>	<b>0.32</b>	<b>2.42</b>

Additional information on the cost-effectiveness test results for each measure category is presented in Appendix E.

## 6 Conclusions and Recommendations

The results from this evaluation study of Rocky Mountain Power’s 2017-2018 Home Energy Savings Program in Utah are summarized by measure category in Table 6-1:

*Table 6-1: wattsmart Homes Program Claimed and Evaluated Savings by Measure Category, 2017-2018*

Year	Measure Category	Claimed Savings (kWh)	Evaluated Gross Savings (kWh/yr)	Realization Rate	Evaluated Net Savings (kWh/yr)	NTG
2017-2018	Lighting	110,043,849	95,368,175	86.7%	70,964,280	74.4%
	Energy Kits	1,647,808	1,707,227	103.6%	1,522,334	89.2%
	Appliances	147,420	147,420	100.0%	110,306	74.8%
	Building Shell	644,874	679,827	105.4%	649,598	95.6%
	HVAC	19,455,860	10,184,667	52.3%	9,759,308	95.8%
	Water Heating	16,830	16,830	100.0%	12,690	75.4%
	Whole Building Multifamily	4,361,710	4,304,662	98.7%	4,107,132	95.4%
	New Homes	2,354,521	2,354,521	100.0%	1,402,824	59.6%
<b>TOTAL</b>		<b>138,672,872</b>	<b>114,763,328</b>	<b>82.8%</b>	<b>88,528,472</b>	<b>77.1%</b>

ADM provides the following conclusions and recommendations to improve the program and the evaluation of the program in future years.

- **Lighting Measure Category:**

Conclusion: ADM’s calculation of an 8% leakage rate for lighting in Utah is on the low end of leakage rates for lighting and is likely due to the relatively large and connected Rocky Mountain Power territory in Utah and the effective or strategic placement of participating retailer locations. The implementation contractor has indicated that the Retail Sales Allocation Tool (RSAT) may be a predictor of bulb leakage in Rocky Mountain Power territories and is used to determine allocations of bulbs to participating stores.

Recommendation: To understand further how the RSAT tool accounts for leakage and how the store allocations relate to the Program Tracking Data, ADM recommends that the next evaluation of subsequent program years includes a full life-cycle review of the lighting contracts.

- **Energy Kits Measure Category:**

Conclusion: The showerhead energy kits component had the lowest overall ISR of all energy kit components. This was driven by a 56% ISR for the second showerhead in the Best Kit – 2 Bathroom Energy Kits compared to an 85% ISR for the first showerhead.

Recommendation: ADM recommends that Rocky Mountain Power consider including only one showerhead in the Best Kit – 2 Bathroom Energy Kits, which could increase the overall ISR for showerheads.

- **HVAC Measure Category:**

HVAC Conclusion #1: The evaporative cooler HVAC measure had the lowest net realization rate in the evaluation, which is likely due to the SEER 13 baseline assumption that is used in the source of the claimed savings value. Through the billing analysis, ADM found that the treatment group for evaporative coolers appear to have already drastically reduced consumption relative to the control group, indicating that the majority of participants who installed evaporative coolers didn't have an air conditioning unit previously and thus the use of a SEER 13 baseline assumption in this evaluation would require additional information on participant baseline data.

HVAC Recommendation #1: In future evaluation cycles, ADM recommends further data collection on evaporative cooler baseline conditions and purchase decisions. Given the move to a midstream measure, ADM recommends working with distributors to either collaborate on a methodology to reach program participants through gathering contact information at the purchase point or interviewing distributors directly as a proxy to understand program participants purchase decisions and baseline conditions.

HVAC Conclusion #2: ADM was limited to a deemed savings review for the heat pump measure category due to the low participant numbers and too low of a sample size to use the results of the billing analysis for this group.

HVAC Recommendation #2: ADM recommends that during the next evaluation cycle, we calculate savings for heat pump measures using an engineering desk review approach in addition to the deemed savings review. In order to do this, ADM would need baseline equipment type and specifications (e.g. make and model) and the post installation equipment specifications (e.g. capacity, HSPF, SEER, number of indoor units).

- **Whole Building Multifamily Measure Category:**

Multifamily Conclusion #1: ADM reviewed the modeling files associated with the claimed savings values for five of the 19 multifamily new construction project sites. The provided documentation was insufficient for verification purposes, but ADM determined that the energy savings claimed for each project were reasonable.

Multifamily Recommendation #1: In order to sufficiently verify the whole building multifamily projects, ADM recommends that more detailed documentation be collected by the program implementer in subsequent program years. Ideal documentation would include as-built drawings, any available compliance documentation (e.g. COMcheck reports, approved building plans), and any calculations done outside of the modeling software. ADM recommends that any additional compliance documentation that is collected is done so in a way that minimizes the burden on program participants. Rocky Mountain Power staff indicated that asking for further compliance information could defer contractors from participating in the program. To address this concern, ADM recommends that all parties work together to ensure that any additional burden is minimized.

Multifamily Conclusion #2: ADM reached out to all 20 of the building managers for multifamily retrofit projects to attempt to conduct interviews regarding NTG inputs and process evaluation specific to multifamily projects. ADM was able to complete six interviews but did not apply the resulting multifamily NTG value because of the limited sample size.

Multifamily Recommendation #2: Because the whole building multifamily measures were newly incentivized in 2018 and represented approximately 7.3% of overall claimed savings in 2018, ADM recommends that the next evaluation cycle includes increased rigor of the evaluation for this measure, including case studies and in-depth interviews with building managers and decision makers at both market-rate and low-income multifamily projects. The interviews conducted during the 2017-2018 evaluation cycle will inform the refinement of the survey tool for the subsequent evaluation cycle.

- **New Homes Measure Category:**

Conclusion: ADM completed 12 interviews with new homes builders that represent approximately 58% of total claimed savings and 47% of all homes for new homes measures in 2017. While this represents a significant sample of new homes in the program, it would be advantageous to reach additional builders in the program to expand the sample during the next evaluation cycle.

Recommendation: In order to reach more new homes builders, ADM recommends that during the next evaluation cycle, interviews focus on two points of contact (e.g. production and purchasing) for each site.

## 7 Appendices

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The following appendices accompany this Final Evaluation Report:

**APPENDIX A: Lighting Tables**

**APPENDIX B: Energy Kits Individual Component Ex-Ante Savings Calculations**

**APPENDIX C: NTG Analysis Approaches**

**APPENDIX D: Billing Analysis Methodology**

**APPENDIX E: Measure Category Cost-Effectiveness Results**

## 7.1 Appendix A: Lighting Tables

Table 7-1: TRL Input Values and Engineering Calculation Ex-Ante UES Savings for 2018 Lighting Measures

Lighting Measures	Upgrade Wattage	Baseline Wattage	$\Delta$ Watts	ISR	HOU	IEF	Engineering Calculation Savings
LED Downlight: 5 watts - Retail - UT	5	75	70	0.91	1.92	0.99	44.17
LED Downlight: 6 watts - Retail - UT	6	75	69	0.91	1.92	0.99	43.54
LED Downlight: 7 watts - Retail - UT	7	45	38	0.91	1.92	0.99	23.98
LED Downlight: 8 watts - Retail - UT	8	45	37	0.91	1.92	0.99	23.35
LED Downlight: 9 watts - Retail - UT	9	65	56	0.91	1.92	0.99	35.34
LED Downlight: 10 watts - Retail - UT	10	65	55	0.91	1.92	0.99	34.71
LED Downlight: 11 watts - Retail - UT	11	75	64	0.91	1.92	0.99	40.39
LED Downlight: 12 watts - Retail - UT	12	65	53	0.91	1.92	0.99	33.45
LED Downlight: 13 watts - Retail - UT	13	65	52	0.91	1.92	0.99	32.81
LED Downlight: 14 watts - Retail - UT	14	65	51	0.91	1.92	0.99	32.18
LED Downlight: 15 watts - Retail - UT	15	65	50	0.91	1.92	0.99	31.55
LED Downlight: 16 watts - Retail - UT	16	75	59	0.91	1.92	0.99	37.23
LED Downlight: 17 watts - Retail - UT	17	75	58	0.91	1.92	0.99	36.60
LED Downlight: 18 watts - Retail - UT	18	75	57	0.91	1.92	0.99	35.97
LED Downlight: 19 watts - Retail - UT	19	75	56	0.91	1.92	0.99	35.34
LED Downlight: 23 watts - Retail - UT	23	90	67	0.91	1.92	0.99	42.28
LED General Purpose: 6 watts - Retail - UT	6	29	23	0.91	1.92	0.99	14.51
LED General Purpose: 7 watts - Retail - UT	7	29	22	0.91	1.92	0.99	13.88
LED General Purpose: 8 watts - Retail - UT	8	29	21	0.91	1.92	0.99	13.25
LED General Purpose: 9 watts - Retail - UT	9	29	20	0.91	1.92	0.99	12.62
LED General Purpose: 10 watts - Retail - UT	10	43	33	0.91	1.92	0.99	20.82
LED General Purpose: 11 watts - Retail - UT	11	43	32	0.91	1.92	0.99	20.19
LED General Purpose: 12 watts - Retail - UT	12	43	31	0.91	1.92	0.99	19.56
LED General Purpose: 13 watts - Retail - UT	13	43	30	0.91	1.92	0.99	18.93
LED General Purpose: 14 watts - Retail - UT	14	43	29	0.91	1.92	0.99	18.30
LED General Purpose: 15 watts - Retail - UT	15	43	28	0.91	1.92	0.99	17.67
LED General Purpose: 16 watts - Retail - UT	16	53	37	0.91	1.92	0.99	23.35
LED General Purpose: 17 watts - Retail - UT	17	72	55	0.91	1.92	0.99	34.71
LED General Purpose: 18 watts - Retail - UT	18	72	54	0.91	1.92	0.99	34.08
LED Specialty - Candelabra: 3 watts - Retail - UT	3	25.00	22	0.91	1.92	0.99	13.88
LED Specialty - Candelabra: 4 watts - Retail - UT	4	25.00	21	0.91	1.92	0.99	13.25
LED Specialty - Candelabra: 5 watts - Retail - UT	5	40.00	35	0.91	1.92	0.99	22.09
LED Specialty - Candelabra: 7 watts - Retail - UT	7	40.00	33	0.91	1.92	0.99	20.82
LED Specialty - Globe: 4 watts - Retail - UT	4	20.00	16	0.91	1.92	0.99	10.10
LED Specialty - Globe: 5 watts - Retail - UT	5	40.00	35	0.91	1.92	0.99	22.09
LED Specialty - Globe: 6 watts - Retail - UT	6	40.00	34	0.91	1.92	0.99	21.46
LED Specialty - 3-Way: 3,8,18 watts - Retail - UT	8	60	52	0.91	1.92	0.99	32.81
LED Fixture - ENERGY STAR - UT	-	-	41	1.00	1.91	1.01	29.03

Table 7-2: 2017 Claimed and Evaluated Utah wattsmart Homes Program Gross Lighting Savings (measure effective date prior to December 12, 2016)

Lighting Measures	Claimed Savings (kWh)	Evaluated Gross Savings (kWh)	Realization Rate
LED Downlight: 6 watts - Retail - UT	22,395	15,202	67.9%
LED Downlight: 7 watts - Retail - UT	73,314	49,760	67.9%
LED Downlight: 8 watts - Retail - UT	394,796	268,009	67.9%
LED Downlight: 9 watts - Retail - UT	81,386	55,252	67.9%
LED Downlight: 10 watts - Retail - UT	136,156	92,425	67.9%
LED Downlight: 11 watts - Retail - UT	396,175	268,928	67.9%
LED Downlight: 12 watts - Retail - UT	4,193,869	2,846,968	67.9%
LED Downlight: 13 watts - Retail - UT	82,918	56,283	67.9%
LED Downlight: 14 watts - Retail - UT	35,699	24,235	67.9%
LED Downlight: 15 watts - Retail - UT	22,278	15,122	67.9%
LED Downlight: 16 watts - Retail - UT	252,255	171,227	67.9%
LED Downlight: 17 watts - Retail - UT	19,211	13,042	67.9%
LED Downlight: 18 watts - Retail - UT	7,229	4,907	67.9%
LED General Purpose: 6 watts - Retail - UT	47,361	32,150	67.9%
LED General Purpose: 7 watts - Retail - UT	36,132	24,522	67.9%
LED General Purpose: 8 watts - Retail - UT	35	24	67.9%
LED General Purpose: 9 watts - Retail - UT	711,111	482,638	67.9%
LED General Purpose: 10 watts - Retail - UT	2,623,609	1,781,220	67.9%
LED General Purpose: 11 watts - Retail - UT	52,786	35,832	67.9%
LED General Purpose: 12 watts - Retail - UT	8,456	5,741	67.9%
LED General Purpose: 13 watts - Retail - UT	601	408	67.9%
LED General Purpose: 14 watts - Retail - UT	71,414	48,471	67.9%
LED General Purpose: 15 watts - Retail - UT	292,234	198,393	67.9%
LED General Purpose: 16 watts - Retail - UT	926	629	67.9%
LED Specialty - Candelabra: 4 watts - Retail - UT	287,924	195,467	67.9%
LED Specialty - Candelabra: 5 watts - Retail - UT	113,238	76,875	67.9%
LED Specialty - Globe: 4 watts - Retail - UT	240	163	67.9%
LED Specialty - Globe: 5 watts - Retail - UT	97,294	66,052	67.9%
<b>TOTAL</b>	<b>10,061,042</b>	<b>6,829,944</b>	<b>67.9%</b>

Table 7-3: 2017 Claimed and Evaluated Utah wattsmart Homes Program Gross Lighting Savings (measure effective date after December 12, 2016)

Lighting Measures	Claimed Gross Savings (kWh)	Evaluated Gross Savings (kWh)	Realization Rate
LED Downlight: 5 watts - Retail - UT	1,059	935	88.3%
LED Downlight: 6 watts - Retail - UT	183,960	162,435	88.3%
LED Downlight: 7 watts - Retail - UT	543,125	479,613	88.3%
LED Downlight: 8 watts - Retail - UT	641,318	566,311	88.3%
LED Downlight: 9 watts - Retail - UT	426,948	376,909	88.3%
LED Downlight: 10 watts - Retail - UT	4,484,540	3,960,007	88.3%
LED Downlight: 11 watts - Retail - UT	9,762,600	8,619,632	88.3%
LED Downlight: 12 watts - Retail - UT	2,827,299	2,496,523	88.3%
LED Downlight: 13 watts - Retail - UT	49,808	43,980	88.3%
LED Downlight: 14 watts - Retail - UT	904,725	798,850	88.3%
LED Downlight: 15 watts - Retail - UT	178,239	157,378	88.3%
LED Downlight: 16 watts - Retail - UT	213,064	188,104	88.3%
LED Downlight: 17 watts - Retail - UT	51,797	45,728	88.3%
LED Downlight: 18 watts - Retail - UT	110,870	97,878	88.3%
LED General Purpose: 6 watts - Retail - UT	923,259	815,413	88.3%
LED General Purpose: 7 watts - Retail - UT	259,355	229,053	88.3%
LED General Purpose: 8 watts - Retail - UT	29,777	26,297	88.3%
LED General Purpose: 9 watts - Retail - UT	9,528,015	8,414,180	88.3%
LED General Purpose: 10 watts - Retail - UT	15,424,185	13,618,790	88.3%
LED General Purpose: 11 watts - Retail - UT	332,042	293,168	88.3%
LED General Purpose: 12 watts - Retail - UT	174,660	154,206	88.3%
LED General Purpose: 13 watts - Retail - UT	208	184	88.3%
LED General Purpose: 14 watts - Retail - UT	2,528,519	2,232,261	88.3%
LED General Purpose: 15 watts - Retail - UT	1,789,965	1,580,179	88.3%
LED General Purpose: 16 watts - Retail - UT	92,900	82,035	88.3%
LED General Purpose: 17 watts - Retail - UT	126,573	92,545	73.1%
LED General Purpose: 18 watts - Retail - UT	57,904	46,273	79.9%
LED Specialty - Candelabra: 4 watts - Retail - UT	1,185,814	1,047,231	88.3%
LED Specialty - Candelabra: 5 watts - Retail - UT	481,589	425,243	88.3%
LED Specialty - Candelabra: 7 watts - Retail - UT	329,689	281,107	85.3%
LED Specialty - Globe: 4 watts - Retail - UT	5,055	4,463	88.3%
LED Specialty - Globe: 5 watts - Retail - UT	389,690	344,096	88.3%
LED Specialty - Globe: 6 watts - Retail - UT	420,852	370,574	88.1%
LED Specialty - Globe: 8 watts - Retail - UT	222	196	88.3%
LED Specialty - 3-Way: 3,8,18 watts - Retail - UT	49,102	40,998	83.5%
LED Fixture - ENERGY STAR - UT	1,858,501	1,789,898	96.3%
<b>TOTAL</b>	<b>56,367,228</b>	<b>49,882,671</b>	<b>88.5%</b>

Table 7-4: 2018 Claimed and Evaluated Utah wattsmart Homes Program Gross Lighting Savings

Lighting Measures	Claimed Gross Savings (kWh)	Evaluated Gross Savings (kWh)	Realization Rate
LED Downlight: 5 watts - Retail - UT	1,015	896	88.3%
LED Downlight: 6 watts - Retail - UT	121,828	107,573	88.3%
LED Downlight: 7 watts - Retail - UT	452,101	399,233	88.3%
LED Downlight: 8 watts - Retail - UT	3,232,628	2,854,547	88.3%
LED Downlight: 9 watts - Retail - UT	453,120	400,014	88.3%
LED Downlight: 10 watts - Retail - UT	2,712,808	2,395,505	88.3%
LED Downlight: 11 watts - Retail - UT	6,174,838	5,451,912	88.3%
LED Downlight: 12 watts - Retail - UT	515,370	455,075	88.3%
LED Downlight: 13 watts - Retail - UT	295,766	261,159	88.3%
LED Downlight: 14 watts - Retail - UT	978,629	864,105	88.3%
LED Downlight: 15 watts - Retail - UT	57,069	50,390	88.3%
LED Downlight: 16 watts - Retail - UT	78,178	69,020	88.3%
LED Downlight: 17 watts - Retail - UT	6,072	5,361	88.3%
LED Downlight: 18 watts - Retail - UT	121,439	107,208	88.3%
LED Downlight: 19 watts - Retail - UT	67,638	59,711	88.3%
LED Downlight: 23 watts - Retail - UT	10,267	9,065	88.3%
LED General Purpose: 6 watts - Retail - UT	806,621	712,399	88.3%
LED General Purpose: 7 watts - Retail - UT	916,016	808,991	88.3%
LED General Purpose: 8 watts - Retail - UT	676,961	597,846	88.3%
LED General Purpose: 9 watts - Retail - UT	7,187,587	6,347,350	88.3%
LED General Purpose: 10 watts - Retail - UT	6,705,357	5,920,497	88.3%
LED General Purpose: 11 watts - Retail - UT	475,340	419,689	88.3%
LED General Purpose: 12 watts - Retail - UT	216,516	191,161	88.3%
LED General Purpose: 13 watts - Retail - UT	38,975	34,410	88.3%
LED General Purpose: 14 watts - Retail - UT	35,848	31,648	88.3%
LED General Purpose: 15 watts - Retail - UT	557,526	492,184	88.3%
LED General Purpose: 16 watts - Retail - UT	91,757	81,025	88.3%
LED General Purpose: 17 watts - Retail - UT	80,839	71,384	88.3%
LED General Purpose: 18 watts - Retail - UT	3,420,003	2,965,074	86.7%
LED Specialty - Candelabra: 3 watts - Retail - UT	415,989	367,386	88.3%
LED Specialty - Candelabra: 4 watts - Retail - UT	922,709	814,874	88.3%
LED Specialty - Candelabra: 5 watts - Retail - UT	637,713	563,100	88.3%
LED Specialty - Candelabra: 7 watts - Retail - UT	96,662	85,348	88.3%
LED Specialty - Globe: 4 watts - Retail - UT	174,466	154,040	88.3%
LED Specialty - Globe: 5 watts - Retail - UT	927,271	818,779	88.3%
LED Specialty - Globe: 6 watts - Retail - UT	935,813	826,300	88.3%
LED Specialty - 3-Way: 3,8,18 watts - Retail - UT	10,230	9,033	88.3%
LED Fixture - ENERGY STAR - UT	3,006,612	2,852,266	94.9%
<b>2018 TOTAL</b>	<b>43,615,579</b>	<b>38,655,560</b>	<b>88.6%</b>

Table 7-5: 2017 Utah wattsmart Homes Program Net Lighting Savings and NTG

Lighting Measures	Evaluated Gross Savings (kWh)	Evaluated Net Savings (kWh)	NTG
LED Downlight: 5 watts - Retail - UT	935	688	73.6%
LED Downlight: 6 watts - Retail - UT	177,637	130,670	73.6%
LED Downlight: 7 watts - Retail - UT	529,374	389,407	73.6%
LED Downlight: 8 watts - Retail - UT	834,320	613,726	73.6%
LED Downlight: 9 watts - Retail - UT	432,161	317,898	73.6%
LED Downlight: 10 watts - Retail - UT	4,052,432	2,980,969	73.6%
LED Downlight: 11 watts - Retail - UT	8,888,560	6,538,425	73.6%
LED Downlight: 12 watts - Retail - UT	5,343,491	3,930,672	73.6%
LED Downlight: 13 watts - Retail - UT	100,263	73,753	73.6%
LED Downlight: 14 watts - Retail - UT	823,085	605,461	73.6%
LED Downlight: 15 watts - Retail - UT	172,500	126,891	73.6%
LED Downlight: 16 watts - Retail - UT	359,331	264,324	73.6%
LED Downlight: 17 watts - Retail - UT	58,770	43,231	73.6%
LED Downlight: 18 watts - Retail - UT	102,785	75,609	73.6%
LED General Purpose: 6 watts - Retail - UT	847,563	623,467	73.6%
LED General Purpose: 7 watts - Retail - UT	253,575	186,530	73.6%
LED General Purpose: 8 watts - Retail - UT	26,321	19,361	73.6%
LED General Purpose: 9 watts - Retail - UT	8,896,818	6,544,499	73.6%
LED General Purpose: 10 watts - Retail - UT	15,400,010	11,328,247	73.6%
LED General Purpose: 11 watts - Retail - UT	328,999	242,012	73.6%
LED General Purpose: 12 watts - Retail - UT	159,948	117,658	73.6%
LED General Purpose: 13 watts - Retail - UT	592	435	73.6%
LED General Purpose: 14 watts - Retail - UT	2,280,732	1,677,706	73.6%
LED General Purpose: 15 watts - Retail - UT	1,778,572	1,308,317	73.6%
LED General Purpose: 16 watts - Retail - UT	82,663	60,807	73.6%
LED General Purpose: 17 watts - Retail - UT	92,545	68,076	73.6%
LED General Purpose: 18 watts - Retail - UT	46,273	34,038	73.6%
LED Specialty - Candelabra: 4 watts - Retail - UT	1,242,698	914,128	73.6%
LED Specialty - Candelabra: 5 watts - Retail - UT	502,118	369,358	73.6%
LED Specialty - Candelabra: 7 watts - Retail - UT	281,107	206,782	73.6%
LED Specialty - Globe: 4 watts - Retail - UT	4,626	3,403	73.6%
LED Specialty - Globe: 5 watts - Retail - UT	410,147	301,704	73.6%
LED Specialty - Globe: 6 watts - Retail - UT	370,574	272,594	73.6%
LED Specialty - Globe: 8 watts - Retail - UT	196	144	73.6%
LED Specialty - 3-Way: 3,8,18 watts - Retail - UT	40,998	30,158	73.6%
LED Fixture - ENERGY STAR - UT	1,789,898	1,629,523	91.0%
<b>2017 TOTAL</b>	<b>56,712,615</b>	<b>42,030,674</b>	<b>74.1%</b>

Table 7-6: 2018 Utah wattsmart Homes Program Net Lighting Savings and NTG

Lighting Measures	Evaluated Gross Savings (kWh)	Evaluated Net Savings (kWh)	NTG
LED Downlight: 5 watts - Retail - UT	896	659	73.6%
LED Downlight: 6 watts - Retail - UT	107,573	79,130	73.6%
LED Downlight: 7 watts - Retail - UT	399,233	293,676	73.6%
LED Downlight: 8 watts - Retail - UT	2,854,547	2,099,805	73.6%
LED Downlight: 9 watts - Retail - UT	400,014	294,250	73.6%
LED Downlight: 10 watts - Retail - UT	2,395,505	1,762,134	73.6%
LED Downlight: 11 watts - Retail - UT	5,451,912	4,010,426	73.6%
LED Downlight: 12 watts - Retail - UT	455,075	334,753	73.6%
LED Downlight: 13 watts - Retail - UT	261,159	192,108	73.6%
LED Downlight: 14 watts - Retail - UT	864,105	635,636	73.6%
LED Downlight: 15 watts - Retail - UT	50,390	37,067	73.6%
LED Downlight: 16 watts - Retail - UT	69,020	50,771	73.6%
LED Downlight: 17 watts - Retail - UT	5,361	3,943	73.6%
LED Downlight: 18 watts - Retail - UT	107,208	78,863	73.6%
LED Downlight: 19 watts - Retail - UT	59,711	43,923	73.6%
LED Downlight: 23 watts - Retail - UT	9,065	6,668	73.6%
LED General Purpose: 6 watts - Retail - UT	712,399	524,041	73.6%
LED General Purpose: 7 watts - Retail - UT	808,991	595,094	73.6%
LED General Purpose: 8 watts - Retail - UT	597,846	439,776	73.6%
LED General Purpose: 9 watts - Retail - UT	6,347,350	4,669,111	73.6%
LED General Purpose: 10 watts - Retail - UT	5,920,497	4,355,118	73.6%
LED General Purpose: 11 watts - Retail - UT	419,689	308,723	73.6%
LED General Purpose: 12 watts - Retail - UT	191,161	140,618	73.6%
LED General Purpose: 13 watts - Retail - UT	34,410	25,312	73.6%
LED General Purpose: 14 watts - Retail - UT	31,648	23,280	73.6%
LED General Purpose: 15 watts - Retail - UT	492,184	362,050	73.6%
LED General Purpose: 16 watts - Retail - UT	81,025	59,602	73.6%
LED General Purpose: 17 watts - Retail - UT	71,384	52,510	73.6%
LED General Purpose: 18 watts - Retail - UT	2,965,074	2,181,109	73.6%
LED Specialty - Candelabra: 3 watts - Retail - UT	367,386	270,249	73.6%
LED Specialty - Candelabra: 4 watts - Retail - UT	814,874	599,421	73.6%
LED Specialty - Candelabra: 5 watts - Retail - UT	563,100	414,216	73.6%
LED Specialty - Candelabra: 7 watts - Retail - UT	85,348	62,782	73.6%
LED Specialty - Globe: 4 watts - Retail - UT	154,040	113,312	73.6%
LED Specialty - Globe: 5 watts - Retail - UT	818,779	602,294	73.6%
LED Specialty - Globe: 6 watts - Retail - UT	826,300	607,826	73.6%
LED Specialty - 3-Way: 3,8,18 watts - Retail - UT	9,033	6,645	73.6%
LED Fixture - ENERGY STAR - UT	2,852,266	2,596,703	91.0%
<b>2018 TOTAL</b>	<b>38,655,560</b>	<b>28,933,606</b>	<b>74.8%</b>

## 7.2 Appendix B: Energy Kits Individual Component Ex-Ante Savings Calculations

Table 7-7: Energy Kits Individual Component Ex-Ante Savings Calculations, Aerators

Energy Kit Component	Input to Savings Calculation	Input Value to Savings Calculation (based on TRL source documents)	Source Worksheet	Source Tab
Kitchen Aerator	In-Service Rate (%)	55.0%	Aerators_v1_1	Parameters
	Average Baseline Flow Rate (GPM)	2.2	Federal Standard	Aerator-Showerhead Analysis
	Average Post Measure Flow Rate (GPM)	1.5	Program materials	-
	Average time of hot water usage per person per day (minutes)	1.8073	Aerators_v1_1	WaterUseModel
	Average number of persons per household (state-specific values)	2.59	Aerators_v1_1	Parameters
	Average temperature differential between hot and cold water (degrees)	75	Aerators_v1_1	Parameters
	Unit Conversion (BTU/gallon)	8.345	N/A	-
	Unit Conversion (BTU/kWh)	3412.14	N/A	-
	Fraction of Homes with Electric Water Heaters (%)	48.7%	Aerators_v1_1	Parameters
	Efficiency of Electric Water Heaters (%)	100%	Aerators_v1_1	Parameters
	Average number of faucets in the home	1.08	Aerators_v1_1	Parameters
Bathroom Aerator	In-Service Rate (%)	55.0%	Aerators_v1_1	Parameters
	Average Baseline Flow Rate (GPM)	2.2	Federal Standard	Aerator-Showerhead Analysis
	Average Post Measure Flow Rate (GPM)	0.5	Program materials	-
	Average time of hot water usage per person per day (minutes)	1.2936	Aerators_v1_1	WaterUseModel
	Average number of persons per household (state-specific values)	2.59	Aerators_v1_1	Parameters
	Average temperature differential between hot and cold water (degrees)	75	Aerators_v1_1	Parameters
	Unit Conversion (BTU/gallon)	8.345	N/A	-
	Unit Conversion (BTU/kWh)	3412.14	N/A	-
	Fraction of Homes with Electric Water Heaters (%)	48.7%	Aerators_v1_1	Parameters
	Efficiency of Electric Water Heaters (%)	100%	Aerators_v1_1	Parameters
	Average number of faucets in the home	2.56	Aerators_v1_1	Parameters

Table 7-8: Energy Kits Individual Component Ex-Ante Savings Calculations, Showerhead

Energy Kit Component	Input to Savings Calculation	Input Value to Savings Calculation (based on TRL source documents)	Source Worksheet	Source Tab
Showerhead	In-Service Rate (%)	76.0%	ResShowerheads_v2_3	Current Input Assumptions
	Average Baseline Flow Rate (GPM)	2.3	ResShowerheads_v2_3	Current Input Assumptions
	Average Post Measure Flow Rate (GPM)	1.35	Program materials	-
	Average gallons of hot water usage per person per day	8.51	ResShowerheads_v2_3	Current Input Assumptions
	Average number of persons per household (state-specific values)	2.35	ResShowerheads_v2_3	RBSA SF
	Average temperature differential between hot and cold water (degrees)	75	ResShowerheads_v2_3	Residential Analysis
	Unit Conversion (BTU/gallon)	8.345	N/A	-
	Unit Conversion (BTU/kWh)	3412.14	N/A	-
	Fraction of Homes with Electric Water Heaters (%)	62.0%	ResShowerheads_v2_3	Current Input Assumptions
	Efficiency of Electric Water Heaters	100%	ResShowerheads_v2_3	Current Input Assumptions
	Average number of showers in the home	1.78	ResShowerheads_v2_3	RBSA SF

Table 7-9: Energy Kits Individual Component Ex-Ante Savings Calculations, LED Lights

Energy Kit Component	Input to Savings Calculation	Input Value to Savings Calculation (based on TRL source documents)	Source Worksheet	Source Tab
10 W LED A Lamp	Change in Watts (Watts)	33	Program materials	-
	In Service Rate, or Installation Rate (%)	91%	HES_UT_LEDs_12-1-2016	Source Data
	Deemed hours of use per year	1.92	HES_UT_LEDs_12-1-2016	Source Data
	Interactive Effects Factor	0.98995	HES_UT_LEDs_12-1-2016	Source Data

## 7.3 Appendix C: NTG Analysis Approaches

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### 7.3.1 General Population Survey and Lighting NTG Methodology

Rocky Mountain Power customers who receive lighting discounts through the *wattsmart* program were surveyed by ADM through the General Population survey to determine a program attribution estimation for the NTG calculation. The attribution scoring system is broken down into two components: free-ridership score and spillover score. Each component is described individually in the subsequent subsections.

The objective of the net-to-gross analysis is to estimate the share of program activity that would have occurred in the absence of the program. To accomplish this, the Evaluators administered a survey to program participants that contained questions regarding the participants' plans to implement the lighting measures and the likelihood of implementing those measures had they not been provided through the program.

#### 7.3.1.1 Freeridership

First, the percentage of light types replaced was found by using the question:

*Did the [LED BULB/LED FIXTURE] replace traditional incandescent, old LED, some other type of bulb/fixture, or a combination? Please provide an estimate of the number of LED light bulbs that replaced each bulb type.*

Each light type was divided by the total number reported replaced.

The importance score was calculated by averaging the responses to this question:

*How important was the discount on your decision to purchase [LED BULBS/LED FIXTURES] at [STORE NAME]?*

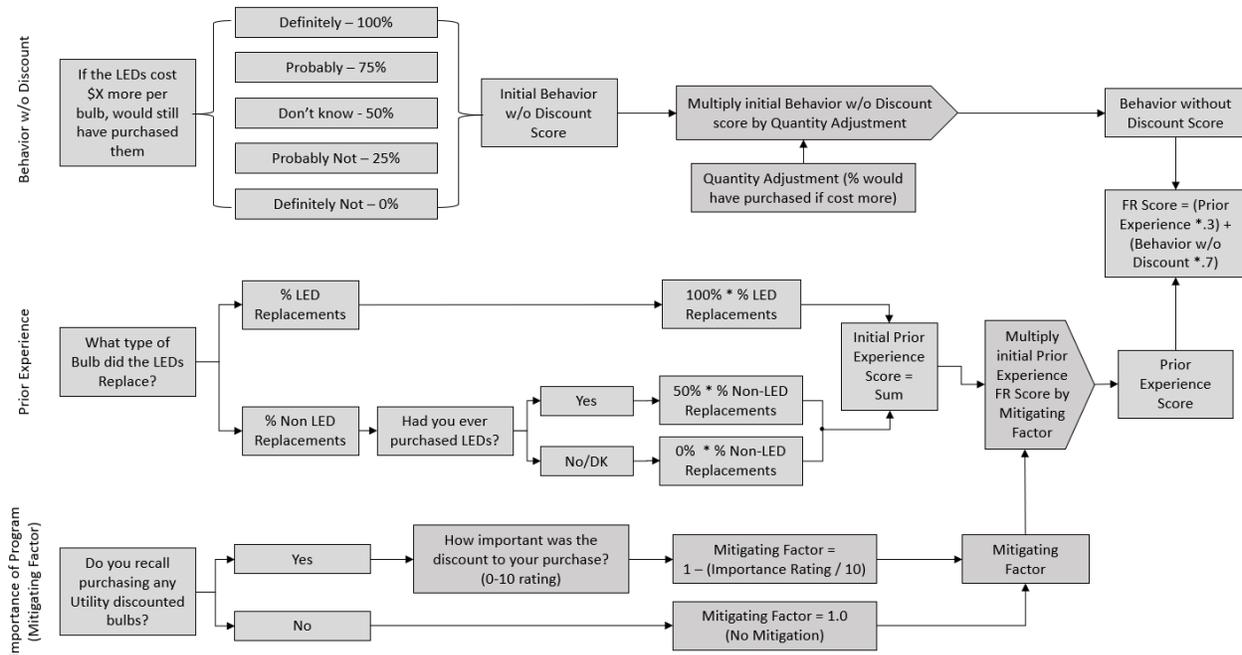
The total LED bulbs was calculated using the following questions:

*How many of those [LED Bulbs/LED Fixtures] would you estimate you installed within one week of purchase?*

*How many of those [LED Bulbs/LED Fixtures] did you save to install at a later date?*

*Approximately how many do you have left?*

Figure 7-1: Freeridership Methodology for Lighting



### 7.3.1.2 Spillover

Program participants may implement additional energy saving measures without receiving a program incentive because of their participation in the program. The energy savings resulting from these additional measures constitute program participant spillover effects.

To assess participant spillover savings, survey respondents were asked whether they implemented any additional energy saving measures for which they did not receive a program incentive. Respondents were also asked to provide information on the attributes of the measures implemented for use in estimating the associated energy savings.

Participants who report implementing one or more efficiency measures are then asked two questions for use in developing a spillover score:

SO1: On a scale of 1 to 5, where 1 represents “not important” and 5 represents “very important”, how important was your experience with the wattsmart program in your decision to purchase the items you just mentioned?

SO2: On a scale of 1 to 5, where 1 represents “very unlikely” and 5 represents “very likely” how likely would you have been to make the additional purchases you just mentioned even if you had not participated in the wattsmart program?

The response to these questions were used to develop a spillover score as follows:

Spillover = Average (SO1, 5 – SO2)

All of the associated measure savings were considered attributable to the program if the resulting score was equal or greater than 3.

### **7.3.2 Energy Kit Survey and NTG Methodology**

Rocky Mountain Power customers who receive Energy Kits through the *wattsmart* program were surveyed by ADM to determine a program attribution estimation for the NTG calculation. The attribution scoring system is broken down into two components: free-ridership score and spillover score. Each component is described individually in the subsequent subsection, followed by a paragraph discussing how the scores will be weighted to extrapolate the survey results to the program level.

The objective of the net-to-gross analysis is to estimate the share of program activity that would have occurred in the absence of the program. To accomplish this, the Evaluators administered a survey to program participants that contained questions regarding the participants' plans to implement the energy kit items and the likelihood of implementing those measures had they not been provided through the program. Program participants were asked questions regarding:

- Whether they had plans to purchase and install the energy kit item;
- When would they have implemented the energy kit item in the absence of the program;
- The likelihood of purchasing and installing the energy kit item had they not received it for free.

Participant responses to these questions will be used to calculate two scores corresponding to the presence of prior plans and the likelihood of installing the items in the absence of the program.

#### *7.3.2.1 Prior Plans Score*

The prior plans score was calculated as follows:

- Respondents who indicated that they did not have plans to install the energy kit item were scored as 0.
- Respondents who indicated that they did have plans to install the energy kit item were scored as 1.

This score is adjusted based on the timing of the planned installation. The timing adjustment is based on when they will have likely installed the items. For respondents that say they would have likely installed the items immediately, no timing adjustment is made. Respondents who indicate that they would have likely installed the item within 6 months, the plans score is multiplied by 0.5. For those that would install after 6 months, the plan score is set to 0.

#### *7.3.2.2 Likelihood of Project Completion Score*

The score reflecting the likelihood of completing the project in the absence of the program was based on the following question:

- Using a scale where 1 is “very unlikely” and 5 is “very likely” how likely is it that you would have purchased and installed one of the below items had it not been in your energy kit?

A score was assigned to each response for this question as follows:

- Very likely: 1
- Slightly likely: 0.75
- Either: 0.5
- Slightly unlikely: 0.25
- Very unlikely: 0

#### *7.3.2.3 Final Freeridership Score*

The final free ridership score is equal to the following:

Free Ridership = Average (Plans Score, Likelihood Score) \* Previous experience adjustment

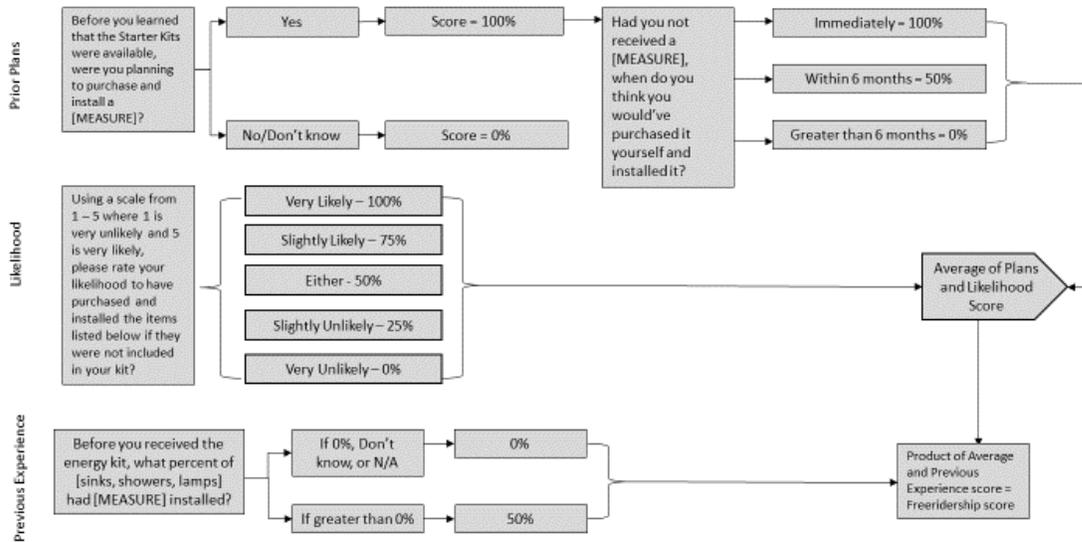
The previous experience adjustment was based on a question about whether the respondent had similar items currently installed in the home. The freeridership score for those that answer zero percent, “Not Applicable” or “Don’t know” to this question was multiplied by 0. The freeridership score for those that answer greater than zero percent to this question was multiplied by 0.5.

The free ridership questions are arranged as follows:

1. Indicator one: prior planning
2. Indicator two: stated likelihood in absence of program incentives
3. Mitigating factor one: reported prior experience with energy conservation measure

How these questions work together to determine a measure level free ridership score is displayed in Figure 7-2 on the following page. Note that the scoring algorithm requires the respondent to indicate a “burden of proof” that they are a free rider. They must state that either 1) they had prior plans to install the measure or 2) they would have likely installed the measure in the absence of the program.

Figure 7-2: Freeridership Methodology for wattsmart Energy Kit Program



#### 7.3.2.4 Methodology for Estimating Spillover

Program participants may implement additional energy saving measures without receiving a program incentive because of their participation in the program. The energy savings resulting from these additional measures constitute program participant spillover effects.

To assess participant spillover savings, survey respondents were asked whether they implemented any additional energy saving measures for which they did not receive a program incentive. Respondents were also asked to provide information on the attributes of the measures implemented for use in estimating the associated energy savings.

Participants who report implementing on one or more efficiency measures are then asked two questions for use in developing a spillover score:

SO1: On a scale of 1 to 5, where 1 represents “not important” and 5 represents “very important”, how important was your experience with *wattsmart* in your decision to purchase the items you just mentioned?

SO2: On a scale of 1 to 5, where 1 represents “very unlikely” and 5 represents “very likely” how likely would you have been to make the additional purchases you just mentioned even if you had not participated in the *wattsmart* program?

The response to these questions were used to develop a spillover score as follows:

Spillover = Average(SO1, 5 – SO2)

All of the associated measure savings were considered attributable to the program if the resulting score was equal or greater than 3.

#### *7.3.2.5 Determination of Program Level NTG*

The free ridership scores for each respondent will be weighted by the ex-ante kWh savings per energy kit type to determine the final weighted average free-ridership estimate per customer in the sample. This estimate will be applied to the program level verified gross savings to determine net savings.

### **7.3.3 HVAC Survey and NTG Methodology**

The following section presents the methodology that was used for estimating the net energy impacts resulting from the *wattsmart* HVAC and appliances measures 2017 and 2018.

#### *7.3.3.1 Survey Data Collection*

A survey of program participants was administered to collect data for use in estimating participant free ridership and spillover. Responses to the free ridership questions were collected through an online survey.

#### *7.3.3.2 Methodology for Estimating Ex-Post Net Energy Savings*

The net savings analysis is used to determine what part of the gross energy savings achieved by program participants can be attributed to the effects of the program. The net savings attributable to program participants are the gross savings less free ridership, plus spillover. ADM estimated free ridership and participant spillover through a survey of program participants. Non-participant spillover was estimated through a survey of non-participants.

### 7.3.3.3 Methodology for Estimating Freeridership

Survey respondents were asked a series of questions designed to elicit information regarding the following factors:

- Financial ability and plans and intentions to implement the efficiency measure;
- The program influence on the decision to implement the efficiency measure;
- The program's influence on the timing of the measure installation.

The calculation of a free ridership score was based on the responses to questions about the participants' prior plans and intentions, program influence on measure selection, and program influence on timing of measure implementation.

#### 7.3.3.3.1 Financial Ability and Plans and Intentions

Two indicator variables were developed based on responses to the survey questions on plans and intentions. The first corresponds to financial ability. Respondents were considered to have not been financially able to install the efficient equipment if they answer "no" to the question below:

FR1: Would you have been able to afford to purchase the efficient [EFF\_MEASURE1] if the rebate was not available from the program?

The second indicator variable is related to whether the customer had plans to implement the efficiency measure. Respondents were considered to have had plans if they answer "yes" to the following question:

FR2: Were you planning to purchase [EFF\_MEASURE1] before you learned of [UTILITY] wattsmart rebate program?

Respondents who were found to not have plans or the financial ability to implement the measures were deemed to not be free riders.

#### 7.3.3.3.2 Program Influence on Decision to Implement Energy Efficiency Measure

Participants were asked about the direct influence of the program on their decision to implement the energy efficiency measures. Specifically, participants were asked:

FR3: On a scale of 1-5 where 1 is "not at all likely" and 5 is "very likely", how likely is it that you would have purchased and installed the [EFF\_MEASURE1] if you had not received the financial or information assistance through the program?

A program influence score was developed based on this response in the following manner:

- A response of “1” = 0% Free Ridership
- A response of “2” = 25% Free Ridership
- A response of “3” = 50% Free Ridership
- A response of “4” = 75% Free Ridership
- A response of “5” = 100% Free Ridership

7.3.3.3.3 Program Influence on Project Timing

To account for deferred free ridership due to the program’s effect on the timing of the implementation of the efficiency measure, respondents were asked the following two questions:

FR4: Did you purchase and install the [EFF\_MEASURE] sooner than you would have if the information and financial assistance from the program had not been available?

FR5: When might you have purchased or installed the same [EFF\_MEASURE] if you had not participated in the program?

If the survey participant responds “yes” to question FR4 then a timing adjustment was calculated based on the answer to FR5 as shown in Table 7-10.

*Table 7-10: Timing Adjustment Score*

Likely Timing of Project in Absence of the Program	Timing Score
Within 6 months	1
Between 6 months and 1 year	0.67
In more than 1 year to 2 years	0.33
In two years or more	0

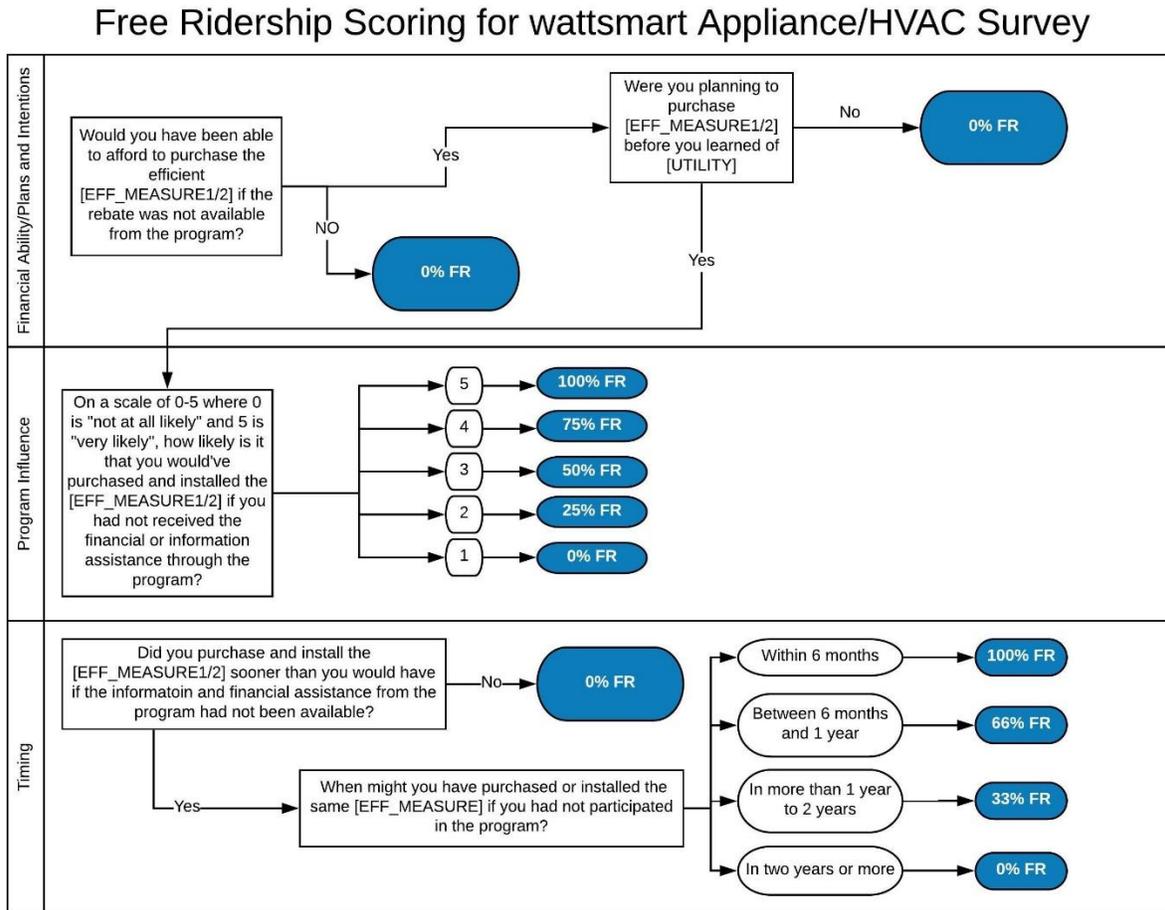
7.3.3.3.4 Freeridership Scoring

For respondents that did not have plans or intentions, an overall free ridership score was developed based on the program influence score and timing score. An overall project free ridership score is based by combining the scores described above using the following equation:

$$\text{Free Ridership} = \text{Program Influence} * \text{Timing Score}$$

The flowchart illustrating the methodology used to calculate free ridership can be found in the diagram in Figure 7-3.

Figure 7-3: Freeridership Methodology for wattsmart Appliance/HVAC Measures



#### 7.3.3.4 Methodology for Estimating Spillover

Program participants may implement additional energy saving measures without receiving a program incentive because of their participation in the program. The energy savings resulting from these additional measures constitute program participant spillover effects.

To assess participant spillover savings, survey respondents were asked whether they implemented any additional energy saving measures for which they did not receive a program incentive. Respondents were also asked to provide information on the attributes of the measures implemented for use in estimating the associated energy savings.

Participants who report implementing on one or more efficiency measures are then asked two questions for use in developing a spillover score:

SO1: On a scale of 1 to 5, where 1 represents “not important” and 5 represents “very important”, how important was your experience with *wattsmart* in your decision to purchase the items you just mentioned?

SO2: On a scale of 1 to 5, where 1 represents “extremely likely” and 5 represents “extremely likely” how likely would you have been to make the additional purchases you just mentioned even if you had not participated in the *wattsmart* program?

The response to these questions were used to develop a spillover score as follows:

- Spillover = Average(SO1, 5 – SO2)

All of the associated measure savings were considered attributable to the program if the resulting score was equal to or greater than 3.

#### **7.3.4 New Homes Interviews and NTG Methodology**

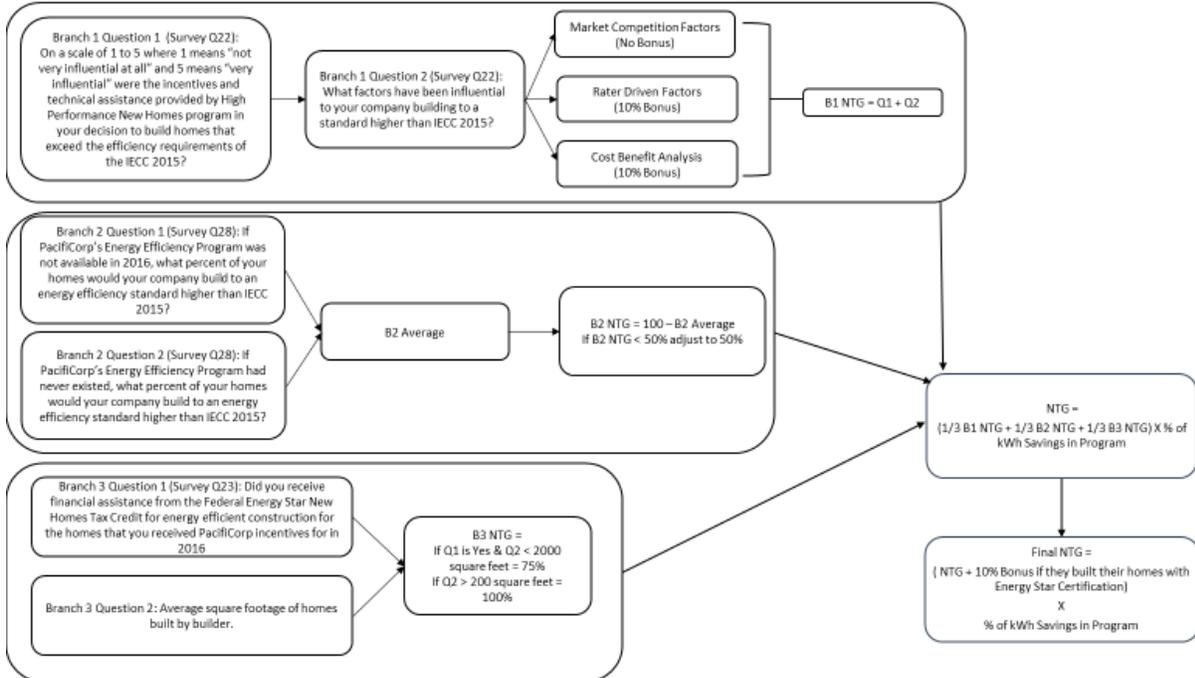
Net-to-Gross scores were developed for each interviewed builder by analyzing responses to three lines of questioning: program influence, building practices in the absence of the program, and co-participation in other rebate programs. Each line of questioning was used to account for 1/3 of the overall free ridership score for each respondent. That is: Total Free Ridership = 1/3 x Program Influence FR + 1/3 x Building Practices in the Absence of the Program FR + 1/3 x Co-Participation FR. The scoring for each line of questioning is detailed below.

- **Program Influence:** Builders were asked to rate the influence of the program on their decision to build an energy efficient home. The ranking was recorded on a scale of one to five with one representing “not at all influential” and five representing “very influential”. Free ridership percentages were applied to the answer as follows; 5 = 100%, 4 = 75%, 3 = 50%, 2 = 25% and 1=0%. The builders were then asked to list all factors influencing in their decision to build an above code energy saving home. In cases where builders reported the program as having very little or no influence, but also reported consideration of incentive reductions to building costs, guidance from raters or program staff, or competition with other program builders as being a contributing factor, the initial Net-to-Gross score was increased by 10 percent.
- **Building Practices in the Absence of the Program:** Builders were then asked about the percentage of homes they would have built to an above code energy standard if the RMP *wattsmart* Homes Program was not available during 2016. They were also asked to report the percentage of homes they would build to an above code standard if the program had never existed (to account for prior year

program influence). The reported percentages from the two questions were averaged to determine a free ridership score for this line of questioning.

- Co-participation in other Rebate Programs:** Builders were then asked about participation in other programs providing financial assistance (e.g. Dominion Energy ThermWise Builder Rebate Program, federal ENERGY STAR New Homes Program). If they did not participate in other programs a Net-to-Gross score of 100% was applied for this line of questioning. If they did participate in other programs and the average square footage of the homes they built in the new homes component of the program was greater than 2000 feet, a Net-to-Gross score of 100% was applied. If they did participate other programs and the average square footage of the homes they built in the new homes component of the program was less than 2000 feet, a Net-to-Gross score of 75% was applied.

Figure 7-4: New Homes Methodology for NTG



## **7.4 Appendix D: Billing Analysis Methodology**

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### **7.4.1 Clean Data**

The analysis began with cleaning the billing and Program Tracking Data to develop a streamlined, simple format for analysis. The billing data contains a unique premise plus customer identifier called 'Concat Agreement Number' which consists of 14 digits. The Program Tracking Data has a similar column called 'Bill Account Number', also consisting of 14 digits. The tracking data account numbers do not always have a full 14 digits. This is the only valid column for mapping billing data of a premise to a specific measure installed in the Program Tracking Data at that premise. Both data sets minimally contain the first 8 digits of the Account Number which is also called the 'Customer Id'. This, combined with an address string (also located in both datasets), can be used to match full Account Numbers from the billing data to the incomplete account numbers in the tracking data.

The cleaning began by identifying any customer IDs in the billing data which have multiple account numbers tied to the same address and removing them from consideration as it would be impossible to say which account number is correct when mapping on customer ID and address alone. Account numbers are then assigned to the Program Tracking Data set based on matching customer IDs and addresses in the billing data.

Predefined analysis groups consisting of multiple versions of the same measure types were assigned to the measures in the Program Tracking Data in order to achieve larger population groups upon which to conduct the billing analysis.

### **7.4.2 Incorporate Weather Data**

Zip codes in the billing data were used to match line items with the nearest weather stations by calculating the Haversine distance between latitudinal and longitudinal coordinates.

An optimizing algorithm applied on integer sets of possible cooling degree day (CDD) and heating degree day (HDD) base conditions was used on the billing data and associated weather data to determine the appropriate average degree day bases by selecting the set of parameters that minimizes the root mean squared error of a piecewise regression on consumption. The optimal values were found to be 63 for a CDD base and 47 for a HDD base.

The cumulative CDD and HDD for a given line item in the billing data was assigned based on the listed billing cycle start and end dates. These values were divided by the number

of days in the billing cycle to get average cooling degree days per day (CDDD) and heating degree days per day (HDDD) values.

### **7.4.3 Regression Analysis**

Any account numbers found to be associated with more than one analysis group were removed from the regression calculation so as to not double count savings. The earliest and latest installation dates were then identified for each account number such that the pre period can be defined as any billing data points with Meter Read dates before the earliest installation of a measure and the post period is any billing data points with Meter Read dates after the latest installation listed.

A control group was developed using “Late Installs”, program participants who had a measure installed too late to be considered in the regression analysis due to not yet having sufficient post period data for analysis. The cutoff date separating treatment participants from the late installs was selected to be 2018-06-01. This date was selected based on a determination of acquiring a sufficient number of potential control group homes to be able to have a reasonably high probability of acquiring a representative control population. Because of the need to use late installs as a control group, billing data with meter read dates after the cutoff date have to be removed from the analysis to remove potential bias.

A propensity score was developed on the pre-period average consumption across the full set of premises and used to determine appropriate control group matches for each treatment home. If t-tests along with some other matching characteristic statistics indicate a poorly matching population, the analysis defaults to running multiple iterations across randomly selected matches to attempt to stabilize observable effects. Specifically, a set of 1000 randomly selected control group homes were selected for each treatment home. The regression analysis was then performed 1000 times for each set and each iteration is filtered down to ensure that matching between a treatment and control home is one-to-one and there are no duplicates.

A regression of the form:

$$kWhd = a_0 * post + a_1 * treat + a_2 * CDDD + a_3 * HDDD + a_4 * post * treat + a_5 * post * CDDD + a_6 * treat * CDDD + a_7 * post * HDDD + a_8 * treat * HDDD + a_9 * post * treat * CDDD + a_{10} * post * treat * HDDD + (1 | \frac{AcctNum}{Month})$$

with nested random effects terms included for the Account Number and the month was run for each iteration. The treatment effect was then calculated as:

$$Daily Savings due to Treatment = a_4 + a_9 * CDDD_{Avg} + a_{10} * HDDD_{Avg}$$

The treatment effect for each iteration was then averaged across the 1000 iterations to give the estimated measure impact for each analysis group.

## 7.5 Appendix E: Measure Category Cost-Effectiveness Results

The following tables show the cost-effectiveness results for each measure category in the Program for each program year, based on evaluated net savings. The 2017 cost-effectiveness was tested using the 2015 IRP east residential whole house 31%, east residential lighting 47%, and east water heating 53% decrements. The 2018 cost-effectiveness was tested using the 2017 IRP decrement for all measure categories.

*Table 7-11: 2017 wattsmart Homes Program Appliances Measure Category Cost-Effectiveness Results*

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.1962	\$217,545	\$74,334	(\$143,211)	0.34
Total Resource Cost Test (TRC) No Adder	\$0.1962	\$217,545	\$67,577	(\$149,968)	0.31
Utility Cost Test (UCT)	\$0.0825	\$91,435	\$67,577	(\$23,859)	0.74
Rate Impact Test (RIM)		\$224,298	\$67,577	(\$156,722)	0.3
Participant Cost Test (PCT)		\$243,785	\$233,868	(\$9,917)	0.96
Lifecycle Revenue Impacts (\$/kWh)					\$0.00000044
Discounted Participant Payback (years)					24.06

*Table 7-12: 2017 wattsmart Homes Program Building Shell Measure Category Cost-Effectiveness Results*

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.1769	\$1,229,620	\$746,365	(\$483,255)	0.61
Total Resource Cost Test (TRC) No Adder	\$0.1769	\$1,229,620	\$678,514	(\$551,106)	0.55
Utility Cost Test (UCT)	\$0.0530	\$368,461	\$678,514	\$310,052	1.84
Rate Impact Test (RIM)		\$1,205,116	\$678,514	(\$526,603)	0.56
Participant Cost Test (PCT)		\$1,199,958	\$1,155,790	(\$44,168)	0.96
Lifecycle Revenue Impacts (\$/kWh)					\$0.00000070
Discounted Participant Payback (years)					n/a

Table 7-13: 2017 wattsmart Homes Program Energy Kits - DHW Measure Category Cost-Effectiveness Results

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.0047	\$29,280	\$403,210	\$373,930	13.77
Total Resource Cost Test (TRC) No Adder	\$0.0047	\$29,280	\$366,555	\$337,275	12.52
Utility Cost Test (UCT)	\$0.0052	\$32,445	\$366,555	\$334,109	11.3
Rate Impact Test (RIM)		\$777,890	\$366,555	(\$411,335)	0.47
Participant Cost Test (PCT)		\$17,118	\$854,411	\$837,293	49.91
Lifecycle Revenue Impacts (\$/kWh)	\$0.00000146				
Discounted Participant Payback (years)	n/a				

Table 7-14: 2017 wattsmart Homes Program Energy Kits - Lighting Measure Category Cost-Effectiveness Results

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.0312	\$62,091	\$143,251	\$81,159	2.31
Total Resource Cost Test (TRC) No Adder	\$0.0312	\$62,091	\$130,228	\$68,137	2.1
Utility Cost Test (UCT)	\$0.0330	\$65,634	\$130,228	\$64,594	1.98
Rate Impact Test (RIM)		\$303,604	\$130,228	(\$173,376)	0.43
Participant Cost Test (PCT)		\$16,826	\$285,418	\$268,593	16.96
Lifecycle Revenue Impacts (\$/kWh)	\$0.00000062				
Discounted Participant Payback (years)	n/a				

Table 7-15: 2017 wattsmart Homes Program HVAC Measure Category Cost-Effectiveness Results

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.1657	\$8,109,700	\$4,958,396	(\$3,151,304)	0.61
Total Resource Cost Test (TRC) No Adder	\$0.1657	\$8,109,700	\$4,507,633	(\$3,602,067)	0.56
Utility Cost Test (UCT)	\$0.0950	\$4,649,286	\$4,507,633	(\$141,653)	0.97
Rate Impact Test (RIM)		\$10,513,230	\$4,507,633	(\$6,005,597)	0.43
Participant Cost Test (PCT)		\$5,931,720	\$8,347,567	\$2,415,848	1.41
Lifecycle Revenue Impacts (\$/kWh)	\$0.00001688				
Discounted Participant Payback (years)	7.9				

Table 7-16: 2017 wattsmart Homes Program Lighting Measure Category Cost-Effectiveness Results

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.0213	\$8,046,802	\$27,466,161	\$19,419,359	3.41
Total Resource Cost Test (TRC) No Adder	\$0.0213	\$8,046,802	\$24,969,237	\$16,922,436	3.1
Utility Cost Test (UCT)	\$0.0156	\$5,886,043	\$24,969,237	\$19,083,195	4.24
Rate Impact Test (RIM)		\$51,103,306	\$24,969,237	(\$26,134,069)	0.49
Participant Cost Test (PCT)		\$9,516,329	\$65,904,281	\$56,387,952	6.93
Lifecycle Revenue Impacts (\$/kWh)	\$0.00008540				
Discounted Participant Payback (years)	0.97				

Table 7-17: 2017 wattsmart Homes Program Water Heating Measure Category Cost-Effectiveness Results

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.0976	\$6,773	\$4,652	(\$2,121)	0.69
Total Resource Cost Test (TRC) No Adder	\$0.0976	\$6,773	\$4,229	(\$2,544)	0.62
Utility Cost Test (UCT)	\$0.0810	\$5,624	\$4,229	(\$1,395)	0.75
Rate Impact Test (RIM)		\$13,939	\$4,229	(\$9,710)	0.3
Participant Cost Test (PCT)		\$6,113	\$14,538	\$8,425	2.38
Lifecycle Revenue Impacts (\$/kWh)	\$0.00000003				
Discounted Participant Payback (years)	3.64				

Table 7-18: 2017 wattsmart Homes Program New Homes Measure Category Cost-Effectiveness Results

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.1543	\$1,643,078	\$800,016	(\$843,062)	0.49
Total Resource Cost Test (TRC) No Adder	\$0.1543	\$1,643,078	\$727,287	(\$915,791)	0.44
Utility Cost Test (UCT)	\$0.0694	\$738,609	\$727,287	(\$11,322)	0.98
Rate Impact Test (RIM)		\$2,019,902	\$727,287	(\$1,292,615)	0.36
Participant Cost Test (PCT)		\$2,436,084	\$2,697,491	\$261,407	1.11
Lifecycle Revenue Impacts (\$/kWh)	\$0.00000178				
Discounted Participant Payback (years)	n/a				

Table 7-19: 2018 wattsmart Homes Program Building Shell Measure Category Cost-Effectiveness Results

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.3329	\$1,154,821	\$242,299	(\$912,521)	0.21
Total Resource Cost Test (TRC) No Adder	\$0.3329	\$1,154,821	\$220,272	(\$934,549)	0.19
Utility Cost Test (UCT)	\$0.0498	\$172,648	\$220,272	\$47,624	1.28
Rate Impact Test (RIM)		\$572,349	\$220,272	(\$352,077)	0.38
Participant Cost Test (PCT)		\$1,104,684	\$522,212	(\$582,472)	0.47
Lifecycle Revenue Impacts (\$/kWh)	\$0.00000045				
Discounted Participant Payback (years)	n/a				

Table 7-20: 2018 wattsmart Homes Program Energy Kits - DHW Measure Category Cost-Effectiveness Results

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.0145	\$50,846	\$147,746	\$96,900	2.91
Total Resource Cost Test (TRC) No Adder	\$0.0145	\$50,846	\$134,315	\$83,468	2.64
Utility Cost Test (UCT)	\$0.0122	\$42,773	\$134,315	\$91,542	3.14
Rate Impact Test (RIM)		\$443,131	\$134,315	(\$308,817)	0.3
Participant Cost Test (PCT)		\$19,296	\$458,117	\$438,820	23.74
Lifecycle Revenue Impacts (\$/kWh)	\$0.00000099				
Discounted Participant Payback (years)	0.23				

Table 7-21: 2018 wattsmart Homes Program Energy Kits - Lighting Measure Category Cost-Effectiveness Results

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.0163	\$20,761	\$56,671	\$35,909	2.73
Total Resource Cost Test (TRC) No Adder	\$0.0163	\$20,761	\$51,519	\$30,757	2.48
Utility Cost Test (UCT)	\$0.0172	\$21,893	\$51,519	\$29,626	2.35
Rate Impact Test (RIM)		\$167,677	\$51,519	(\$116,159)	0.31
Participant Cost Test (PCT)		\$10,446	\$173,936	\$163,491	16.65
Lifecycle Revenue Impacts (\$/kWh)	\$0.00000034				
Discounted Participant Payback (years)	n/a				

Table 7-22: 2018 wattsmart Homes Program HVAC Measure Category Cost-Effectiveness Results

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.1672	\$8,429,455	\$3,181,965	(\$5,247,490)	0.38
Total Resource Cost Test (TRC) No Adder	\$0.1672	\$8,429,455	\$2,892,695	(\$5,536,760)	0.34
Utility Cost Test (UCT)	\$0.0849	\$4,279,079	\$2,892,695	(\$1,386,384)	0.68
Rate Impact Test (RIM)		\$10,058,997	\$2,892,695	(\$7,166,302)	0.29
Participant Cost Test (PCT)		\$6,276,328	\$7,896,005	\$1,619,676	1.26
Lifecycle Revenue Impacts (\$/kWh)	\$0.00001849				
Discounted Participant Payback (years)	9.73				

Table 7-23: 2018 wattsmart Homes Program Lighting Measure Category Cost-Effectiveness Results

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.0275	\$7,305,463	\$11,835,111	\$4,529,648	1.62
Total Resource Cost Test (TRC) No Adder	\$0.0275	\$7,305,463	\$10,759,192	\$3,453,729	1.47
Utility Cost Test (UCT)	\$0.0167	\$4,427,499	\$10,759,192	\$6,331,693	2.43
Rate Impact Test (RIM)		\$34,873,270	\$10,759,192	(\$24,114,077)	0.31
Participant Cost Test (PCT)		\$8,508,117	\$44,166,169	\$35,658,052	5.19
Lifecycle Revenue Impacts (\$/kWh)	\$0.00007153				
Discounted Participant Payback (years)	1.61				

Table 7-24: 2018 wattsmart Homes Program Water Heating Measure Category Cost-Effectiveness Results

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.0922	\$5,205	\$2,592	(\$2,613)	0.5
Total Resource Cost Test (TRC) No Adder	\$0.0922	\$5,205	\$2,356	(\$2,849)	0.45
Utility Cost Test (UCT)	\$0.0819	\$4,628	\$2,356	(\$2,272)	0.51
Rate Impact Test (RIM)		\$11,100	\$2,356	(\$8,744)	0.21
Participant Cost Test (PCT)		\$4,292	\$11,194	\$6,902	2.61
Lifecycle Revenue Impacts (\$/kWh)	\$0.00000002				
Discounted Participant Payback (years)	2.63				

Table 7-25: 2018 wattsmart Homes Program Whole Building Multifamily Measure Category Cost-Effectiveness Results

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.1555	\$6,922,313	\$2,834,334	(\$4,087,979)	0.41
Total Resource Cost Test (TRC) No Adder	\$0.1555	\$6,922,313	\$2,576,667	(\$4,345,646)	0.37
Utility Cost Test (UCT)	\$0.0313	\$1,393,629	\$2,576,667	\$1,183,038	1.85
Rate Impact Test (RIM)		\$6,496,950	\$2,576,667	(\$3,920,283)	0.4
Participant Cost Test (PCT)		\$7,053,094	\$6,549,524	(\$503,570)	0.93
Lifecycle Revenue Impacts (\$/kWh)	\$0.00000950				
Discounted Participant Payback (years)	18.27				

Table 7-26: 2018 wattsmart Homes Program New Homes Measure Category Cost-Effectiveness Results

Cost-Effectiveness Test	Levelized \$/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
Total Resource Cost Test (PTRC) + Conservation Adder	\$0.1634	\$1,941,216	\$829,793	(\$1,111,422)	0.43
Total Resource Cost Test (TRC) No Adder	\$0.1634	\$1,941,216	\$754,358	(\$1,186,858)	0.39
Utility Cost Test (UCT)	\$0.0659	\$783,367	\$754,358	(\$29,009)	0.96
Rate Impact Test (RIM)		\$2,152,208	\$754,358	(\$1,397,850)	0.35
Participant Cost Test (PCT)		\$2,890,985	\$2,862,083	(\$28,901)	0.99
Lifecycle Revenue Impacts (\$/kWh)	\$0.00000177				
Discounted Participant Payback (years)	n/a				