Final Report: 2013–2014 Utah Home Energy Savings Program Evaluation

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Table of Contents

Glossary of Terms 3

Executive Summary 5

- Key Findings 5
- Summary and Recommendations 10

Introduction 13

- Program Description 13
- Program Participation 14
- Data Collection and Evaluation Activities 17

Impact Evaluation 20

- Evaluated Gross Savings 23
- Evaluated Net Savings 58
- Lighting Leakage Study 67

Process Evaluation 84

- Methodology 84
- Program Implementation and Delivery 86
- Marketing 90
- Program Challenges and Successes 91
- Customer Response 92

Cost-Effectiveness 102

Conclusions and Recommendations 106

- Measure Categorization 106
- Upstream Lighting Tracking Database 106
- Lighting Cross-Sector Sales 107
- Nonparticipant Spillover 107
- Lighting Leakage 107
- Lighting Spillover 108
- Customer Outreach 108
- Application Processing 109
- Satisfaction with Program Experience 109

Appendices 110

Appendix A. Survey and Data Collection Forms 110
Appendix B. Lighting Impacts 110
Appendix C. Billing Analysis 110
Appendix D. Self-Report NTG Methodology 110
Appendix E. Nonparticipant Spillover 110
Appendix F. Lighting Retailer Allocation Review 110
Appendix G. Measure Category Cost-Effectiveness 110
Appendix H. Logic Model 110

Glossary of Terms

Analysis of Covariance (ANCOVA)

An ANCOVA model is an Analysis of Variance (ANOVA) model with a continuous variable added. An ANCOVA model explains the variation in the independent variable, based on a series of characteristics (expressed as binary variables equaling either zero or one).

Evaluated Gross Savings

Evaluated gross savings represent the total program savings, based on the validated savings and installations, before adjusting for behavioral effects such as freeridership or spillover. They are most often calculated for a given measure 'i' as:

$$Evaluated\ Gross\ Savings_i = Verified\ Installations_i * Unit\ Consumption_i$$

Evaluated Net Savings

Evaluated net savings are the program savings net of what would have occurred in the program's absence. These savings are the observed impacts attributable to the program. Net savings are calculated as the product of evaluated gross savings and net-to-gross (NTG) ratio:

$$Net\ Savings = Evaluated\ Gross\ Savings * NTG$$

Freeridership

Freeridership in energy-efficiency programs is participants who would have adopted the energy-efficient measure in the program's absence. This is often expressed as the freeridership rate, or the proportion of evaluated gross savings that can be classified as freeridership.

Gross Realization Rate

The ratio of evaluated gross savings and the savings reported (or claimed) by the program administrator.

In-Service Rate (ISR)

The ISR (also called the installation rate) is the proportion of incented measures actually installed.

Net-to-Gross (NTG)

The NTG ratio is the ratio of net savings to evaluated gross savings. Analytically, NTG is defined as:

$$NTG = (1 - Freeridership\ Rate) + Spillover\ Rate$$

P-Value

A p-value indicates the probability that a statistical finding might be due to chance. A p-value less than 0.10 indicates that, with 90% confidence, the finding was due to the intervention.

Spillover

Spillover is the adoption of an energy-efficiency measure induced by the program's presence, but not directly funded by the program. As with freeridership, this is expressed as a fraction of evaluated gross savings (or the *spillover rate*).

T-Test

In regression analysis, a t-test is applied to determine whether the estimated coefficient differs significantly from zero. A t-test with a p-value less than 0.10 indicates that there is a 90% probability that the estimated coefficient is different from zero.

Trade Ally

For the purposes of the process evaluation, trade allies are respondents of the participant retailer/contractor survey. Trade allies include retailers and contractors who supply and install discounted compact florescent lamps (CFLs), appliances, HVAC, or insulation through the program.

Executive Summary

Rocky Mountain Power first offered the Home Energy Savings (HES) Program in Utah in 2006. The program provides residential customers with incentives to facilitate their purchases of energy-efficient products and services through upstream (manufacturer) and downstream (customer) incentive mechanisms. During the 2013 and 2014 program years, Rocky Mountain Power's HES program reported gross electricity savings of 171,614,661 kWh. The largest of Rocky Mountain Power's Utah residential programs, the HES program contributed 63% of the reported Utah residential portfolio savings and 35% of Utah's total wattsmart portfolio savings in 2013 and 2014.[1]

During the evaluation period (2013-2014), the HES program included energy efficiency measures in four categories:

1. ***Appliances:*** Rocky Mountain Power provided customer incentives for efficient clothes washers, dishwashers, refrigerators, freezers, room air conditioners, portable evaporative coolers, ceiling fans, light fixtures, and high-efficiency electric storage water heaters.
2. ***Heating, ventilation, and air conditioning (HVAC):*** Rocky Mountain Power provided customer incentives for high-efficiency heating and cooling equipment and services, heat pump water heaters, and duct sealing and insulation.
3. ***Lighting:*** Rocky Mountain Power provided upstream incentives for manufacturers to reduce retail prices on CFLs, LEDs, and began providing light fixtures upstream starting in 2015.
4. ***Weatherization:*** Rocky Mountain Power provided customer incentives for attic, wall, and floor insulation as well as for high-efficiency windows.

Rocky Mountain Power contracted with Cadmus to conduct impact and process evaluations of the Utah HES program for program years 2013 and 2014. For the impact evaluation, Cadmus assessed energy impacts and program cost-effectiveness. For the process evaluation, Cadmus assessed program delivery and efficacy, bottlenecks, barriers, best practices, and opportunities for improvements. This document presents these evaluations' results.

Key Findings

Cadmus' impact evaluation addressed over 99% of the HES program savings. Cadmus collected primary data on the top savings measures, performed billing analyses for insulation and HVAC measures, and completed engineering reviews using secondary data for the remaining measures. CFLs and LEDs, which accounted for almost 76% of total HES program reported savings, were the primary focus of the evaluation.

[1] Residential portfolio and total portfolio savings (at the customer site) sourced from the 2013 and 2014 Rocky Mountain Power Utah annual reports.

Key Impact Evaluation Findings

Key evaluation findings include the following (and summarized in Table 1):

- ***Appliances:*** Overall, Cadmus estimated a gross realization rate of 117% of reported savings for the appliance measure category. Incented appliances showed an overall weighted average installation rate of 100%. Evaluated gross savings realization rates ranged from 102% for light fixtures to 282% for clothes washers. Clothes washers realized a high evaluated gross savings mainly due to differences in the baselines between reported and evaluated savings (current practice baseline vs. federal standard baseline). Appliance measures had a savings-weighted net-to-gross (NTG) of 81%.
- ***HVAC****:* Overall, the HVAC measure category realized 104% of reported gross savings. Evaluated gross savings realization rates ranged from 91% (gas furnace with an electrically commutated motor [ECM]) to 112% (evaporative coolers). HVAC measures had a savings-weighted NTG of 83%.
- ***Lighting:*** Incented CFL and LED bulbs realized 70% and 91% installation rates, respectively, based on installation, storage, and removal practices reported through telephone surveys. The evaluation estimated lower savings variables for LEDs than expected (in-service rates, hours-of use and delta watts) and the program realized only 70% of reported savings for LEDs, while realizing 100% for CFLs. The HES lighting component realized 91% of reported savings and had a weighted NTG of 61% (which falls within the typical range for upstream lighting NTG).
- ***Lighting Leakage:*** Through intercept surveys conducted with customers purchasing light bulbs at 15 participating retail stores, Cadmus found that lighting leakage rates were an average of roughly 5.1 percentage points higher than predicted by the Retail Sales Allocation Tool (RSAT), with a confidence level of 90% and precision of ± 5.3%, indicating that the RSAT is performing well as a predictor of bulb leakage. While there is some variation in the scores by store, particularly when the number of intercept surveys we were able to conduct in a store were low, the RSAT scores are within the range of our estimated leakage rates calculated from the intercept survey responses. A leakage rate of 49.8% was calculated across all surveyed stores outside of Rocky Mountain Power's territory, indicating that one-half of the bulbs purchased at these stores likely were installed within Rocky Mountain Power's territory. Leakage rates were not applied to evaluated savings estimates.
- ***Weatherization:*** Overall, Cadmus estimated a 105% gross realization rate[2] for the weatherization measure category, consisting of attic, wall, and floor insulation as well as windows, and an NTG of 99%. Cadmus evaluated the insulation measures using a billing analysis that produced a net realization rate, therefore not applying a net adjustment (NTG = 100%) to those particular measures, resulting in the high NTG ratio for the entire measure category.

[2] Billing analysis for insulation consisted of comparing a participant group to a nonparticipant group, which produced realization rates that are not truly gross.

Table 1. 2013 and 2014 HES Program Savings*

Measure Category	Evaluated Units**	Reported Gross Savings (kWh)	Evaluated Gross Savings (kWh)	Gross Realization Rate	Precision (at 90% Confidence)	Evaluated Net Savings (kWh)	NTG
Appliances	673,351	20,958,880	24,562,256	117%	±4.8%	19,895,427	81%
HVAC	26,710	12,940,429	13,489,546	104%	±7.3%	11,136,474	83%
Lighting	5,690,342	130,333,666	118,402,600	91%	±3.2%	72,463,841	61%
Weatherization	31,012,151	7,381,687	7,732,902	105%	±6.1%	7,646,818	99%
Total	**37,402,553**	**171,614,661**	**164,187,303**	**96%**	**±2.5%**	**111,142,560**	**68%**

*Totals in tables may not add exactly due to rounding.

**Cadmus counted each square foot of incented insulation or windows as one unit. The Weatherization category also includes 29 bonus incentives for insulation measures.

Table 2 and Table 3 show the breakout of impact evaluation findings by program year. The change in the lighting and overall realization rates are mainly caused by a shift in the gross realization rate for CFLs from 114% in 2013 to 81% in 2014, due to multiple factors, but primarily to shifting baselines between the years.

Net-to-gross ratios were applied to each measure consistently across the program years, however measure-category NTG ratios change slightly between years simply due to shifting participation and savings within each measure category across the two years.

Table 2. 2013 HES Program Savings*

Measure Category	Evaluated Units**	Reported Gross Savings (kWh)	Evaluated Gross Savings (kWh)	Gross Realization Rate	Evaluated Net Savings (kWh)	NTG
Appliances	142,565	4,970,689	6,489,059	131%	5,256,138	81%
HVAC	12,244	5,217,089	5,457,113	105%	4,567,430	84%
Lighting	3,303,663	75,175,597	76,062,706	101%	46,421,125	61%
Weatherization	16,820,512	4,118,409	4,314,165	105%	4,265,450	99%
Total	**20,278,984**	**89,481,784**	**92,323,042**	**103%**	**60,510,142**	**66%**

*Totals in tables may not add exactly due to rounding.

**Cadmus counted each square foot of incented insulation or windows as one unit. The Weatherization category also includes 18 bonus incentives for insulation measures.

Table 3. 2014 HES Program Savings*

Measure Category	Evaluated Units**	Reported Gross Savings (kWh)	Evaluated Gross Savings (kWh)	Gross Realization Rate	Evaluated Net Savings (kWh)	NTG
Appliances	530,786	15,988,190	18,073,197	113%	14,639,289	81%
HVAC	14,466	7,723,340	8,032,433	104%	6,569,044	82%
Lighting	2,386,679	55,158,069	42,339,894	77%	26,042,716	62%
Weatherization	14,191,639	3,263,278	3,418,737	105%	3,381,369	99%
Total	**17,123,570**	**82,132,877**	**71,864,261**	**87%**	**50,632,419**	**70%**

*Totals in tables may not add exactly due to rounding.

**Cadmus counted each square foot of incented insulation or windows as one unit. The Weatherization category also includes 11 bonus incentives for insulation measures.

Key Process Evaluation Findings

Key process evaluation findings include the following:

- Retailers (32%) and bill inserts (16%) constituted the most commonly cited sources of program awareness for non-lighting participants, while the general population most commonly mentioned bill inserts (31%) and television ads (30%) as ways they learned about wattsmart offerings.
- Efforts to improve the ease of completing the non-lighting incentive application appear to have succeeded; non-lighting participants reported faster incentive check processing times and relative ease in filling out applications, relative to the 2011-2012 program evaluation.
    - Ninety-six percent of survey respondents found the incentive application very easy to fill out.
    - According to participant surveys, 82% of non-lighting customers reported receiving their incentive in less than six weeks during 2013–2014, representing an improvement from the previous evaluation period where 67% reported receiving their incentive in six weeks or less.
    - Eighty-eight percent of non-lighting customers reported satisfaction with the time required to receive the incentive.
- Non-lighting participants expressed overwhelming satisfaction with the program, with 99% reporting satisfaction with the program overall. In addition, non-lighting customers expressed high satisfaction levels with the measures they installed, their contractor, and the incentive amounts they received.
- Non-lighting participants indicated participating to save energy, and reduce costs, and replace broken equipment. Price proved much less important than in past evaluation cycles.
- General population survey respondents expressed increasing satisfaction levels with LEDs (with product satisfaction levels consistently higher than for CFL purchasers).

Cost-Effectiveness Results

As shown in Table 4, the program proved cost-effective across the 2013–2014 evaluation period from all test perspectives, except for the Ratepayer Impact Measure (RIM) test. The program proved cost-effective from the UCT perspective, with a benefit/cost ratio of 2.04.

Table 4. 2013–2014 Evaluated Net HES Program Cost-Effectiveness Summary

Cost-Effectiveness Test	Levelized $/kWh	Costs	Benefits	Net Benefits	Benefit/ Cost Ratio
PacifiCorp Total Resource Cost Test (PTRC) (TRC + 10% Conservation Adder)	$0.096	$82,583,696	$101,696,330	$19,112,634	1.23
Total Resource Cost (TRC) No Adder	$0.096	$82,583,696	$92,451,645	$9,867,950	1.12
Utility Cost Test (UCT)	$0.053	$45,282,677	$92,451,645	$47,168,968	2.04
Ratepayer Impact Measure (RIM) Test		$137,344,020	$92,458,047	($44,885,972)	0.67
Participant Cost Test (PCT)		$95,113,688	$162,472,086	$67,358,398	1.71
Lifecycle Revenue Impacts ($/kWh)	$0.000113657				
Discounted Participant Payback (years)	4.17				

The RIM test measures program impacts on customer rates. Most energy efficiency programs do not pass the RIM test because, while energy efficiency programs reduce energy delivery costs, they also reduce energy sales. As a result, the average rate per unit of energy may increase. A RIM benefit-cost ratio greater than 1.0 indicates that rates, as well as costs, will go down as a result of the program. Typically, this only happens for demand response programs or programs that are targeted to the highest marginal cost hours (when marginal costs are greater than rates).

Table 5 and Table 6, respectively, show HES program cost-effectiveness for the 2013 and 2014 program years, based on evaluated net savings. The program proved cost-effective from the UCT perspective for both 2013 and 2014.

Table 5. 2013 Evaluated Net HES Program Cost-Effectiveness Summary

Cost-Effectiveness Test	Levelized $/kWh	Costs	Benefits	Net Benefits	Benefit/ Cost Ratio
PTRC (TRC + 10% Conservation Adder)	$0.097	$42,916,759	$50,655,816	$7,739,057	1.18
TRC No Adder	$0.097	$42,916,759	$46,050,742	$3,133,983	1.07
UCT	$0.047	$20,792,304	$46,050,742	$25,258,439	2.21
RIM		$67,112,029	$46,050,742	($21,061,287)	0.69
PCT		$48,884,330	$81,989,613	$33,105,283	1.68
Lifecycle Revenue Impacts ($/kWh)					$0.000054127
Discounted Participant Payback (years)					3.60

Table 6. 2014 Evaluated Net HES Program Cost-Effectiveness Summary

Cost-Effectiveness Test	Levelized $/kWh	Costs	Benefits	Net Benefits	Benefit/ Cost Ratio
PTRC (TRC + 10% Conservation Adder)	$0.096	$42,396,815	$54,553,122	$12,156,307	1.29
TRC No Adder	$0.096	$42,396,815	$49,594,213	$7,197,398	1.17
UCT	$0.059	$26,175,801	$49,594,213	$23,418,412	1.89
RIM		$75,065,356	$49,601,056	($25,464,300)	0.66
PCT		$49,410,863	$86,021,277	$36,610,414	1.74
Lifecycle Revenue Impacts ($/kWh)					$0.000064096
Discounted Participant Payback (years)					3.90

Summary and Recommendations

From impact and process evaluation interviews, surveys, and other analyses, Cadmus drew the following conclusions and recommendations (this report's Conclusions and Recommendations section provides a more complete discussion of the findings):

- **Measure Categorization:** For some measures (such as light fixtures), measure categories were assigned in the tracking database based on delivery channels rather than end uses. Cadmus also found inconsistent use of measure categories between the participant tracking database and annual report cost-effectiveness assumptions.
    - Recommendation: Assign measure categories by end use to ensure the most appropriate cost-effectiveness results.
- **Upstream Lighting Database:** Cadmus experienced difficulties in mapping the Program Administrator's lighting tracking database to the price scheduling database (for example, inconsistent use of SKUs and model numbers). Data tracking, however, did improve significantly between 2013 and 2014.

  - Recommendation: Track all data in a consistent manner across each program evaluation period (i.e. 2015-2016, 2016-2017 etc.).
- **Lighting Cross-Sector Sales**: Cadmus estimated that 3.9% of efficient bulbs purchased at retail stores ultimately would be installed in commercial applications. Bulbs installed in commercial spaces produce higher first-year savings than bulbs installed in a residential space as commercial locations typically have a higher daily use of bulbs than residential locations (i.e., higher HOU). Currently, Rocky Mountain Power does not account for cross-sector sales from the upstream lighting incentives.
  - Recommendation: Consider accounting for commercial installation of upstream bulbs in the reported savings.
- **Nonparticipant Spillover:** Nonparticipant spillover results in energy savings caused by, but not rebated through, a utility's demand-side management activities. Through responses to the general population survey, Cadmus estimated nonparticipant spillover as 1% of HES program savings. As the estimation of these savings is relatively new in the industry, and as savings have not been assessed in previous program evaluations, Cadmus did not apply this adjustment.
  - Recommendation: Consider allowing nonparticipant spillover analysis to be an integral component of NTG estimations for all programs.
- **Lighting Leakage:** The RSAT allocation score is performing well in Utah. Through intercept surveys conducted with customers purchasing light bulbs at 15 participating retail stores, Cadmus found that lighting leakage rates were an average of roughly 5.1 points higher than predicted by the RSAT, with a confidence level of 90% and precision of ± 5.3%, indicating that the RSAT is performing well as a predictor of bulb leakage. While there is some variation in the scores by store, particularly when the number of intercept surveys we were able to conduct in a store were low, the RSAT scores are within the range of our estimated leakage rates calculated from the intercept survey responses.
  - Recommendation: Rocky Mountain Power should continue using the RSAT to determine which stores in their territory should be included as participating stores in the program.
- **Lighting Spillover:** This evaluation examined a portion of participant spillover found from the upstream lighting store intercept leakage survey, however, it was not an exhaustive view of spillover since the sample was designed to capture leakage and not spillover. Stores were chosen for intercepts based on their RSAT scores, instead of randomly sampled within all participating stores within the Rocky Mountain Power territory, which is what would be required to calculate spillover.
  - Recommendation: Consider additional studies to quantify spillover and market transformation for use in lighting NTG calculations.
- **Customer Outreach:** Bill inserts and retailers constituted the most commonly cited program awareness sources for non-lighting participants. While the website was an influential source of general wattsmart awareness for the general population of customers, it did not serve as a main participation driver for the non-lighting program.
  - Recommendation: Continue to pursue a multi-touch marketing strategy, using a mix of bill inserts and retailer/contractor training. Given the large percentage of customers who learned of wattsmart offerings through bill inserts, examine the proportion of customers

selecting to receive online bills and ensure these online channels proportionately advertise the programs with the messages that motivated customers to participate: long-lasting products, saving energy, replacing equipment and reducing costs.

- **Application Processing:** Despite substantive improvements in participant-reported application processing times, reported processing times remained lengthy for duct sealing and insulation and attic, floor and wall insulation, indicating opportunities for improvements for these specific measures.
    - Recommendation: Continue to review methods for simplifying the applications, particularly for duct sealing and insulation applications which have been prone to greater errors. Implement additional training for HVAC and weatherization contractors to help mitigate this issue by covering the data points required for a complete application and how to best support a customer who chooses to fill out the application, and explore making duct sealing and insulation an online application to reduce errors.
- **Satisfaction with Program Experience:** While Cadmus was not able to verify the efficacy of the program administrator's efforts to reach out to non-registered contractors who worked with rebate-seeking participants, the program's efforts to mitigate contractor confusion regarding tariff changes appeared to support the customers' reported satisfaction.
    - Recommendation: Continue regular trainings with trade allies (e.g., distributors, retailers, sales associates, contractors), updating them on tariff changes and, where appropriate, supporting them with sales and marketing training. Analyze success of efforts to register non-registered contractors who worked with rebate participants within 90 days to determine whether the additional outreach mitigated the number of rejected applications due to non-qualified contractors.

Introduction

Program Description

CLEAResult (formerly Portland Energy Conservation Inc.) administered the program during the 2013-2014 period, providing prescriptive incentives to residential customers who purchased qualifying, high-efficiency appliances, heating, ventilation, and air conditioning (HVAC) and weatherization measures. The HES program also included an upstream lighting component, with incentives applied to eligible CFLs and LEDs at the manufacturer level, providing discounted high-efficiency lighting options. In early 2015, light fixtures moved from a prescriptive offering to an upstream delivery.

The HES program offered the following measures for part or all of the evaluation period:

- Appliances:
  - Ceiling fan
  - Clothes washer
  - Dishwasher
  - Electric water heater
  - Freezer
  - Light fixture
  - Portable evaporative cooler
  - Refrigerator
  - Room air conditioner
- HVAC:
  - Central air conditioner best practice installations
  - Central air conditioner proper sizing
  - Central air conditioners
  - Duct sealing and insulation
  - Evaporative cooler (permanently installed, premium, ducted, and replacement)
  - Gas furnaces with an electronically commutated motor (ECM)
  - Heat pump water heater
- Lighting
  - CFLs
  - LEDs
- Weatherization:
  - Insulation (attic, floor, and wall)
  - Windows

Program Participation

During the 2013–2014 HES program years, Rocky Mountain Power provided prescriptive incentives to over 60,000 residential customers and provided upstream discounts for over 6,000,000 products. Table 7 shows participation and savings by measures and measure categories for this period.

Table 7. HES Reported Quantity and Savings by Measure, 2013–2014*

Measure Category	Measure Name	Reported Participants	Reported Quantity	Quantity Type	Reported Savings
Appliance	Ceiling Fan	23	39	Units	6,201
	Clothes Washer	16,845	16,934	Units	1,809,152
	Dishwasher	6,550	6,566	Units	301,388
	Electric Water Heater	19	19	Units	2,398
	Freezer	10	10	Units	944
	Light Fixture	43,889	646,893	Units	18,497,095
	Portable Evaporative Cooler	187	191	Units	131,026
	Refrigerator	1,745	1,746	Units	139,953
	Room Air Conditioner	894	953	Units	70,722
HVAC	Central Air Conditioner Best Practice Installation	3,229	3,275	Units	265,351
	Central Air Conditioner Equipment	3,405	3,452	Units	1,190,372
	Central Air Conditioner Proper Sizing	1,956	1,980	Units	478,575
	Duct Sealing and Insulation	8,104	12,339	Projects	5,293,997
	Evaporative Cooler—Permanently Installed	232	233	Units	346,707
	Evaporative Cooler—Premium	1,536	1,979	Units	2,968,326
	Evaporative Cooler—Premium Ducted	44	44	Units	64,968
	Evaporative Cooler—Replacement	547	590	Units	857,961
	Gas Furnace	2,774	2,817	Units	1,473,291
	Heat Pump Water Heater	1	1	Units	881
Lighting**	CFL Bulbs	456,369	4,563,694	Units	88,770,695
	LED Bulbs	1,126,648	1,126,648	Units	41,562,972
Weatherization	Attic Insulation	15,150	29,570,513	Square Feet	6,271,444
	Floor Insulation	8	4,000	Square Feet	12,574
	Wall Insulation	1,051	975,786	Square Feet	619,427
	Windows	2,736	461,823	Square Feet	478,242
Total					**171,614,661**

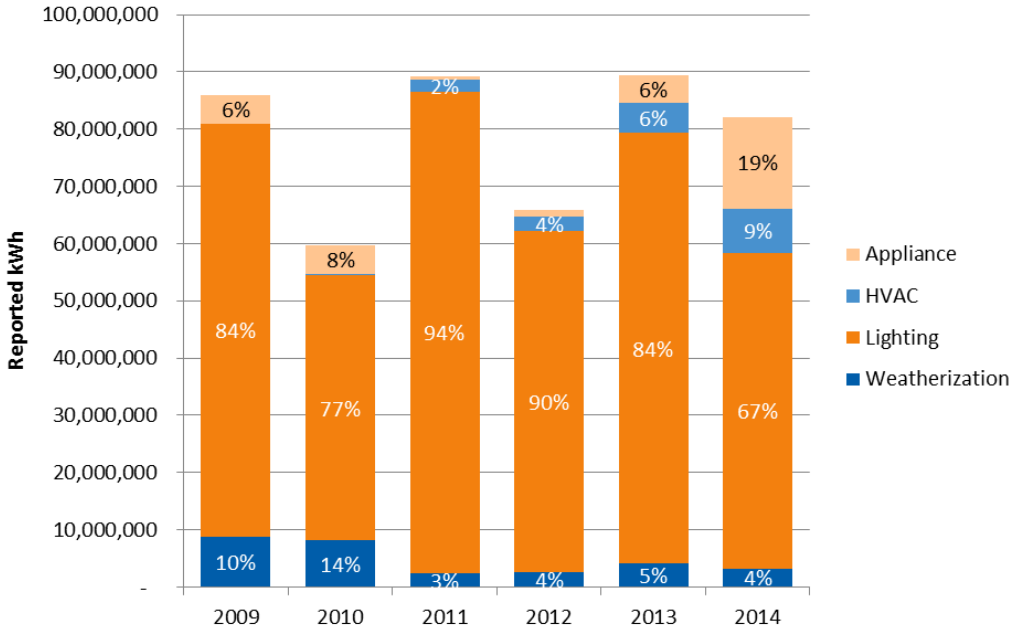
Source: Rocky Mountain Power 2013 and 2014 annual reports and 2013-2014 non-lighting and lighting databases provided by the program administrator.

* Rocky Mountain Power also reported 29 whole house bonus incentives in the annual reports (18 in 2013 and 11 in 2014). These were incentive-only measures with savings captured in insulation and HVAC measures.

** Participation for upstream products was estimated by Rocky Mountain Power in the annual reports.

Historically, lighting savings have comprised a vast majority of HES program savings. The 2013 program year was no exception, as upstream lighting measures contributed 84% of HES annual reported gross program savings, as shown in Figure 1. In 2014, however, savings from CFL and LED bulbs decreased by roughly 25% from 2013 levels due to a drop in the total bulbs incented by roughly one-third. Despite the decrease in lighting participation in 2014, lighting (including fixtures) still represented over 80% of savings for both years. The impact and process evaluations focused heavily on the HES program's lighting component due to continued high savings from lighting incentives.

Figure 1. Reported Gross kWh Savings by Measure Category from 2009–2014*



* Percentages may not add to 100% due to rounding

Data Collection and Evaluation Activities

Table 8 summarizes evaluation activities that supported the impact and process evaluations.

Table 8. Summary of Evaluation Approach

Activities	Impact		Process
	Gross Savings	Net-to-Gross	
Program Staff and Program Administrator Interviews			X
Participant Non-Lighting Surveys	X	X	X
General Population Surveys	X	X*	X
Weatherization and HVAC Billing Analysis	X	X	
Engineering Reviews	X		
Demand Elasticity Modeling		X	
Intercept Surveys	X**	X***	X
Logic Model Review			X

* This activity provided an estimate of nonparticipant spillover savings that was not applied to the program savings.

**This activity provided an estimate of cross-sector lighting sales that was not applied to the program savings.

*** This activity provided a conservative spillover estimate that was not applied to the program savings.

Appendix A provides survey and data collection instruments used.

Sample Design and Data Collection Methods

Cadmus developed samples, designed to achieve precision of ±10% with 90% statistical confidence for each surveyed population (via sample sizes based on assuming a 0.5 coefficient of variation [CV]).[3] For small population sizes, Cadmus applied a finite population adjustment factor; this reduced the necessary completion target to achieve precision of ±10% with 90% statistical confidence.

Table 9 shows the final sample disposition for various data collection activities. For nearly all data collection (except administrator and management staff interviews), Cadmus drew samples using simple or stratified random sampling.[4]

[3] The CV equals the ratio of standard deviation (a measure of the dispersion of data points in a data series) to the series mean.

[4] Simple random samples are drawn from an entire population, whereas stratified random samples are drawn randomly from subpopulations (strata) and are then weighted to extrapolate to the population.

Table 9. Sample Disposition for Various HES Program Data Collection Activities in Utah

Data Collection Activity	Population	Sampling Frame	Target Completes	Achieved Completes
Program Staff Interview	N/A	N/A	1	1
Program Administrator Interviews	N/A	N/A	1	1
Non-Lighting Participant Surveys	55,982*	3,150	204	204
General Population Surveys	745,363**	10,000	250	250
Intercept Surveys***	345 stores	244 stores	600 surveys	385 surveys

* Non-lighting population represents all unique participants by account number.
**The Lighting population derived from Rocky Mountain Power's average 2014 residential customers in Utah. Customer data provided by Rocky Mountain Power.
***Cadmus collected as much data in stores as possible within the available resources and met the confidence and precision targets within achieved completes.

Non-Lighting Participant Telephone Surveys

Cadmus surveyed 204 non-lighting participants, gathering measure-level and measure-category level information on installations, freeridership, spillover, program awareness and satisfaction, and demographics.

In developing the targets by measure category, Cadmus used the measure mix from the 2013-2014 non-lighting database and randomly selected participants and measures within each measure category for the survey. Table 10 provides the population of non-lighting participants, targets, and achieved numbers of surveys.

Table 10. Non-Lighting Participant Survey Sample

Measure Category	Population	Targeted	Achieved
Appliances	30,793	68	68
HVAC	11,088	68	68
Weatherization	18,184	68	68
Total	**60,065***	**204**	**204**

*The total population differs from total population in Table 9 as some participants participated in multiple measure categories.

General Population Surveys

The general population survey collected information on general program awareness and key lighting metrics from a random group of customers in Utah. Cadmus drew the lighting survey sample from a random list of 10,000 Utah residential customers, provided by Rocky Mountain Power, and achieved 250 completed responses.

Intercept Surveys

Cadmus conducted intercept surveys at participating and nonparticipating stores in Utah to determine how many light bulbs being purchased within Rocky Mountain Power's territory were being installed

outside of the territory (leakage), with the primary purpose to evaluate the accuracy of the Retail Sales Allocation Tool (RSAT).

Cadmus targeted 20 stores in Utah: 15 stores within Rocky Mountain Power service territory and five stores located outside the territory, but faced some challenges with getting as many surveys as targeted per store (Table 11). To make up for low numbers of survey completes at some stores, Cadmus visited four extra stores to maximize the number of surveys completed, but still fell short of the targeted survey quantity. The surveys, however, produced leakage results that achieved the target precision of ±10% with 90% statistical confidence.

Table 11. Intercept Store and Survey Samples in Utah

Store Location	RSAT Score	Target Stores	Achieved Stores*	Target Surveys	Achieved Surveys
Within Rocky Mountain Power	Greater or equal to 96%	8	14	450	296
	Less than 96%	7	5		
Outside of Rocky Mountain Power	n/a	5	6	150	89
Total		**20**	**27**	**600**	**385**

*Includes three stores (two within Rocky Mountain Power territory, one outside) in which Cadmus administered zero surveys.

Impact Evaluation

This chapter provides impact evaluation findings for the HES program, based on Cadmus' data analysis, which used the following methods:

- Participant surveys
- General population surveys
- Intercept surveys
- Billing analysis
- Engineering reviews
- Elasticity modeling

This report presents two evaluated saving values: gross savings and net savings. To determine evaluated net savings, Cadmus applied all four steps shown in Table 12 and described in the following text. Reported gross savings are electricity savings (kWh) that Rocky Mountain Power reported in the 2013 and 2014 Rocky Mountain Power Energy Efficiency and Peak Reduction Annual Reports (annual reports).[5]

Table 12. Impact Steps to Determine Evaluated Net Savings

Savings Estimate	Step	Action
Evaluated Gross Savings	1	Tracking Database Review: validate accuracy of data in the participant database
	2	Verification: Adjust gross savings with the actual installation rate
	3	Unit Energy Savings: Validate saving calculations (i.e., billing analysis and engineering reviews)
Evaluated Net Savings	4	Attribution: Apply net-to-gross adjustments

Step one (verify participant database) included reviewing the program tracking database to ensure participants and reported savings matched 2013 and 2014 annual reports.

Step two (adjust gross savings with the actual installation rate) determined the number of program measures installed and remaining installed. Cadmus determined this value through telephone surveys.

[5] Rocky Mountain Power Utah Annual Reports:
2013 - http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Demand_Side_Management/2014/2013-UT-Annual-Report-FINAL-Report-051614.pdf
2014 - http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Demand_Side_Management/2015/UT_2014-Annual-Report_FINAL042915.pdf

Step three (estimate gross unit energy savings [UES]) included reviews of measure saving assumptions, equations, and inputs (e.g., engineering reviews for lighting and appliances, billing analysis for weatherization and HVAC measures).

The first three steps determined evaluated gross savings. The fourth step (applying net adjustments) determined evaluated net savings. Cadmus calculated the net saving adjustments using results from customer self-response and demand elasticity modeling.

Table 13 outlines the methodology for each gross and net savings step, by measure, in the 2013–2014 HES program.

Table 13. 2013–2014 HES Impact Methodology by Measure

<table>
<tr><th rowspan="2">Measure Category</th><th rowspan="2">Measure Name</th><th rowspan="2">% of Savings*</th><th colspan="3">Gross Method</th><th rowspan="2">Step 4: Attribution</th></tr>
<tr><th>Step 1: Database Review</th><th>Step 2: Verification</th><th>Step 3: Unit Energy Savings</th></tr>
<tr><td rowspan="9">Appliance</td><td>Dishwasher</td><td>0.2%</td><td rowspan="25">Non-Lighting Tracking Database Review</td><td rowspan="9">In-Service Rate: Non-Lighting Survey</td><td rowspan="5">Reported**</td><td rowspan="26">Self-Response: Non-Lighting Survey</td></tr>
<tr><td>Electric Water Heater</td><td>0.0%</td></tr>
<tr><td>Freezer</td><td>0.0%</td></tr>
<tr><td>Ceiling Fan</td><td>0.0%</td></tr>
<tr><td>Portable Evaporative Cooler</td><td>0.1%</td></tr>
<tr><td>Refrigerator</td><td>0.1%</td><td rowspan="3">Engineering Review</td></tr>
<tr><td>Room Air Conditioner</td><td>0.0%</td></tr>
<tr><td>Clothes Washer</td><td>1.1%</td></tr>
<tr><td>Light Fixture</td><td>10.8%</td></tr>
<tr><td rowspan="11">HVAC</td><td>Gas Furnace</td><td>0.9%</td><td>Reported*</td></tr>
<tr><td>Heat Pump Water Heater</td><td>0.0%</td><td rowspan="10" colspan="2">Billing Analysis</td></tr>
<tr><td>CAC Best Practice Installation</td><td>0.2%</td></tr>
<tr><td>CAC Equipment</td><td>0.7%</td></tr>
<tr><td>CAC Proper Sizing</td><td>0.3%</td></tr>
<tr><td>Evaporative Cooler—Permanently Installed</td><td>0.2%</td></tr>
<tr><td>Evaporative Cooler—Premium</td><td>1.7%</td></tr>
<tr><td>Evaporative Cooler—Premium Ducted</td><td>0.0%</td></tr>
<tr><td>Evaporative Cooler—Replacement</td><td>0.5%</td></tr>
<tr><td>Duct Sealing and Insulation</td><td>3.1%</td></tr>
<tr><td rowspan="4">Weatherization</td><td>Attic Insulation</td><td>3.7%</td></tr>
<tr><td>Floor Insulation</td><td>0.0%</td><td colspan="3" rowspan="2">Billing Analysis</td></tr>
<tr><td>Wall Insulation</td><td>0.4%</td></tr>
<tr><td>Windows</td><td>0.3%</td><td>In-Service Rate: Non-Lighting Survey</td><td>Reported**</td><td>Self-Response: Non-Lighting Survey</td></tr>
<tr><td rowspan="2">Lighting</td><td>CFL Bulb</td><td>51.7%</td><td rowspan="2">Upstream Lighting Tracking Database Review</td><td rowspan="2">In-Service Rate: general population survey</td><td rowspan="2">Engineering Review</td><td rowspan="2">Demand Elasticity Modeling</td></tr>
<tr><td>LED Bulb</td><td>24.2%</td></tr>
</table>

* Sum of column may not add to 100% due to rounding.

** Measures with “reported” gross measurement methodology contributed less than 0.5% of program savings and did not qualify for measurement analysis.

Evaluated Gross Savings

To calculate gross savings for HES program measures, Cadmus conducted tracking database reviews, measure verification, and, lastly, either engineering reviews or billing analysis of measures accounting for at least 98% of program savings. Table 14 presents the share of savings and gross savings evaluation method for measures representing 99% of program savings during the 2013–2014 period.

Table 14. Measure Selection For Step 3: Engineering and Billing Analysis*

Measure Category	Measure	Percent of Reported kWh Savings	Step 3: Evaluation Method
Appliances	Clothes Washer	1%	Engineering Review
	Light Fixture	11%	Engineering Review
HVAC	Central Air Conditioning	1%	Billing Analysis
	Evaporative Cooler	2%	Billing Analysis
	Duct Sealing and Insulation	3%	Billing Analysis
	Gas Furnace with ECM	1%	Engineering Review
Lighting	CFL Bulb	52%	Engineering Review
	LED Bulb	24%	Engineering Review
Weatherization	Attic, Floor & Wall Insulation	4%	Billing Analysis
Sum % of Reported Savings Evaluated		**99%**	

Table 15 provides the gross savings evaluation results: evaluated quantities, gross savings, and realization rates by measure type.

Table 15. Reported and Evaluated Gross HES Program Savings for 2013–2014

Measure Category	Measure Name	Quantity	Program Savings (kWh)		Realization Rate
			Reported	Evaluated Gross	
Appliance	Ceiling Fan	39	6,201	6,201	100%
	Clothes Washer	16,934	1,809,152	5,098,515	282%
	Dishwasher	6,566	301,388	301,388	100%
	Electric Water Heater	19	2,398	2,398	100%
	Freezer	10	944	944	100%
	Light Fixture	646,893	18,497,095	18,811,108	102%
	Portable Evaporative Cooler	191	131,026	131,026	100%
	Refrigerator	1,746	139,953	139,953	100%
	Room Air Conditioner	953	70,722	70,722	100%
HVAC	Central Air Conditioner Best Practice Installation	3,275	265,351	296,228	112%
	Central Air Conditioner Equipment	3,452	1,190,372	1,328,888	112%

Measure Category	Measure Name	Quantity	Program Savings (kWh)		Realization Rate
			Reported	Evaluated Gross	
	Central Air Conditioner Proper Sizing	1,980	478,575	534,264	112%
	Duct Sealing and Insulation	12,339	5,293,997	5,645,973	107%
	Evaporative Cooler—Permanently Installed	233	346,707	354,946	102%
	Evaporative Cooler—Premium	1,979	2,968,326	3,038,862	102%
	Evaporative Cooler—Premium Ducted	44	64,968	66,512	102%
	Evaporative Cooler—Replacement	590	857,961	878,349	102%
	Gas Furnace with ECM	2,817	1,473,291	1,344,644	91%
	Heat Pump Water Heater	1	881	881	100%
Lighting	CFL Bulbs	4,563,694	88,770,695	89,199,262	100%
	LED Bulbs	1,126,648	41,562,972	29,203,338	70%
Weatherization *	Attic Insulation	29,570,513	6,271,444	6,590,506	105%
	Floor Insulation	4,000	12,574	13,214	105%
	Wall Insulation	975,786	619,427	650,940	105%
	Windows	461,823	478,242	478,242	100%
Total**			**171,614,661**	**164,187,303**	**96%**

*Quantities for weatherization measures are in square feet.

**Savings may not add exactly to total row due to rounding.

Step 1: Tracking Database Reviews

The program administrator provided two tracking databases containing Utah data, covering all 2013 and 2014 participation for the two delivery methods: upstream (lighting) and downstream (non-lighting).

The upstream lighting measures database collected meaningful information, tracking lighting at a per-bulb level and including information such as retailers, electric savings, purchased dates, and stock keeping units (SKUs).[6] Cadmus' review of the database tracking for 2013 and 2014 found no discrepancies in total reported quantities or total savings compared to the 2013 and 2014 annual reports.

Cadmus also reviewed the program administrator's tracking of 2013 and 2014 non-lighting measures. This database collected measure-level information such as efficiency standards, quantities of units, purchase dates, and incentive amounts. Cadmus found the total quantities and savings exactly matched the 2013 and 2014 annual reports.

[6] SKU numbers represent unique make and model indicators for a specific retailer.

Step 2: Verification

Cadmus used the non-lighting participant survey to verify the in-service rate (ISR) (i.e., installation rate) for non-lighting measures, and used the general population survey to verify the upstream CFL and LED ISRs.

Non-Lighting In-Service Rate

For each measure category, Cadmus used surveys to ask participants a series of questions designed to determine whether they installed incented products. Table 16 shows ISRs for each measure surveyed. All survey respondents reported installing all surveyed measures, resulting in a 100% ISR for all non-lighting measure categories. Table 16 also shows the breadth and quantity of measures addressed by the survey.

Table 16. ISR by Measure Category, 2013–2014

Measure Category	Measure	2013 and 2014			
		Total Surveyed Measures	Installed Measures	Installed %	Average Weighted Installation %
Appliances	Clothes Washer	19	19	100%	100%
	Dishwasher	13	13	100%	
	Light Fixture	449	449	100%	
	Refrigerator	3	3	100%	
	Room Air Conditioner	2	2	100%	
HVAC	Central Air Conditioner	17	17	100%	100%
	Central Air Conditioner Best Practice Installation	11	11	100%	
	Central Air Conditioner Proper Sizing	9	9	100%	
	Duct Sealing and Insulation	13	13	100%	
	Evaporative Cooler	11	11	100%	
	Gas Furnace with ECM	7	7	100%	
Weatherization	Attic Insulation (Sq Ft)	72,604	72,604	100%	100%
	Wall Insulation (Sq Ft)	8,467	8,467	100%	
	Windows (Sq Ft)	697	697	100%	

CFL and LED In-Service Rates

Cadmus calculated CFL and LED first-year ISRs for 2013–2014 using data collected through the general population survey of 250 Utah Rocky Mountain Power customers. The survey asked participants about the number of CFL and LEDs bulbs they purchased, installed, removed, and stored within the prior 12 months. If respondents reported removing bulbs, the survey asked why the removal took place and

adjusted the ISR accordingly. The calculated ISR does not account for installations occurring after the first year of purchase. Appendix D of the 2011-2012 Rocky Mountain Power Home Energy Savings Program Evaluation Report provides more information regarding second and third year ISRs. The Uniform Methods Project (UMP) recommends adjusting (increasing) the ISR to account for bulbs initially placed in storage that the customer will subsequently install in the years following the purchase.[7] This evaluation takes a conservative approach and claims savings attributed to just the first year of bulb installations.

CFL

Of the 250 customers surveyed, 75 did not purchase CFLs and 14 could not confirm or estimate how many they had purchased; consequently, the analysis excluded these data. The analysis also removed an additional 27 responses for other reasons, including not knowing how many bulbs were installed, removed, or stored, or reporting demonstrably inconsistent bulb quantities. Cadmus used data from the remaining 134 respondents to calculate the ISR.

Cadmus implemented two changes in the methodology relative to the 2011-2012 program evaluation, which prove important when comparing ISRs across the years and for other jurisdictions as shown in

Table 18. The first change affecting the ISR calculations was including a bulb that burned out as having been installed, as the burnout rate is considered in the assumed effective useful life.

The second change occurred in the survey's phrasing about timing. For this evaluation, the survey asked customers to consider bulbs purchased in the past 12 months as opposed to those purchased during the entire two-year evaluation period. Cadmus updated this question due to concerns regarding a customer's ability to recall purchases that occurred more than two years prior to the survey. Table 17 provides ISR results for 2013–2014 CFLs.

Table 17. 2013 and 2014 First-Year CFL ISR*

Bulb Status	Number of Bulbs Reported	ISR
Purchased	**1,264**	**70.5%**
Installed	942	
Stored	320	
Removed	124	
Removed After Burning Out	73	
In-Service Bulbs (including burned out)	**891**	

*n = 134 respondents

[7] The UMP is a framework and set of protocols established by the U.S. Department of Energy for determining energy savings from energy efficiency measures and programs. Its latest update was in February 2015: http://energy.gov/sites/prod/files/2015/02/f19/UMPChapter21-residential-lighting-evaluation-protocol.pdf

The revised formula for calculating the lighting ISR is:

$$ISR = \frac{Installed\ in\ first\ year - (Removed - Removed\ After\ Burning\ Out)}{Purchased}$$

Table 18 compares first-year ISRs evaluated for similar programs across the country (and for some past HES program evaluations in Utah). Utah's CFL ISR has remained very stable over the past three evaluations (e.g., 2009–2010, 2011–2012, and 2013–2014).

Table 18. Comparison of Evaluated First-Year CFL ISR Estimates

Source	Data Collection Method	Reported Year	ISR
Midwest Utility 1	Self-reporting: determined by interview during home inventory site visits	2016	86%
Avista 2012-2013 Electric Impact Report	Regional Technical Forum (RTF)*	2014	75%
Northeast Utility	Self-Reporting: 200 telephone surveys	2012	73%
Rocky Mountain Power Utah 2013–2014 HES Evaluation	**Self-reporting: 134 in-territory lighting surveys**	**2016**	**70%**
Rocky Mountain Power Utah 2011–2012 HES Evaluation	Self-reporting: 245 in-territory lighting surveys	2014	69%
Rocky Mountain Power Utah 2009-2010 HES Evaluation	Self-reporting: 250 in-territory lighting surveys	2011	69%
Midwest Utility 2	Self-reporting: 301 customer surveys	2012	68%

*The RTF is an advisory committee in the northwest that develops standards to verify and evaluate conservation savings.

LED

Cadmus calculated the first-year LED ISR using the same methodology and customer sample as those used for CFLs. After filtering survey results for those purchased LEDs and provided reliable responses, 99 customers remained for inclusion in the LED ISR analysis. Table 19 summarizes the LED ISR results and shows a higher, LED ISR compared to the CFL ISR. The higher cost of LEDs is most likely driving the higher ISR: customers are more likely to install the bulb right after purchasing it if they just spent a significant amount of money on the bulb (significant compared to CFL costs).

Table 19. 2013–2014 First-Year LED ISR*

Bulb Status	Number of Bulbs	ISR
Purchased	**987**	90.9%
Installed	898	
Stored	89	
Removed	13	
Removed After Burning Out	12	
In-Service Bulbs (including burned out)	**897**	

*n = 99 respondents

Table 20 compares LED ISR values to those calculated for LEDs in other jurisdictions. Fewer comparable studies have assessed the ISR for LEDs compared to CFLs due to the emergence of the LED technology in recent years. For this reason, Table 20 compares just one self-report LED ISR value to the Rocky Mountain Power 2013-2014 LED ISR value. The other LED ISR values are based on data collected through site visits.

Table 20. Comparison of Evaluated LED ISR Estimates

Source	Data Collection Method	Reported Year	ISR
Avista 2012-2013 Electric Impact Report	RTF	2014	100%
Arkansas 2013 Evaluation Report	75 Residential Site Visits	2014	100%
Midwest Utility 1	Self-reporting: determined by interview during home inventory site visits	2016	99%
Midwest Utility 2	103 Residential Site Visits	2013	96%
Northeast Utility	70 Residential Site Visits	2015	96%
Rocky Mountain Power Utah 2013–2014 HES Evaluation	**Self-reporting: 250 General Population Survey**	**2016**	**91%**
Southwest Utility	70 Residential Site Visits	2015	84%

Step 3: Unit Energy Savings Reviews

Cadmus either conducted an engineering review or a billing analysis to estimate UES values for measures representing 99% of program-reported gross savings. Engineering reviews addressed the following program measures:

- CFL and LED bulbs
- Light fixtures
- Clothes washers
- Gas furnaces with ECMs

Cadmus evaluated the following measures using billing analysis:

- Central air conditioners
- Evaporative coolers
- Attic, wall, and floor insulation
- Duct sealing and insulation

Further, Cadmus applied realization rates of 100% to all measures not listed above (when combined, they contributed less than 1% of savings to the program). As shown in Table 21, UES realization rates for evaluated measures ranged between 70% for LEDs and 282% for clothes washers.

Table 21. 2013–2014 Measurement Analysis and Gross Unit Realization Rate Summary Table

Measure Category	Measure	Average Unit Energy Savings (kWh/Unit)		UES Realization Rate*	Gross UES Method
		Reported	Evaluated		
Appliance	Light Fixture	28.6	29.1	102%	Engineering Review
	Clothes Washer	107	301	282%	Engineering Review
HVAC	Gas Furnace ECM	523	477	91%	Engineering Review
	Central Air Conditioner**	222	248	112%	Billing Analysis
	Evaporative Cooler***	1,489	1,524	102%	Billing Analysis
	Duct Sealing and Insulation	429	458	107%	Billing Analysis
Lighting	CFL Bulbs	19.5	19.5	100%	Engineering Review
	LED Bulbs	36.9	25.9	70%	Engineering Review
Weatherization	Attic Insulation+	0.21	0.22	105%	Billing Analysis
	Floor Insulation+	3.14	3.30	105%	Billing Analysis
	Wall Insulation+	0.63	0.67	105%	Billing Analysis

* UES realization rate may not calculate exactly due to rounding reported and evaluated UES values.

**Central air conditioner measure includes equipment installation, best practice installation, and proper sizing.

***Evaporative cooler measure includes permanently installed, premium, premium ducted, and replacement measures.

+Attic, floor, and wall insulation units are kWh/square foot.

The following sections describe the methodology and results of the measurement activities for each measure listed in Table 21.

CFL and LED Bulbs

During the 2013–2014 program years, Rocky Mountain Power incented 4.6 million CFLs and 1.1 million LEDs through 69 different retailers, representing 321 stores. Table 22 shows quantities and savings for the 14 different bulb types. Overall, upstream lighting represented 76% of the total HES reported savings.

Table 22. 2013-2014 Incented CFL and LEDs Bulbs by Type

Lighting Type	Bulb Category	Bulb Type	Reported Quantity (Bulbs)	Reported Savings (kWh)
CFL	Standard	A-Lamp	48,710	798,536
		Spiral	3,438,397	62,600,268
	Specialty	3-Way	2,064	79,780
		Candelabra	34,361	542,990
		Daylight	367,459	7,934,514
		Dimmable	15,918	424,489
		Globe	61,299	1,122,227
		Outdoor	539	14,595
		Reflector	594,947	15,253,296
LED	Standard	A-Lamp	262,375	8,413,660
	Specialty	Candelabra	113,121	2,828,554
		Globe	354,626	9,340,613
		Reflector	1,069	30,609
	Downlight	Downlight	395,457	20,949,537
Total*			**5,690,342**	**130,333,666**

* Savings may not add exactly to totals due to rounding.

Cadmus estimated four parameters to calculate gross savings for LEDs and CFLs:

- Delta watts (ΔWatts)
- ISR
- Hours-of-use (HOU)
- Waste heat factor (WHF)

The following equation provides gross lighting savings:

$$Evaluated\ Per\ Unit\ Savings\ (kWh\ per\ unit) = \frac{\Delta Watts * ISR * HOU * 365 * WHF}{1{,}000}$$

Where:

ΔWatts = The difference in wattage between a baseline bulb and an evaluated efficient bulb

ISR = The percentage of incented units installed within the 1st year

HOU = The daily lighting operating hours

WHF = Accounts for the interactive effects with the home's heating and cooling systems

To calculate the various CFL and LED lighting component inputs, Cadmus conducted the primary and secondary data collection and analysis activities shown in Table 23.

Table 23. CFL and LED Bulb Evaluated Gross Savings Activities

Gross Savings Variables	Activity
ΔWatts	Lumen Equivalency Method
ISR	General Population Survey (n=250)
HOU	Multistate HOU Model
WHF	RTF Space Interaction Calculator

Cadmus derived the annual savings algorithm from industry standard engineering practices, consistent with the methodology prescribed by the UMP for calculating residential lighting energy use and savings. Discussion follows of each equation component (ISR discussed above in the Step 2: Verification section).

Delta Watts

Delta watts represents the wattage difference between a baseline bulb and an equivalent CFL or LED. Cadmus determined baseline wattages using the 2013–2014 upstream lighting tracking data, which included CFL and LED sales data by SKU numbers and bulb types for the 5,690,342 bulbs sold through the program.

The lumen equivalency method produces delta watts for a given lamp by first determining the lamp's lumen output and type. Each lamp type corresponds with a set of lumen bins, and each bin corresponds to an assumed baseline wattage. Delta watts is the difference between this baseline wattage and the bulb's efficient wattage. Whenever possible, Cadmus estimated each lamp's lumens output and efficient wattage by mapping it to the ENERGY STAR database. When this was not possible, Cadmus used the database values for lumens and/or efficient wattage. And finally, when even that was not possible, Cadmus interpolated lumen output from efficient wattage, based on a best-fit line derived from the ENERGY STAR database.

In the 2011–2012 HES program evaluation, Cadmus used the three lamp types defined by the UMP:

1. Standard
2. EISA-exempt
3. Reflector

The UMP was updated in February 2015, and now defines five lamp types:

1. Standard
2. Decorative
3. Globe
4. EISA-exempt (typically three-way and certain globe lamps)
5. Reflector

Cadmus used the latest methodology available in the UMP to evaluate delta watts. Table 24 shows the reported quantities for the five lamp categories.

Table 24. 2013 and 2014 CFL and LED Database Quantities by Bulb Types

Bulb Type	2013 Quantity	2013 %	2014 Quantity	2014 %	Overall Quantity	Overall %
Standard	2,393,493	72.4%	1,747,211	73.2%	4,140,704	72.8%
Decorative	41,431	1.3%	97,345	4.1%	138,776	2.4%
Globe	214,820	6.5%	201,111	8.4%	415,931	7.3%
EISA-Exempt	1,430	0.0%	634	0.0%	2,064	0.0%
Reflectors	652,489	19.8%	340,378	14.3%	992,867	17.4%
Total	**3,303,663**		**2,386,679**		**5,690,342**	

Several federal baseline changes took effect in 2013 and 2014 due to the Energy Independence Security Act of 2007 (EISA). Table 25 presents the baseline wattage and estimated efficient wattage, grouped by lumen bin for standard bulbs as an example to show how baseline wattages changed. Starting in 2013, the standard 100 W bulb baseline declined to 72 W, and the 75 W baseline declined to 53 W. Similarly, starting in 2014, the 60 W baseline declined to 43 W, and the 40 W baseline declined to 29 W.

Table 25. Lumen Bins for Standard Lamps and Lamp Quantities

Lumen Bin	2012 Baseline Wattage*	2013 Baseline Wattage	2013 Reported Lamp Quantity	2014 Baseline Wattage	2014 Reported Lamp Quantity
0–309	25	25	0	25	0
310–449	25	25	0	25	0
450–799	40	40	97,057	29	144,645
800–1,099	60	60	1,564,218	43	1,179,750
1,100–1,599	75	53	269,168	53	79,516
1,600–1,999	100	72	463,050	72	343,300
2,000–2,600	100	72	0	72	0

*2012 baseline wattages are shown for comparison only, and were not used in the evaluation

Appendix B provides lumen bins[8] and quantities for the remaining bulb types, including a plot of baseline wattage vs. lumen output for various bulb types. Overall, for a given lumen output, standard lamps possess a lower baseline wattage than reflectors, globes, or EISA-exempt lamps.

ENERGY STAR Qualified Product List Analysis

Cadmus primarily analyzed the ENERGY STAR-qualified lamps to estimate lumen outputs of bulbs that could not be matched directly to the qualified list by SKU number (6% of CFLs and 7% of LEDs did not match the ENERGY STAR database). Secondarily, Cadmus sought to develop the list of estimated CFL and LED wattages associated with each lumen bin provided in Table 25.

To determine a relationship between CFL and LED wattages and lumen outputs, Cadmus used the ENERGY STAR-qualified bulb product list updated on October 5, 2015.[9] The database consisted of approximately 7,900 CFL products and 11,500 LED products, along with their associated wattages and lumens. The lumen outputs for a given lamp wattage varied significantly; for example, 266 CFL products rated for 20 watts had lumen outputs ranging from 850 to 1,500.

Cadmus addressed these variations by using median lumens to create the relationship shown in Figure 2; the figure's calculated trend line shows a strong linear relationship between the CFL wattage and lumen output. Cadmus used this linear relationship to determine the lumen output for the CFL lamps that did not have a model number matching the ENERGY STAR-qualified lamp product list.

[8] Though the UMP provides lumen bins for standard, decorative, globe, and EISA-exempt lamps, it defers to EISA requirements for the determination of lumen bins for reflector lamps. The Mid-Atlantic Technical Reference Manual (TRM) presents an analysis examining the requirements and defines lumen bins for six different reflector categories, depending on reflector type and diameter. http://www.neep.org/mid-atlantic-technical-reference-manual-v5

[9] The most recent ENERGY STAR-qualified bulb list can be downloaded from the ENERGY STAR webpage: http://www.energystar.gov/productfinder/product/certified-light-bulbs/results.

Figure 2. Median Lumens vs. CFL Wattage for ENERGY STAR-Qualified Standard CFLs

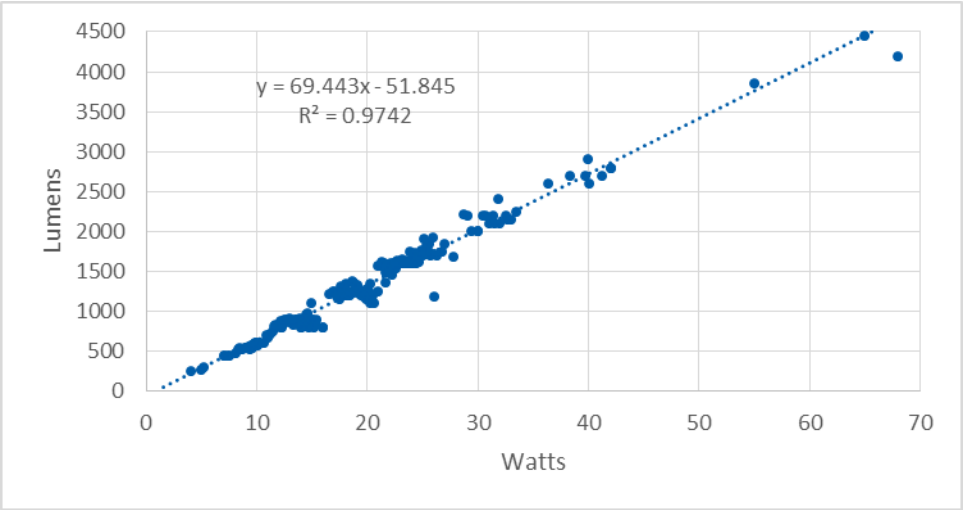
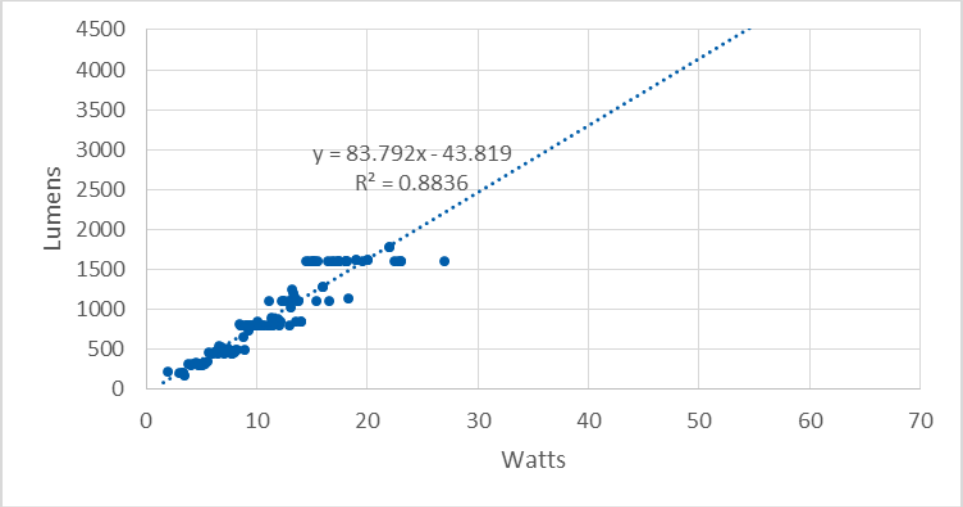


Figure 3 shows the same chart for LED standard lamps.

Figure 3. Median Lumens vs. LED Wattage for ENERGY STAR-Qualified Standard LEDs



In total, the upstream lighting analysis employed six linear best-fit lines such as those shown above: for LED and CFL standard, reflector, and specialty lamps. Generally, watts and lumens exhibited a stronger relationship for CFLs than for LEDs, as shown in the above figures. Cadmus created two additional trend lines from the ENERGY STAR database for CFL and LED fixtures. All trend lines employed are listed in Appendix B.

Hours of Use

For 2013–2014 lighting products, Cadmus calculated an average of 1.87 HOU for CFLs and 1.92 HOU for LEDs using analysis of covariance (ANCOVA) model coefficients, drawn from combined, multistate, multiyear data produced by two recent CFL HOU metering studies. This model expressed average HOU

as a function of room type. Appendix B provides a more detailed explanation of the impact methodology Cadmus used to estimate HOU as well as differences in the model between evaluations.

This method is consistent with those used in the 2009–2010 and 2011–2012 program year evaluations, though the metering studies from which the data were sourced have been updated. The data used for the 2011–2012 evaluation consisted of data for five states (Maryland, Michigan, Maine, Missouri, and Ohio) whereas the data for the current evaluation uses data from only two (Maryland and Missouri). The number of loggers included in the current data from just two states, however, is greater than the number from the five states used for the previous evaluation, which allowed Cadmus to use the states Missouri and Maryland, which are most latitudinally representative of Utah without sacrificing precision. Lastly, these two data sources included LEDs in the logger sample, which allowed testing for differences in HOU for LEDs and CFLs, whereas the prior data did not.

Table 26 compares the evaluations' HOU results.

Table 26. HOU by Evaluation Period

Evaluation Period	Evaluated HOU
2009–2010	2.48 hours
2011–2012	2.27 hours
2013–2014 CFLs	1.87 hours
2013–2014 LEDs	1.92 hours

The lower HOU values for 2013–2014 likely resulted from increased saturations of efficient bulbs. As the efficient lighting market matures and the saturation increases within the average home, efficient lamps become installed in lower-use sockets, whether in rooms with lower usage or in supplemental lighting (such as desk lamps).

Cadmus estimated the lighting distribution by room using response data from the general population surveys, as shown in Table 27. The reported proportion of bulbs installed in some room types changed markedly between evaluation cycles. The proportion of bulbs installed in living spaces roughly halved in 2013 and 2014 as compared to 2011-2012. Bedrooms also accounted for fewer installations. The "Other" category (e.g., closets, hallways, garages, dining, home office, and utility or storage rooms) exhibited a large increase. As many rooms types in the "Other" category include those with a lower average HOU, an increase in the proportion of bulbs installed in these room types lowers the overall average HOU.

Table 27. Survey-Reported CFL and LED Installation Locations*

Bulb Location	Percent of Total CFLs			Percent of Total LEDs
	2009-2010	2011-2012	2013-2014	2013-2014
Living Space	31%	28%	15%	17%
Bedroom	21%	32%	17%	16%
Kitchen	15%	11%	19%	19%
Bathroom	14%	12%	11%	9%
Outdoor	7%	5%	4%	8%
Basement	5%	5%	5%	4%
Other	7%	7%	29%	27%
Total**	**100%**	**100%**	**100%**	**100%**

*n=228 for the 2009 and 2010 program years; n=212 for the 2011 and 2012 program years; n = 250 for the 2013–2014 program years.

** Percentages may not total to 100% due to rounding.

Current estimated HOU remain consistent and very similar to HOU calculated by the RTF and a recent metering study for the Northwest Energy Efficiency Alliance (NEEA). The RTF workbook approved for 2014[10] provided an average HOU of 1.9; the current version 4 RTF workbook has a value of 2.04,[11] and the NEEA study found an average of 1.8.

Appendix B provides further details as well as a more detailed list of room installations.

Waste Heat Factor

A WHF adjustment made to energy savings accounts for the effects lighting measures have on the operation of heating and cooling equipment. Lower wattage bulbs produce less waste heat; consequently, their use requires more heating and less cooling to maintain a room's setpoint temperature.

For this evaluation, Cadmus used SEEM modeling (Simplified Energy Enthalpy Model)[12] results from the most recent RTF residential CFL and LED savings workbook to serve as a foundation for the analysis.[13]

Table 28 and Table 29 show the RTF SEEM results and evaluation weightings. Saturation weightings for heating and cooling derive from results of Rocky Mountain Power's surveys of its Utah residential

[10] RTF savings workbook for residential, screw-in, CFL and LED lamps: ResLightingCFLandLEDLamps_v3_3.xlsm

[11] Both RTF HOU numbers are weighted average HOUs (i.e., weighted by the number of total lamps provided in the RTF workbook for each category).

[12] SEEM is a building simulation model. The RTF calibrated the SEEM model for residential homes to provide the magnitude of interaction between the lighting and HVAC systems. Additional background information for SEEM may be found here: http://rtf.nwcouncil.org/measures/support/seem/

[13] RTF savings workbook for residential, screw-in, CFL and LED lamps: ResLighting_Bulbs_v4_0.xlsm

customers in 2013; cooling zone weightings derive from typical meteorological year (TMY3) weather data and census population data for Utah counties.

Table 28. WHF Heating Inputs Summary

WHF Component	Heating System Type	SEEM Results (kWh/kWh Saved)	Cadmus Saturation Weighting
Heating Impact	Electric Zonal	-0.440	1.5%
	Electric Forced Air	-0.479	7.2%
	Heat Pump	-0.258	0.9%
	Non-Electric	0.000	90.3%

* Percentages may not add to 100% due to rounding.

Table 29. WHF Cooling Inputs Summary

WHF Component	System Type	SEEM Results (kWh/kWh Saved)	Cadmus Zone Weighting*	Cadmus Saturation Weighting
Cooling Impact	Cooling Zone 1	0.033	0.6%	70%
	Cooling Zone 2	0.053	0.7%	
	Cooling Zone 3	0.074	98.5%	

* Percentages may not add to 100% due to rounding.

Calculating the weighted averages of values in Table 28 and Table 29 provided the impacts from heating and cooling of a bulb installed in a conditioned space, shown in Table 30. Summing the heating and cooling impacts produced an estimated combined impact of 0.008 kWh per kWh of lighting savings.

Table 30. WHF Weighted Average Impact, Conditioned Space

Component	kWh/kWh Savings*
Heating	-0.044
Cooling	0.051
Combined	**0.008**

* Table may not sum to total due to rounding

Cadmus also considered the location of bulbs to determine the appropriate WHF, accounting for bulbs not installed in conditioned spaces. As shown in Table 31, Cadmus applied bulb allocations by space type from the 2013-2014 Rocky Mountain Power general population survey data to thermal coupling factors from the RTF.

Table 31. Thermal Coupling by Space Type

Space Type	RTF Thermal Coupling Correction Factor	Bulb Allocation*
Basement	50%	4.3%
Main House	75%	89.6%
Outdoor	0%	6.0%
Weighted Average		**69%**

* Percentages may not add to 100% due to rounding.

Multiplying the combined impact from Table 30 with the weighted thermal coupling in Table 31 and adding 1 provided the final WHF shown in Table 32.

Table 32. Utah CFL and LED Bulb WHF, Average Installation Location

Fuel	Value	Units
Electric	1.005*	kWh/kWh Saved

*Final WHF value does not compute exactly from reported variables due to rounding.

Cross-Sector Sales

During the intercept surveys, Cadmus collected data on the intended installation locations of efficient bulbs purchased at retailer stores. Recent data collected in several jurisdictions around the country, reveal that many program bulbs are installed in commercial settings. Bulbs installed in commercial spaces produce more first-year savings than bulbs installed in a residential space because commercial locations typically have a higher daily use of bulbs than residential locations (i.e., higher HOU). Percentages of bulbs purchased from retail stores and installed in commercial buildings are called cross-sector sales.

Of all bulbs purchased at participating retailers, Cadmus estimated that 3.9% of efficient bulbs ultimately would be installed in commercial applications. Cadmus did not include this adjustment in the gross savings calculation. Other jurisdictions around the country have increasingly accommodated cross-sector sales factors in calculating lighting savings; such an adjustment would require an update to savings calculations from those presented in this report. Appendix B contains further details regarding cross-sector sales methodology and results.

CFL and LED Bulbs Total Savings

Table 33 shows reported savings inputs and input sources. Cadmus determined these inputs using assumptions provided by Rocky Mountain Power and information drawn from the tracking database. Reported values for ISR, HOU, and WHF were sourced directly from the assumption workbooks provided. Reported values for UES were calculated from the tracking database, and average values for delta watts were back-calculated from the reported savings using the ISR, HOU, and WHF assumptions from the UES workbooks provided.

Table 33. 2013-2014 Reported CFL and LED Bulb Savings Inputs

Bulb Type	Reported Inputs	2013	2014	Source
CFLs	Quantity	2,753,115	1,810,579	Database/Annual Report
	Total Gross Savings (kWh)	51,870,557	36,900,138	Database/Annual Report
	Average Unit Energy Savings (kWh/bulb)	18.8	20.4	Database/Annual Report
	Average Delta Watts*	38.2	35.2	Back-calculated
	ISR	71.6%	69.4%	2013: RTF + 2011-2012 Utah Residential Home Energy Savings Evaluation Report. 2014: 2011-2012 Utah Residential Home Energy Savings Evaluation Report
	HOU	1.88	2.27	2013: RTF. 2014: 2011-2012 Utah Residential Home Energy Savings Evaluation Report
	WHF	1.007	1.007	2011-2012 Utah Residential Home Energy Savings Evaluation Report
LEDs	Quantity	550,548	576,100	Database/Annual Report
	Total Savings (kWh)	23,305,041	18,257,931	Database/Annual Report
	Average Unit Energy Savings (kWh)	42.3	31.7	Database/Annual Report
	Average Delta Watts*	62.4	38.0	Back-calculated
	ISR	99.0%	100.0%	2013: RTF. ResLightingLED_v3.0 2014: RTF. ResSpecialtyLighting_v1.2
	HOU	1.864	2.27	2013: RTF. 2014: 2011-2012 Utah Residential Home Energy Savings Evaluation Report
	WHF	1.007	1.007	2011-2012 Utah Residential Home Energy Savings Evaluation Report

*Reported ΔW values back-calculated from average reported unit savings and reported ISR, HOU, and WHF.

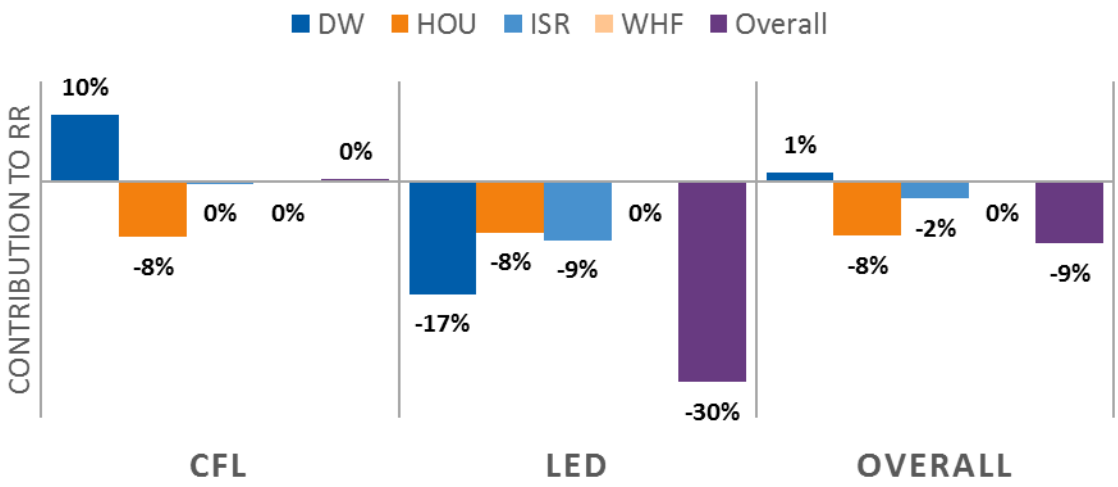
Table 34 shows evaluated savings inputs and input sources. The preceding section described the sources for these inputs.

Table 34. 2013–2014 Evaluated CFL and LED Bulb Savings Inputs

Bulb Type	Evaluated Inputs	2013	2014	Source
CFLs	Quantity	2,753,115	1,810,579	Upstream Lighting Tracking Database
	Total Savings (kWh)	59,395,170	29,804,091	Calculated
	Average Unit Energy Savings (kWh)	21.6	16.5	
	Average Delta Watts	44.7	34.1	Lumens equivalence method
	ISR	70.5%	70.5%	General Population Survey (n= 250)
	HOU	1.87	1.87	Cadmus HOU model
	WHF	1.005	1.005	RTF, updated for Utah
LEDs	Quantity	550,548	576,100	Upstream Lighting Tracking Database
	Total Savings (kWh)	16,667,536	12,535,802	Calculated
	Average Unit Energy Savings (kWh)	30.3	21.8	
	Average Delta Watts	47.4	34.1	Lumens equivalence method
	ISR	90.9%	90.9%	General Population Survey (n= 250)
	HOU	1.92	1.92	Cadmus HOU model
	WHF	1.005	1.005	RTF, updated for Utah

Figure 4 compares the impact of reported and evaluated inputs on savings shown in Table 33 and Table 34. Positive percentages indicate that an evaluated input was higher than a reported input, driving up the realization rate by that percentage due to that input. For example, the average evaluated delta watts for CFLs in 2013 and 2014 was 10% higher than the reported average. But because evaluated HOU was 8% lower than reported HOU, and the other variables had minor negative contributions, overall evaluated savings for CFLs were very close to the reported savings (realization rate = 100%). Overall, differences in delta watts and HOU produced the greatest disparity between reported and evaluated savings, although ISR makes notable contributions for LEDs.

Figure 4. 2013-2014 Impact of Calculation Parameters on Savings

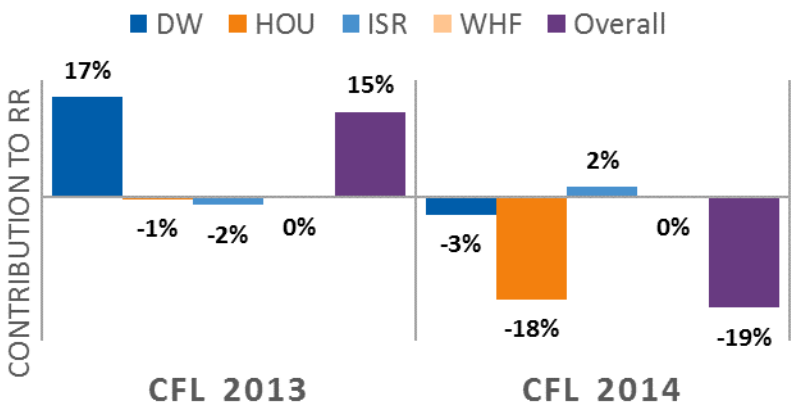


In 2013 for both LEDs and CFLs, a combination of RTF and 2011-2012 Cadmus values were used for HOU, ISR, WHF, and delta watts inputs. Notably in 2013, for most bulbs an RTF watts ratio (WR) of 3.6 or 4.0 was used to calculate baseline wattages (W_{base}) from bulb efficient wattages (W_{eff}) using the formula $W_{base} = WR * W_{eff}$. The resulting formula for delta watts is $\Delta W = W_{base} – W_{ee} = (W_{ee} * WR) – W_{ee} = (WR – 1) * W_{ee}$. However for standard bulbs ≥ 20 W, EISA-impacted baseline wattages were used, which reduced savings for these bulbs.

As a result, for CFLs in 2013 the average reported watts ratio was approximately 3.4. However for evaluated bulbs the average watts ratio was 3.8, meaning that average evaluated delta watts is 17% higher than average reported delta watts for 2013 CFLs. This is likely a result of several factors. A first likely factor is that the RTF bulb categorizations and binning practices are different from those of the evaluation. This may have affected savings in either direction, in this case likely in favor of higher evaluated delta watts. A second likely factor is that the RTF watt ratios come from residential bulb stock assessments conducted in 2013 and 2010. These assessments had higher average efficient wattages than the average efficient wattages of the 2013 HES upstream program, which reduces watt ratios derived from them.

Because the reported input values for HOU, ISR, and WHF closely matched their evaluated values, the difference in delta watts is responsible for the 2013 CFL realization rate. This can be seen in Figure 5. This figure also shows input contributions to the realization rate for CFLs in 2014. In 2014, PacifiCorp began reporting CFL savings for all wattages based on the lumen equivalency method, as recommended in the 2011-2012 program evaluation. As a result, reported delta watts numbers were quite close to evaluated numbers, and the primary driver for realization rate is the reported HOU value of 2.27, a legacy of the 2011-2012 evaluation.

Figure 5. Impact of Calculation Parameters on CFL Savings by 2013 and 2014



For LEDs in 2013, watt ratios and EISA baseline wattages are employed in much the same way as for 2013 CFLs, with two differences. First, bulb categories and binning are different. Second and more notably, while the same watt ratios of 3.6 and 4.0 are used, an LED baseline factor of 150% is applied to these which increases them to 5.4 and 6.0. As a result, the overall reported watt ratio for 2013 LEDs is approximately 6.3. However for evaluated 2013 LEDs the average watts ratio was 5.1, meaning that the average evaluated delta watts is 24% lower than average reported delta watts for 2013 LEDs. This discrepancy is largely driven by the aggressive LED baseline factor applied to the watt ratios for LEDs in 2013. The realization rate for LEDs in 2013 is driven down further by an 8% discrepancy in ISR.

For LEDs in 2014, realization rate is driven down by a similar discrepancy in ISR, a 16% difference in HOU, and a 10% difference in delta watts numbers. The 10% average difference for delta watts reflects several differences in baseline wattages for various bulb types. For instance, 99% of 2014 LED globe bulbs are 8 W bulbs. The reported assumption is that all such bulbs produce 483 lumens and have a baseline wattage of 40 W. However, Cadmus analyzed each bulb on a model basis, and found that they all produced 500 – 510 lumens, producing a baseline wattage of 43 W. In this case, reported delta watts was 32 W and evaluated delta watts was 35 W – a 9% reported under-prediction. Similar discrepancies exist for other bulb types, but they are all over-predictions, producing an average reported delta watts value that is 10% higher than evaluated delta watts.

Figure 6. Impact of Calculation Parameters on LED Savings by 2013 and 2014

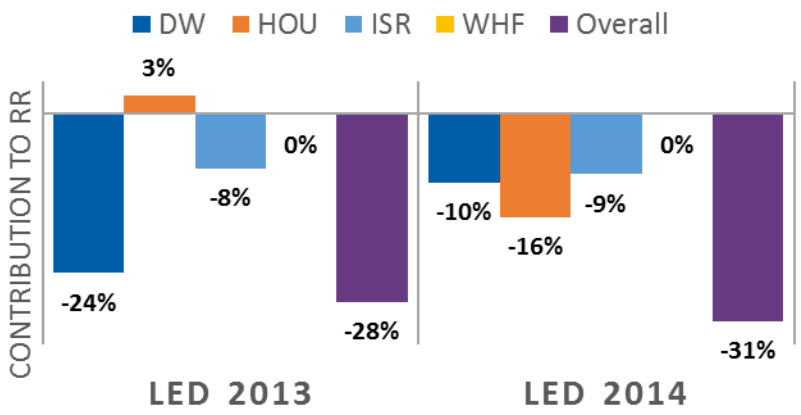


Table 35 provides evaluated CFL quantities, gross savings, and realization rates by bulb type. Overall, CFL and LED bulbs realized 91% of reported savings.

Table 35. 2013-2014 Evaluated and Reported HES Program CFL and LED Savings

Program Year	Technology	Quantity Purchased	Program Savings (kWh)		Average Unit Energy Savings (kWh)		Realization Rate
			Reported	Evaluated	Reported	Evaluated	
2013	CFL	2,753,115	51,870,557	59,395,170	18.84	21.57	115%
	LED	550,548	23,305,041	16,667,536	42.33	30.27	72%
2014	CFL	1,810,579	36,900,138	29,804,091	20.38	16.46	81%
	LED	576,100	18,257,931	12,535,802	31.69	21.76	69%
2013–2014	CFL	4,563,694	88,770,695	89,199,262	19.45	19.55	100%
	LED	1,126,648	41,562,972	29,203,338	36.89	25.92	70%
Total		**5,690,342**	**130,333,666**	**118,402,600**	**22.90**	**20.81**	**91%**

Light Fixtures

During the 2013–2014 program period, Rocky Mountain Power provided incentives for nearly 650,000 ENERGY STAR light fixtures, representing 11% of reported program savings.

Due to the ramp up of light fixture participation in 2014, Cadmus conducted a more granular evaluation of light fixtures in 2013-2014 than in the 2011-2012 program evaluation. In the 2011-2012 evaluation period, Cadmus used weighted averages based on model lookups to determine mean values for the efficient wattages and number of bulbs per fixture, and applied a weighted average CFL baseline wattage to all fixtures. These mean values were then applied across all fixtures to calculate delta watts. For 2013-2014, Cadmus grouped and analyzed savings for the fixtures within three categories:

1. Downlight fixtures
2. Fluorescent fixtures
3. Miscellaneous fixtures

These categories respectively contributed 94.9%, 0.7%, and 2.8% of program fixtures by quantity (with 1.6% unidentifiable). Generally, fixture savings calculations used the same methodology as that employed for light bulbs, though the three fixture types required slight variations in their energy savings calculations. Again, the general equation for lighting gross saving evaluation follows:

$$Evaluated\ Per\ Unit\ Savings\ (kWh\ per\ unit) = \frac{\Delta Watts * ISR * HOU * 365 * WHF}{1{,}000}$$

To calculate the various light fixture component inputs, Cadmus conducted the primary and secondary data collection activities shown in Table 36.

Table 36. Light Fixture Evaluated Gross Savings Activities and Results

Gross Savings Variables	Activity	Mean Value
ΔWatts	Downlights and Miscellaneous: Lumens Equivalence Fluorescents: RTF	41.4*
ISR	Non-Lighting Participant Survey	1.00
HOU	Multistate HOU Model	1.91*
WHF	RTF Space Interaction Calculator	1.005

* Weighted average for all fixtures

Cadmus applied the same HOU and WHF as used in the CFL and LED bulb analysis, and generated an ISR (100%) from the non-lighting participant surveys. For delta watts, Cadmus conducted a lumens equivalence approach whenever possible (and when appropriate for the fixture type). A detailed discussion of the delta watts calculation follows for each fixture category.

Downlight Fixtures

Figure 7 provides an example of a downlight fixture. These fixtures are designed to be installed into recessed ceiling or "can" light receptacles (intended to accept reflector lamps). Therefore, this fixture type differs from other fixtures in that each purchase replaces a particular lamp, meriting the application of the lumens equivalence method to calculate delta watts.

Figure 7. Example of a Donwlight Fixture

The types of lamps typically replaced by LED downlight fixtures must be determined in order to calculate baseline wattages for LED downlights. While recessed ceiling fixtures are typically designed to accommodate reflector lamps that point light down to maximize the light output, sometimes other lamp types may be installed. Using data compiled from household lighting inventories conducted in four other jurisdictions across the United States, Cadmus calculated a weighted baseline wattage for LED downlight fixtures that accounts for the mix of bulb types typically installed in recessed ceiling receptacles.

To do this, Cadmus first calculated an average set of reflector lumen bins and baseline wattages that account for the six different types of reflector lamps. The lumen bins and baseline wattages for each reflector type were weighted by their quantities in the upstream lighting database, which is the closest source of granular sales data available.

This set of average reflector baseline wattages and lumen bins was then combined with the lumen bins and baseline wattages for other lamp types, weighted by saturation of bulb types typically installed in recessed ceiling receptacles as determined by the four lighting inventories. The inventories collected data on the type of bulb installed in every fixture in over 200 homes. Using this data, Cadmus determined saturation levels of various lamp types typically installed in recessed ceiling receptacles. Results are presented in Table 37, showing that 85.6% of lamps installed in ceiling receptacles were reflector lamps and 13.5% were standard lamps, with the other categories comprising the rest. These saturation values were used to create an average set of lumen bins and baseline wattages for recessed ceiling receptacles, for both 2013 and 2014. Plots of the weighted reflector and final recessed can lumen bins and baseline wattages can be seen in Appendix B. Like reflector baseline wattages in general, the recessed can baseline wattage values are generally higher than those for standard lamps.

Table 37. Lamp Type Saturation in Recessed Ceiling Receptacles

Lamp Type	Southwestern Utility	Central Utility	Midwest Utility	Mid-Atlantic Utility	Combined
Standard	11.70%	17.60%	13.20%	12.70%	13.52%
Globe	0.60%	0.50%	0.00%	0.90%	0.60%
Reflector	87.70%	81.90%	86.00%	86.00%	85.57%
Decorative	0.00%	0.00%	0.30%	0.40%	0.22%
EISA-Exempt	0.00%	0.00%	0.50%	0.00%	0.09%
Total Bulbs	**473**	**431**	**393**	**928**	**2225**
Total Households	**38**	**46**	**68**	**65**	**217**

Fluorescent Fixtures

The lumens equivalency method cannot be applied to fluorescent lamps (0.7% of fixtures). Instead, a single delta watts value was applied for all fluorescent lamps in the database. While the database includes some circline and other types of fluorescent lights, the majority (> 80%) of fluorescent lamps are two-lamp T8 fluorescents.

Cadmus applied the delta watts value from the RTF for fluorescent fixtures. The High-Performance T8 Lamps Workbook[14] (Version 1.1) provides a delta watts value of 42 W for 4-foot, two-lamp T8 fixtures installed in kitchens and 43 W value for the same fixtures installed in garages. As the installation locations for these fixtures remains unknown, Cadmus applied a 42.5 delta watts value for all fluorescent lamp fixtures in the database. Cadmus applied CFL values for HOU and WHF.

Miscellaneous Fixtures

Just under 3% of fixtures sold could not be classified as downlights or fluorescent lights (e.g., single- and multi-bulb sconce lights, motion sensors, track lighting). Roughly one third were single-lamp CFL fixtures, one third were two-lamp CFL fixtures, and one third were LED fixtures of various types. Cadmus applied the lumens equivalence approach to evaluate these fixtures.

Unknown Fixtures

The database included 1.6% of fixtures falling within unknown categories. Of these, 94% had no model numbers in the database. The remainder could not be matched to the ENERGY STAR database. Consequently, Cadmus applied the weighted average UES for the downlight, fluorescent, and miscellaneous fixture categories.

Lighting Fixture Findings

In 2013–2014, the HES program provided incentives for 646,893 light fixtures. Table 38 provides lamp quantities, savings, and realization rates by fixture type for 2013–2014.

[14] http://rtf.nwcouncil.org/measures/res/ResLightingHPT8Lamps_v1_1.xlsm

Table 38. 2013–2014 Light Fixture Quantity and Gross Savings

Fixture Category	CFL/LED	Quantity	Reported Savings	Evaluated Savings	Realization Rate
Downlight	LED	613,485	17,302,490	17,969,417	104%
	CFL	236	11,847	6,293	53%
Fluorescent	n/a	4,503	221,941	131,062	59%
Miscellaneous	LED	12,581	355,508	265,187	75%
	CFL	5,456	273,335	131,497	48%
Unknown	n/a	10,632	331,973	307,651	93%
Total		**646,893**	**18,497,095**	**18,811,108**	**102%**

* Savings may not sum exactly to totals due to rounding.

The overall realization rate of 102% is heavily driven by the realization rate for downlights (104%) which have high delta watts values. However realization rates for other fixture types are lower, ranging from 48% to 75%.

Clothes Washers

Cadmus estimated clothes washer energy savings using the same approach outlined in the ENERGY STAR calculator from April 2013, which compared the modified energy factor (MEF) of an efficient unit to the MEF of a unit meeting the federal standard. The evaluation divided savings among the three possible end uses—clothes washer machines, dryers, and water heating—and adjusted the savings based on program-specific data from our survey, such as the number of loads washed per year and the percent of loads dried in a dryer. This presented the most appropriate approach as it drew upon the federal standard that was effective from 2011–2015 and, whenever possible, incorporated program-specific information from the tracking database and participant surveys.

The evaluation estimated an average gross evaluated savings value of 301 kWh per unit, yielding a 282% realization rate for 2013–2014. Two factors primarily drove the high realization rate:

1. Reported savings were consistent with the RTF values, which had been calculated using a current practice baseline, not a federal standard baseline (thus tending to decrease savings because the current practice baseline was more efficient than the federal standard).
2. Savings typically were underreported for the highest-efficiency clothes washers. Many incented units falling into the highest energy efficiency levels (MEF $\geq$ 3.2) were assigned the same savings values as less-efficient units. For example, 103 units with MEF of 3.45 received the same reported savings as units with an MEF as low as 2.6, despite the significant improvements in expected performance.

Using the following equations, Cadmus compared the energy consumption of efficient ENERGY STAR clothes washers to a model that met the minimum federal standard concurrently with the program (2013–2014):

$$kWh_{sav\ total} = kWh_{sav\ dryer} + kWh_{sav\ HW} + kWh_{sav\ mach}$$

$$kWh_{sav\ dryer} = \left[\left(\frac{1}{MEF_{base}} - \frac{1}{MEF_{ES}}\right) \times Loads_{act} \times Cap - kWh_{sav\ HW} - kWh_{sav\ mach}\right] \times (\%Dry)$$

$$kWh_{sav\ HW} = (Ref\ Energy_{base} - Ref\ Energy_{ES}) \times (\%WH) \times \left(\frac{Loads_{act}}{Loads_{ref}}\right)$$

$$kWh_{sav\ mach} = (Ref\ Energy_{base} - Ref\ Energy_{ES}) \times (1 - \%WH) \times \left(\frac{Loads_{act}}{Loads_{ref}}\right)$$

Table 39 defines the variables in the equations above and, when applicable, provides values and sources.

Table 39. Clothes Washer Key Variables and Assumptions

Parameter	Definition	Value	Unit	Source
$kWh_{sav\ total}$	Total energy savings	Varied	$\frac{kWh}{year}$	Calculated
$kWh_{sav\ dryer}$	Total dryer energy savings	Varied	$\frac{kWh}{year}$	Calculated
$kWh_{sav\ HW}$	Total hot water energy savings	Varied	$\frac{kWh}{year}$	Calculated
$kWh_{sav\ mach}$	Total machine energy savings	Varied	$\frac{kWh}{year}$	Calculated
MEF_{base}	Modified energy factor of baseline unit	1.26	$\frac{ft^3 * load}{kWh}$	Federal Standard (as of 2011)
MEF_{ES}	Modified energy factor of ENERGY STAR unit	Varied	$\frac{ft^3 * load}{kWh}$	Tracking Data
$Loads_{act}$	Loads per year	307*	$\frac{loads}{year}$	Utah 2013–2014 non-lighting participant survey
Cap	Clothes washer capacity	3.9	ft^3	Tracking Data (Model # lookup of 95% of installed washers)
$\%Dry$	Percent of loads dried in the dryer	85%**	%	Utah 2013–2014 non-lighting participant survey
$Ref\ Energy_{base}$	Reference rated energy consumption of baseline unit	417	$\frac{kWh}{year}$	ENERGY STAR Appliance Calculator (April 2013)
$Ref\ Energy_{ES}$	Reference rated energy consumption of ENERGY STAR unit	186	$\frac{kWh}{year}$	ENERGY STAR Appliance Calculator (April 2013)
$\%WH$	Percent of rated electricity consumption used for water heating	80%	%	ENERGY STAR Appliance Calculator (April 2013)
$Loads_{ref}$	Reference loads per year	392	$\frac{loads}{year}$	ENERGY STAR Appliance Calculator (April 2013)

*The number of loads per year used in the 2011-2012 Utah HES Program Evaluation was 286.

**The percent of loads dried in the dryer used in the 2011-2012 Utah HES Program Evaluation was 81%.

Cadmus identified four clothes washer efficiency levels, based on measure names and the rated MEF provided in the program tracking database. The evaluation estimated savings for each efficiency level by estimating savings for each combination of domestic hot water (DHW) fuel, dryer fuel, and average MEF for each level. If the DHW or dryer fuel was not electrically powered (e.g., natural gas or propane), Cadmus set those savings components—respectively, $kWh_{sav\ HW}$ and $kWh_{sav\ dryer}$—equal to zero.

Table 40 shows the quantity of units incented, reported and evaluated savings, realization rates, and percentages of reported savings for each combination of DHW and dryer fuel at each efficiency level during 2013 and 2014.

Table 40. Clothes Washer Savings by Performance Level and DWH/Dryer Fuel

Efficiency Level	MEF Low	MEF High	DHW Fuel	Dryer Fuel	Quantity		Reported Unit Energy Savings		Evaluated Unit Energy Savings		Realization Rate*		Percent of Reported Savings*	
					2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Level 1**	2.0	2.19	Electric	Electric	2	0	112	n/a	337	n/a	300%	n/a	0%	0%
			Electric	Other	0	0	n/a	n/a	n/a	n/a	n/a	n/a	0%	0%
			Other	Electric	0	0	n/a	n/a	n/a	n/a	n/a	n/a	0%	0%
			Other	Other	0	0	n/a	n/a	n/a	n/a	n/a	n/a	0%	0%
Level 2	2.2	2.59	Electric	Electric	214	271	141	140	425	425	301%	304%	3%	4%
			Electric	Other	13	13	69	69	181	181	263%	263%	0%	0%
			Other	Electric	1,144	1,271	73	73	280	280	384%	384%	9%	10%
			Other	Other	237	317	1	1	36	36	2426%	2426%	0%	0%
Level 3	2.6	3.19	Electric	Electric	501	349	223	225	481	481	215%	214%	13%	8%
			Electric	Other	35	25	99	101	181	181	183%	179%	0%	0%
			Other	Electric	2,943	2,150	128	128	337	337	263%	263%	43%	30%
			Other	Other	761	558	4	4	36	36	861%	861%	0%	0%
Level 4	3.2	n/a	Electric	Electric	221	487	224	225	522	522	233%	232%	6%	12%
			Electric	Other	17	33	97	101	181	181	187%	179%	0%	0%
			Other	Electric	1,695	2,516	128	128	377	377	295%	295%	25%	35%
			Other	Other	458	703	4	4	36	36	861%	854%	0%	0%
All Levels	2.0	n/a	Electric	Electric	938	1,107	205	205	478	477	233%	232%	22%	24%
			Electric	Other	65	71	92	95	181	181	196%	191%	1%	1%
			Other	Electric	5,782	5,937	117	117	337	337	288%	288%	77%	74%
			Other	Other	1,456	1,578	4	4	36	36	962%	959%	1%	1%
Weighted Average* **					**8,241**	**8,693**	**107**	**107**	**299**	**303**	**280%**	**284%**	**100%**	**100%**

*Realization rates may not calculate exactly due to rounding of evaluated UES values. Percent of reported savings may not add to 100% due to rounding.

**Two level 1 clothes washer applications were approved in late 2012, and fell into the 2013–2014 program accounting period. Clothes washers at the level 1 level (MEF 2.0-2.19) were not eligible in the 2013–2014 program period.

**"Quantity" and "Percent of Report Savings" values are summations, not average values.

As shown in Table 40, a clothes washer, paired with a non-electric dryer and a non-electric water heater, offer lower savings than units with an electric dryer and/or water heater. Rocky Mountain Power allowed this measure's installation as the Company considered it: "extremely rare and as such has minimal impact on the measure's cost-effectiveness."[15] In 2013 and 2014, however, units combining natural gas dryers and water heaters accounted for 18% of all incented units (source: tracking database). Although the savings are low for units with non-electric dryers and water heaters, instituting fuel eligibility requirements could lead to logistical burdens and inaccurate self-reporting if customers are aware that their eligibility depends upon and electric dryer and/or water heater.

Table 41 shows the percent of units installed in 2013 and 2014 at each performance level.

Table 41. Clothes Washer Performance Level by Year

Efficiency Level	Percent of Units		Source
	2013	2014	
Level 1—Least Efficient	0%	0%	UT 2013–2014 Non-Lighting Tracking Database
Level 2	20%	22%	UT 2013–2014 Non-Lighting Tracking Database
Level 3	51%	35%	UT 2013–2014 Non-Lighting Tracking Database
Level 4—Most Efficient	29%	43%	UT 2013–2014 Non-Lighting Tracking Database

From 2013 to 2014, the percent of units incented in the highest efficiency level (Level 4) increased by 14%. Participating units became more efficient in 2014, while federal standards remained the same; so average savings per clothes washer increased from 2013 to 2014. In most cases, reported per-unit savings for Level 4 units equaled Level 3 units, despite the increase in efficiency (as shown in Table 40). Increasing the savings for these high-efficiency units increased the realization rate of evaluated savings.

Table 42 summarizes the percent of savings attributable to each of the three savings components associated with clothes washers: dryers, DWHs, and the machines themselves.

Table 42. Clothes Washer Savings by System Component

Source of Clothes Washer Savings	Percent of Savings*			
	Level 1	Level 2	Level 3	Level 4
Dryer	46%	57%	62%	65%
DHW	43%	34%	30%	28%
Clothes Washer	11%	9%	8%	7%

*Calculated using the equations above and the parameters listed in Table 39.

Reduced dryer load produces the largest energy savings component, with its share of savings increasing as the units become more efficient.

[15] Public Service Commission of Utah, Advice No. 14-07. *Proposed Changes to Schedule 111 Home Energy Saving Incentive Program.* July 9, 2014. Page 6.

Table 43 shows the percent of units installed in homes with electrically heated DHW and dryers.

Table 43. Clothes Washer Percent of Electric DHW and Dryer Fuel

Input Categories		2013–2014 Saturation of Fuel Types	2011–2012 Saturation of Fuel Types	Source
DHW Fuel	Electric	12.9%	99.2%*	UT 2011–2012 and 2013–2014 Non-Lighting Tracking Databases
	Other	87.1%	0.8%	
Dryer Fuel	Electric	81.3%	91.2%	
	Other	18.7%	8.8%	

*In 2011 and 2012, applicants were required to have an electric hot water heater in order to receive a clothes washer incentive until the requirement was removed in November 2012.

Only 12.9% of the clothes washers incented from 2013-2014 were installed in homes that had electric hot water heaters. This is a significant decrease from the previous evaluation period (2011-2012), during which time electric DHW was a requirement of the program. The electric dryer fuel saturation also decreased since the 2011–2012 program period, from 91.2% to 81.3%. The decrease in electric DHW and dryer fuel saturations reduced the average per unit savings, but increased the total savings by broadening the eligibility requirements for clothes washers incented through this program.

Gas Furnace ECM

Cadmus estimated evaluated gross savings for furnace ECMs, based on metered data collected in 2013 for an ECM study in Wisconsin and Utah weather data.[16] This study provided the best available estimate of savings for this technology. No other comparable metering study exists within the PacifiCorp regions.

The 2013 Wisconsin study involved collecting fan use data over a two-year period from 67 single-family homes. Cadmus calculated gross electric savings for gas furnaces with ECMs within Rocky Mountain Power's territory by applying a linear ratio adjustment, using typical heating degree days (HDDs) and cooling degree days (CDDs) in Wisconsin and Utah.

Cadmus used the following equations to estimate savings:

$$kWh_{savings\ total} = kWh_{savings\ cool} + kWh_{savings\ heat} + kWh_{savings\ circ}$$

$$kWh_{savings\ cool} = tons \times EFLH_{cooling} \times 12 \times \left(\frac{1}{SEER_{base}} - \frac{1}{SEER_{ECM}}\right) \times \%AC$$

$$kWh_{savings\ heat} = hours_{heat} \times \Delta kW_{heat}$$

[16] Cadmus. *Focus on Energy Evaluated Deemed Savings Changes*. Prepared for the Public Service Commission of Wisconsin. November 14, 2014. Available online: https://focusonenergy.com/sites/default/files/FoE_Deemed_WriteUp%20CY14%20Final.pdf.

$$kWh_{savings\ circ} = hours_{circ} \times \Delta kW_{circ}$$

Table 44 outlines the values used in the above equations, the sources for these values, and the resulting energy savings.

Table 44. ECM Assumptions and Calculated Savings

Parameter	Definition	Value	Unit	Source
$tons$	Air conditioner capacity	2.425	$tons$	Focus on Energy Evaluation, Residential Programs: CY09 Deemed Savings Review. March 26, 2010
$EFLH_{cooling}$	Effective full load cooling hours	926	$hours$	Cadmus Wisconsin 2013 metering study scaled using CDD ratios between Salt Lake City, UT, and average CDDs in Wisconsin*
12	Unit conversion	12	$\frac{kBtu}{ton}$	Constant
$SEER_{base}$	Baseline SEER	12	$\frac{kBtu}{kWh}$	2013 Cadmus Wisconsin ECM metering study
$SEER_{ECM}$	Efficient SEER	13	$\frac{kBtu}{kWh}$	2013 Cadmus Wisconsin ECM metering study
$\%AC$	Percentage of furnaces with air conditioning	95%	%	Utah 2013–2014 non-lighting participant survey.
$\boldsymbol{kWh_{savings\ cool}}$	**Cooling mode energy savings**	**164**	$\boldsymbol{\frac{kWh}{year}}$	**Calculated**
$hours_{heat}$	Hours of heating operation	880	$\frac{hours}{year}$	Cadmus metering study, scaled using HDD ratios between Salt Lake City, UT, and average HDDs in Wisconsin*
ΔkW_{heat}	Power savings in heating	0.116	kW	2013 Cadmus Wisconsin ECM metering study
$\boldsymbol{kWh_{savings\ heat}}$	**Heating mode energy savings**	**102**	$\boldsymbol{\frac{kWh}{year}}$	**Calculated**
$hours_{circ}$	Hours of fan-only operation	1,020	$\frac{hours}{year}$	2013 Cadmus Wisconsin ECM metering study
ΔkW_{circ}	Power savings in fan-only mode	0.207	kW	2013 Cadmus Wisconsin ECM metering study
$\boldsymbol{kWh_{savings\ circ}}$	**Circulation mode energy savings**	**211**	$\boldsymbol{\frac{kWh}{year}}$	**Calculated**
$\boldsymbol{kWh_{savings\ total}}$	**Total Savings**	**477**	$\boldsymbol{\frac{kWh}{year}}$	**Calculated**

*Website for HDDs and CDDs: http://www.climate-zone.com/climate/united-states/

The 2013 Cadmus metering study used a baseline SEER of 12 rather than the federal standard baseline SEER of 13 as the study found: "many air conditioners were not replaced when the furnace was replaced and were installed before the minimum efficiency standard increased to 13 SEER."[17]

Attic, Wall, and Floor Insulation

Cadmus conducted billing analysis to assess actual net energy savings associated with insulation measure installations.[18] The analysis determined the savings estimate using a pooled, conditional savings analysis (CSA) regression model, which included the following groups:

- 2013–2014 insulation participants (combined attic, wall, and floor insulation); and
- Nonparticipant homes, serving as the comparison group.

Cadmus used program participants, a control group, billing consumption, and Utah weather data to create a final database for conducting the billing analysis. This required matching participant program data with billing data, and, using zip codes, mapping daily HDDs and CDDs to respective monthly read-date periods. The process defined the billing analysis pre-period as 2012 (before measure installations occurred) and the post-period as September 2014 through August 2015.[19]

To ensure the final model used complete pre- and post-participation and nonparticipant billing data, Cadmus applied several screening mechanisms (Appendix C provides further details).

Insulation Results

Cadmus estimated average insulation savings of 284 kWh per participant, translating to a 105% net realization rate for insulation measures. This analysis resulted in net (rather than gross) savings as it compared participant usage trends to a nonparticipant group, accounting for market conditions outside of the program.

With an average participant pre-usage of 12,690 kWh, savings represented a 2% reduction in total energy usage from insulation measures installed. Table 45 presents the overall net savings estimate for wall, floor, and attic insulation.

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[17] Cadmus. *Focus on Energy Evaluated Deemed Savings Changes*. Prepared for the Public Service Commission of Wisconsin. November 14, 2014. Available online: https://focusonenergy.com/sites/default/files/FoE_Deemed_WriteUp%20CY14%20Final.pdf.

[18] Billing analysis performed for customers installing only attic, wall, or floor insulation measures.

[19] As participants who installed measures in late 2014 had less than 10 months of post-period data, Cadmus removed them from the analysis. Similarly, Cadmus removed customers participating in 2013 with measure installation dates before November 2012 as this produced less than 10 months of pre-period data.

Table 45. Insulation Net Realization Rates

Model	Billing Analysis Participants (n)	Reported kWh Savings per Premise	Evaluated Net kWh Savings per Premise	Net Realization Rate	Relative Precision at 90% Confidence	90% Confidence Bounds
Overall	**6,928**	**271**	**284**	**105%**	**±10%**	**95%–116%**
Electric Heat	88	1,913	1,652	86%	±14%	74%–98%
Gas Heat	6,840	249	267	107%	±11%	95%–118%

* Overall model includes both electric and gas heat

Cadmus used only overall model results (which included both electric and gas heat) to determine measure-level net savings, but provided results by space heating fuel: electric and gas.

Duct Sealing and Insulation

Cadmus conducted billing analysis to assess the net energy savings associated with duct sealing and duct insulation measure installations.[20] The analysis determined the savings estimate using a pooled, CSA regression model, which included the following groups:

2013–2014 ductwork participants (combined duct sealing and duct insulation); and

Nonparticipant homes, serving as the comparison group.

Cadmus used program participants, a control group, billing consumption, and Utah weather data to create the final database to conduct the billing analysis. This required matching participant program data with billing data and, using zip codes, mapping daily HDDs and CDDs to respective monthly read-date periods. The process defined the billing analysis pre-period as 2012 (before measure installations occurred) and the post-period as September 2014 through August 2015.[21]

To ensure the final model used complete pre- and post-participation and nonparticipation billing data, Cadmus applied several screening mechanisms (Appendix C provides further details).

Duct Sealing and Insulation Results

Cadmus estimated average duct sealing and duct insulation savings of 344 kWh per home, translating to a 107% net realization rate for these measures. As with insulation results, this produced net (rather than gross) savings as it compared participant usage trends to a nonparticipant group, accounting for market conditions outside of the program.

[20] Billing analysis performed for customers installing only duct sealing and/or duct insulation measures.

[21] As participants installing measures in late 2014 had less than 10 months of post-period data, Cadmus removed them from the analysis. Similarly, Cadmus removed customers participating in 2013 and having measure installation dates before November 2012 as this produced less than 10 months of pre-period data.

With average participant pre-usage of 10,925 kWh, savings represented a 3% reduction in total energy usage from duct sealing and duct insulation measures installed. Table 46 presents the overall savings estimate for duct sealing and duct insulation.

Table 46. Ductwork Net Realization Rates

Model	Billing Analysis Participant (n)	Reported kWh Savings per Premise	Evaluated Net kWh Savings per Premise	Net Realization Rate	Relative Precision at 90% Confidence	90% Confidence Bounds
Overall	**753**	**323**	**344**	**107%**	**±23%**	**82%–131%**
Electric Heat	7	2,472	1,683	68%	±44%	38%–98%
Gas Heat	746	303	331	110%	±24%	84%–135%

* Overall model includes both electric and gas heat

Cadmus only used overall model results (electric and gas heat combined) to determine measure-level net savings, but provided results by space heating fuel: electric and non-electric. Overall, electrically heated homes achieved duct sealing and duct insulation savings of 1,683 kWh per home.

Central Air Conditioners and Evaporative Coolers

Cadmus conducted billing analyses to assess gross energy savings associated with high-efficiency air conditioners and evaporative coolers. The analysis required construction of three regression models (Appendix C provides further details on the regression model):

1. A central air conditioner and sizing and installation measures (SEER 15+) model[22]
2. An evaporative cooling model
3. A model of SEER 13 nonparticipant units (to serve as a baseline)[23]

Cadmus used program participants, billing consumption, Utah weather, and square footage data to create the final database for conducting the billing analysis, the results of which provided gross realization rates for central air conditioners and evaporative cooler equipment types across both years. This billing analysis resulted in gross savings (as opposed to the net savings that the billing analysis for ductwork and insulations estimated) due of the nature of the comparisons group used. The central air conditioner and evaporative cooler comparison group did not reflect the average market conditions as

[22] This model contained sizing + TXV (thermal expansion valve) and proper installation central air-conditioning measures. It calculated a realization rate applying to all of these measures.

[23] This assessment adopted a central assumption: participants would have installed a base-efficiency (13 SEER) unit had they not participated in the program. Given this, Cadmus used a control group composed of 2005 Cool Cash Program participants known to have received a 13 SEER air-conditioning unit—without sizing + TXV or proper installation incentives—as their primary cooling system. SEER 13 air-conditioning equipment represents the federal minimum efficiency level for residential central air conditioners manufactured after January 2006.

did the other billing analyses, because it consisted of a group of customers who purchased a SEER 13 model in a prior HES program year. As SEER 13 was the federal baseline during 2013 and 2014 (and was not a market baseline), the comparison yields a gross result.

Table 47 shows the regression model results.

Table 47. Cool Cash Billing Data Regression Results

Group	Consumption per CDD (kWh)	Annual Consumption Based on 1,391 Average CDD (kWh)	Evaluated Gross Savings (kWh)
SEER 13 (Baseline)	1.42	1,979	N/A
Evaporative Cooling	0.32	448	1,531
Central Air Conditioner	1.01	1,409	570

SEER 13 units' average consumption per CDD, estimated at 1.42 kWh, represented the baseline or consumption level occurring in the program's absence.[24] Cadmus used this baseline to estimate savings from each participating central air conditioner and evaporative cooler unit.

Central Air Conditioners and Evaporative Cooler Results

Table 48 presents overall gross savings estimates and realization rates for 2013–2014 cooling equipment.

Table 48. Cooling Equipment Gross Realization Rates

Measure	Billing Analysis Participants (n)	Reported kWh Savings per Premise	Evaluated Gross kWh Savings per Premise	Gross Realization Rate	Relative Precision at 90% Confidence	90% Confidence Bounds
Evaporative Coolers	1,252	1,495	1,531	102%	±10%	92%–113%
Central Air Conditioners	2,455	510	570	112%	±27%	81%–142%

Cadmus estimated overall evaporative cooler savings of 1,531 kWh per participant. Given the average evaporative cooler had expected savings of 1,495 kWh, this translated to a 102% gross realization rate.

Further, Cadmus estimated average central air conditioner savings of 570 kWh per unit. Given the average central air conditioner had expected savings of 510 kWh, this translated to a 112% gross realization rate.

[24] Cadmus considered SEER 13 as the baseline, given it was the federal minimum efficiency level for residential central air conditioners manufactured after January 2006 and could be assumed to represent the efficiency of cooling equipment purchased in the program's absence.

Evaluated Net Savings

Cadmus tailored the net savings adjustment analysis to each measure and measure category, and developed net-to-gross (NTG) analysis methods prioritized by the highest saving measures. For CFLs and LEDs bulbs, Cadmus conducted demand elasticity modeling, which estimated freeridership by modeling the elasticity of a discounted bulb's price. For non-lighting measure categories, Cadmus conducted freeridership and participant spillover analysis using responses from the non-lighting survey.

Further, Cadmus included a spillover battery in the general population survey to estimate nonparticipant spillover, consisting of savings generated by customers motivated by the program's reputation and marketing to conduct energy efficiency installations that did not receive an incentive. The analysis did not apply nonparticipant spillover to program savings for this period, however, it was calculated for informational purposes at 1% of total HES program savings. Appendix E provides detailed nonparticipant spillover analysis methods and results.

Table 49 provides the net savings evaluation results: evaluated gross savings, evaluated net savings, and NTG by measure type, as well as the NTG methodology utilized.

Table 49. HES Program NTG Methods and Results for 2013–2014

Measure Category	Measure Name	Program Savings (kWh)		NTG	NTG Methodology
		Evaluated Gross	Evaluated Net		
Appliance	Ceiling Fan	6,201	5,023	81%	Self-Response NTG
	Clothes Washer	5,098,515	4,129,797		
	Dishwasher	301,388	244,124		
	Electric Water Heater	2,398	1,942		
	Freezer	944	765		
	Light Fixture	18,811,108	15,236,997		
	Portable Evaporative Cooler	131,026	106,131		
	Refrigerator	139,953	113,362		
	Room Air Conditioner	70,722	57,285		
HVAC	Central Air Conditioner Best Practice Installation	296,228	207,359	70%	Self-Response NTG
	Central Air Conditioner Equipment	1,328,888	930,222		
	Central Air Conditioner Proper Sizing	534,264	373,985		
	Evaporative Cooler—Permanently Installed	354,946	248,462		
	Evaporative Cooler—Premium	3,038,862	2,127,203		
	Evaporative Cooler—Premium Ducted	66,512	46,558		

Measure Category	Measure Name	Program Savings (kWh)		NTG	NTG Methodology
		Evaluated Gross	Evaluated Net		
	Evaporative Cooler—Replacement	878,349	614,844		
	Gas Furnace	1,344,644	941,251		
	Heat Pump Water Heater	881	617		
	Duct Sealing and Insulation	5,645,973	5,645,973	100%	No Adjustments*
Lighting	CFL Bulbs	89,199,262	53,222,566	60%	Demand Elasticity Modeling
	LED Bulbs	29,203,338	19,241,275	66%	Demand Elasticity Modeling
Weatherization	Attic Insulation	6,590,506	6,590,506	100%	No Adjustments*
	Floor Insulation	13,214	13,214		
	Wall Insulation	650,940	650,940		
	Windows	478,242	392,158	82%	Self-Response NTG
Total		**164,187,303**	**111,142,560**	**68%**	

*No net adjustments applied to insulation and ductwork measures as the billing analysis conducted to generate net savings produced a net result.

The following sections outline the NTG methodology used and the detailed results for lighting and non-lighting.

Lighting Evaluated Net Savings

To estimate HES program freeridership for CFLs and LEDs, Cadmus performed demand elasticity modeling using information from the tracking database (provided by the program administrator). Elasticity modeling provided a method for estimating net lighting savings, based on actual observed sales.

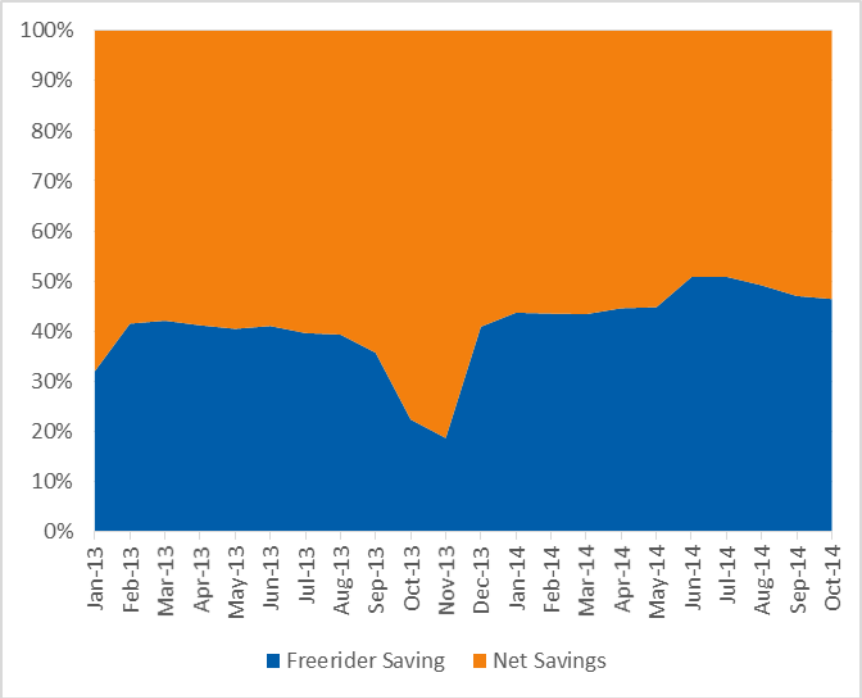
Using a demand elasticity model, Cadmus predicted bulb sales in the absence of program incentives. The analysis expressed sales as a function of price (including incentives), seasonality, retail channel, and bulb characteristics. The model then predicted the likely sales of CFLs and LEDs at the original retail prices. Appendix B outlines the equation for the elasticity model.

To complete the analysis, Cadmus used model coefficients to predict sales as though prices had remained at their original levels and promotional events had not taken place. Predicted sales at the incented program price and at the price-absent program incentives are then multiplied by the evaluated gross kWh savings per bulb.[25] The difference in savings between the hypothetical original price scenario

[25] Though statistical models over- or under-predict to some degree, predicted program sales should be close to actual sales using a representative model. Using predicted program sales rather than actual sales mitigates bias by comparing predicted program sales to predicted non-program sales.

and what actually occurred provided CFL and LED bulb savings attributable to the program, as shown in Figure 8.

Figure 8. CFL and LED Bulb Net Savings Attributable to Utah HES Program by Program Month



The ratio of these savings to predicted total program savings provided freeridership. Freerider sales (and therefore savings) remained relatively steady throughout both years, but the lowest freeridership rate occurred in late fall 2013. This rate largely resulted from a drop in CFL prices, particularly at club stores, which tend to exhibit the greatest responses to price changes, and sales of both CFLs and LEDs peaked at Club stores as new, multi-pack products were introduced. Table 50 shows the net savings results.

Table 50. Lighting Freeridership and NTG

Bulb Type	Freeridership	NTG*
CFLs	40%	60%
LEDs	34%	66%
All Bulbs**	**38%**	**62%**

* Some upstream lighting spillover was estimated from the intercept surveys at 0.4% but was not applied.
** The model results for all bulbs were not applied at this level. Individually modeled CFL and LED NTG rates were applied to determine net savings.

Overall, freerider savings were estimated at 38%, resulting in a 62% NTG (60% for CFLs and 66% for LEDs). Cadmus estimated higher freeridership rates for CFL bulbs than for LED bulbs due to lower observed price elasticities of demand for CFL bulbs. That is, sales did not increase as greatly as LEDs due to price reductions, indicating that sales of CFLs are less attributable to program activities than sales of LEDs.

As shown in Table 51, Cadmus also estimated freeridership by distribution channel. Upon predicting monthly savings for each individual bulb model, as described above, Cadmus aggregated the results by retail channel and bulb type. Taking the difference between predicted savings with the program and in the program's absence provides freeridership estimates by retail channels and bulb types.

Table 51. Per-Bulb Price and Freeridership by Retail Channel and Bulb Type

Retail Channel	Bulb Type	Average Original Price Per Bulb	Average Final Price Per Bulb	Markdown %	Freeridership
Non-Club Store	CFL	$ 2.56	$ 1.25	51%	56%
	LED	$ 15.37	$10.61	31%	77%
Club Store	CFL	$ 1.96	$ 0.67	66%	34%
	LED	$ 9.74	$ 4.99	49%	30%

Freeridership was lower at club stores than at non-club stores, both for LEDs and CFLs. This likely resulted from a number of factors:

- The price elasticities at club stores are greater than those at non-club stores, particularly for LEDs, which were more than twice the non-club store elasticities[26]. This suggests club store shoppers tend to be more sensitive to price changes, the same proportional markdown (i.e., the incentive as a share of the original price) led to a greater increase in sales at club stores compared to non-club stores.
- As shown in Table 51, incentive levels were higher at club stores than at non-club stores for both CFLs and LEDs. This contributed to average per-bulb prices at club stores roughly one-half of per-bulb prices at non-club stores.
- Club stores offer a different product mix compared to non-club stores, with club stores often only stocking a few options for the most commonly purchased products and not dedicating much shelf space to products with more limited uses.
- Big-box, non-club retailers, accounting for the majority of non-club store sales, tend to stock a wide assortment of products, some with limited, specialty applications. Demand for these products tends to be the least elastic, lowering average elasticities within a retail channel.

Appendix B provides a detailed report on the price response modeling methodology and results.

Freeridership Comparisons

Table 52 compares CFL freeridership estimates from several recent evaluations using the elasticity model approach. The table also shows the average, sales-weighted original retail price of program bulbs and the markdown as a percent of the original price, which is a significant driver of freeridership estimates.

[26] LED elasticities for general purpose bulbs were 1.706 at club stores compared to 0.743 at non-club stores. Full model details and detailed elasticity estimates are included in Appendix B.

The freeridership estimates for Rocky Mountain Power are within the range of those observed in other programs, however, they have increased since the 2011-2012 modeling effort. Part of the increase may be the maturation of the efficient lighting market. As CFLs become a more familiar and accepted technology, demand may become less elastic – that is, for those consumers who are willing to substitute CFLs for less efficient bulbs, their willingness to buy CFLs may have become less dependent on promotional activities over time. Some of this effect may be due to utility-sponsored programs, such as the Rocky Mountain Power program, as well factors such as improved lighting quality and customers realizing energy savings from switching to CFLs. And for those that are less inclined to substitute CFLs, their decision may remain the same regardless of price changes.

Saturation of CFLs could be another factor. Customers that responded to price drops in 2011 or 2012 and stocked up on CFLs may buy fewer bulbs in subsequent years if they still have previously purchased bulbs in storage.

Another potential factor could be the lack of merchandising data. Without data to explicitly control for sales lift due to merchandising in either evaluation, there is an unobserved variable influencing sales. Because the model is trying to explain variation in sales over time, the price elasticity estimates may absorb some of the impact of product merchandising to the degree that merchandising and price changes co-vary. That is to say, if prices decrease are observed and sales increase at the same time, but there are also promotions occurring at the same time but are unobserved, the model will attribute the change in sales to the price change because that is the variable that is observed.

Table 52. Comparisons of CFL Freeridership and Incentive Levels

Utility	Bulb Type	Average Original Price per bulb	Average Markdown per bulb	Markdown %	Freeridership
Rocky Mountain Power Utah 2011-2012	Standard	$2.18	$1.37	63%	17%
Mid-Atlantic Utility 1	Standard	$1.97	$1.41	72%	27%
Mid-Atlantic Utility 3	Standard	$2.10	$1.59	76%	27%
New England	Standard	$2.11	$1.00	47%	32%
Mid-Atlantic Utility 2	Standard	$2.14	$1.43	67%	35%
Mid-Atlantic Utility 4	Standard	$2.22	$1.46	66%	35%
Rocky Mountain Power Utah 2013-2014	**Standard**	**$2.21**	**$1.30**	**58%**	**40%**
Midwest Utility	Standard	$1.82	$1.13	62%	43%
Southeast	Standard	$2.15	$1.09	51%	48%

Table 53 shows LED freeridership estimates for four other recent evaluations. Additional details for markdown levels and prices are not provided because the retail and product mix varies considerably between evaluations, which is a major factor in the per-bulb prices. The Rocky Mountain Power Utah program is in the lower range of observed freeridership estimates.

Table 53. Comparison of LED Freeridership

Utility	Freeridership
Wisconsin (2015)	29%
Midwest (2014)	30%
Rocky Mountain Power Utah (2013-2014)	**34%**
South (2015)	48%
Mid-Atlantic (2014-2015)	48%

Upstream Lighting Spillover

Upstream participant lighting spillover was estimated from the intercept surveys at 0.4% (the Intercept Survey Spillover section outlines the methodology). That is, for every 1,000 kWh of evaluated gross savings, an additional 4 kWh of unreported savings may have occurred as a result of the program's operation. This value, however, was not applied due to the nature of sampling which was prioritized by the leakage study. The majority of stores that Cadmus visited were on the edges and outside of Rocky Mountain Power's service territory, and therefore the results did not represent the full picture of spillover occurring from the upstream lighting incentives, and likely provided a low estimate. Also, spillover proves particularly difficult to measure for upstream programs. As customers often remain unaware of their participation in the program, they generally cannot identify its influence on other purchasing decisions.

Non-Lighting Evaluated Net Savings

Cadmus relied on the non-lighting participant survey to determine non-lighting NTG for appliance, HVAC, and weatherization measure categories for 2013 and 2014 participants.

Freeridership and participant spillover constitute the NTG. Cadmus used the following formula to determine the final NTG ratio for each non-lighting program measure:

Net-to-gross ratio = (1 – Freeridership) + Spillover

Methodology

Cadmus determined the freeridership amount based on a previously developed approach for Rocky Mountain Power, which ascertained freeridership using patterns of responses to a series of survey questions. These questions—answered as "yes," "no," or "don't know"—asked whether participants would have installed the same equipment in the program's absence, at the same time, amount, and

efficiency. Question response patterns received freerider scores, and confidence and precision estimates were calculated based on score distributions.[27]

Cadmus determined participant spillover by estimating the savings amount derived from additional measures installed and whether respondents' credited Rocky Mountain Power with influencing their decisions to install additional measures. Cadmus included measures eligible for program incentives, provided the respondent did not request or receive the incentive.

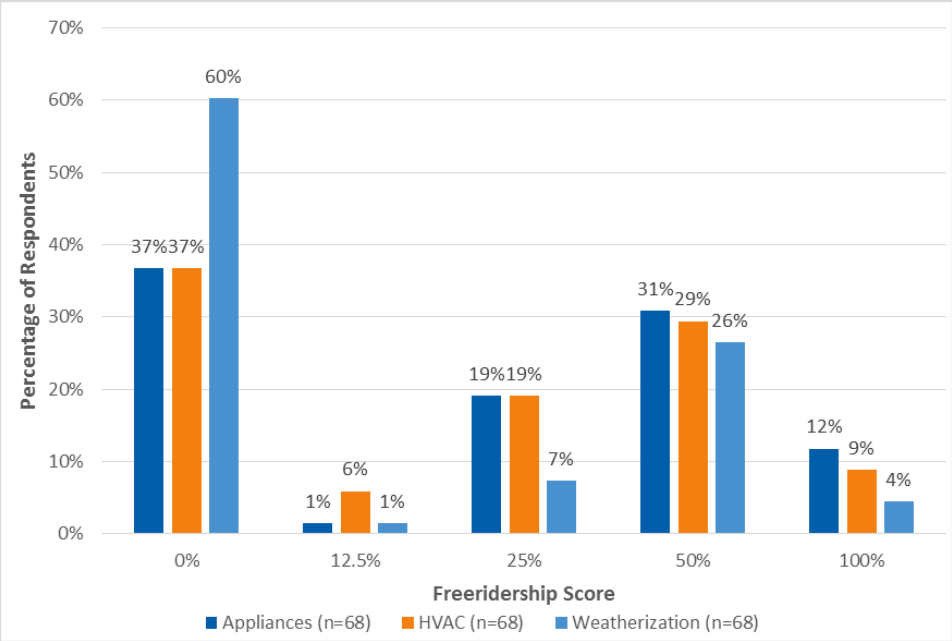
Cadmus then used freeridership and spillover results to calculate the program NTG ratio. Appendix D provides a detailed explanation of Cadmus' self-reported NTG methodology.

Freeridership

After conducting non-lighting participant surveys with appliance, HVAC, and weatherization participants, Cadmus converted the responses to six freeridership questions into a score for each participant, using the Excel-based matrix approach described in Appendix D. Cadmus then derived each participant's freerider score by translating their responses into a matrix value and applying a rules-based calculation.

Figure 9 shows freeridership score distributions for appliances, HVAC, and weatherization survey respondents.

Figure 9. Distribution of Freeridership Scores by Measure Category*



*Total may not sum to 100% due to rounding.

** This figure is not weighted by measure savings and does not reflect the final freeridership rates.

[27] This approach was outlined in: Schiller, Steven et al. "National Action Plan for Energy Efficiency." Model Energy Efficiency Program Impact Evaluation Guide. 2007. www.epa.gov/eeactionplan.

Approximately 37% of appliance and HVAC measure respondents and 60% of weatherization respondents indicated no freeridership. That is, they would not have purchased the efficient measure in the absence of Rocky Mountain Power's program. More appliance respondents indicated high freeridership (scores of 50-100%) than the other measure categories.

Spillover

This section presents the results from additional, energy-efficient measures customers installed after participating in the HES program. While many participants installed such measures after receiving incentives from Rocky Mountain Power, Cadmus only attributed program spillover to additional purchases significantly influenced by HES program participation and not claimed through the program. Only one respondent—an HVAC participant—fell into this category.

Cadmus used evaluated savings values from the deemed savings analysis to estimate spillover measure savings. This involved estimating the spillover percentage for the HVAC measure category by dividing the sum of the additional spillover savings by the total incentivized gross savings achieved by all 68 HVAC respondents. Table 54 shows the results.

Table 54. Non-Lighting Spillover Responses

Measure Category	Spillover Measure Installed	Quantity	Electric Savings (kWh)	Surveyed Measure Category Savings	Spillover Ratio
HVAC	Furnace	1	477	35,915	1%

Non-Lighting NTG Findings

Cadmus conducted 68 surveys with participants in each measure category (appliance, HVAC and weatherization) to generate NTG ratios ranging from 70% for HVAC measures to 82% for weatherization. Table 55 summarizes these findings.

Table 55. Non-Lighting NTG Ratio by Measure Category

Program Category	Responses (n)	Freeridership Ratio	Spillover Ratio	NTG	Absolute Precision at 90% Confidence
Appliances	68	19%	0%	81%	±6%
HVAC	68	31%	1%	70%	±9%
Weatherization	68	18%	0%	82%	±6%

*Weighted by evaluated program savings.

The NTG column indicates the percentage of gross savings attributable to the program. For example, participants purchasing an appliance measure received an 81% NTG, indicating that 81% of gross savings for appliance measures could be attributed to the HES program.

Table 56 shows freeridership, spillover, and NTG estimates for appliance and HVAC rebate programs reported for prior Rocky Mountain Power program years as well as for other utilities with similar programs and measure offerings.

Table 56. Non-Lighting NTG Comparisons*

Utility/Region	Reported Year	Responses (n)	FR** %	Spillover %	NTG
Appliances					
Rocky Mountain Power Utah 2013–2014 HES Evaluation: Appliances	**2016**	**68**	**19%**	**0%**	**81%**
Rocky Mountain Power Utah 2011–2012 HES Evaluation: Appliances	2013	247	42%	8%	66%
Northeast Utility—Appliances	2015	65	65%	3%	38%
Northwest Utility—Appliances	2014	73	79%	2%	23 %
HVAC					
Rocky Mountain Power Utah 2011–2012 HES Evaluation: HVAC	2013	64	11%	0%	89%
Rocky Mountain Power Utah 2013–2014 HES Evaluation: HVAC	**2016**	**68**	**31%**	**1%**	**70%**
Midwest Utility—HVAC	2015	73	51%	1%	50%
Northwest Utility—HVAC	2014	48	72%	1%	29%
Weatherization					
Rocky Mountain Power Utah 2013–2014 HES Evaluation: Weatherization	**2016**	**68**	**18%**	**0%**	**82%**
Midwest Utility—Weatherization	2015	208	30%	2%	72%
Midwest Utility—Weatherization	2015	79	36%	2%	66%

*NTG values derive from self-response surveys, though differences in analysis and scoring methodologies may vary across evaluations.

**Freeridership.

For the appliance measure category, fewer respondents in 2013–2014 reported already purchasing measures before learning of the program—the largest driver of the NTG increase compared with the 2011–2012 evaluation. Fewer appliance measure category respondents in 2013-2014 reported that they would have purchased a measure at the same efficiency level within one year without the HES program incentive compared to 2011-2012 respondents. These shifts in freeridership response patterns are key contributing factors to HES appliance freeridership rates decreasing since the prior evaluation.

Another contributing factor to the drop in appliance measure category freeridership since the 2011-2012 evaluation is that lighting fixture respondents represented 47% of total appliance measure category responses in the 2013–2014 analysis and lighting fixture respondents indicated an average 7% freeridership rate. In the 2011–2012 appliance measure category's freeridership analysis sample, lighting fixture respondents represented 28% of the appliance category analysis sample, with an average, estimated freeridership rate of 27%. All other appliance measure level freeridership estimates in the 2011–2012 and 2013–2014 evaluations were over 38%.

The 2013–2014 HVAC measure category exhibited a NTG estimate of 70%, which is higher than other utilities' comparable HVAC programs, but lower than the 89% estimate for 2011–2012 HVAC NTG. Comparing HVAC NTG ratios across evaluation years for HES proved challenging due to different measure categories in the participant sample. The 2011–2012 evaluation mostly included duct sealing and duct insulation respondents, while the 2013–2014 respondents received HES rebates for central air conditioners, evaporative coolers, furnaces, and room air conditioners measures. Compared to the 2011–2012 HVAC NTG estimate, the 2013–2014 HVAC NTG came closer to NTG estimates from other recent utility evaluations with similar HVAC program measure offerings.

In 2013–2014, the weatherization measure category's 82% NTG estimate was higher than for other utilities' comparable weatherization programs. The 2011–2012 Utah HES Evaluation did not include a weatherization NTG estimate.

Lighting Leakage Study

Cadmus conducted intercept surveys at stores in Utah, Idaho, and Washington which were designed to determine how many light bulbs purchased within PacifiCorp's territory had been installed outside of PacifiCorp's territory—generally referred to as leakage.[28] Cadmus also conducted intercept surveys at stores outside of PacifiCorp's territory to determine the percentage of those light bulbs installed within PacifiCorp's territory. Given the low number of surveys completed in Washington and Idaho, and that the RSAT algorithm is the same across states, Cadmus combined the results for all states to show key findings along with Utah-specific results.

The leakage study sought to test scores from PacifiCorp's RSAT, developed to determine the best stores for cost-effectively offering discounted energy-efficient light bulbs. The Retailer Allocation Review in Appendix F describes the RSAT; this section also discusses the leakage study's methodology and results.

Overall, Cadmus found that the RSAT is performing well. While there is some variation in the results by store, particularly when the number of intercept surveys we were able to conduct in a store were low, the RSAT scores were within our estimate range of leakage scores calculated from the intercept survey responses. Cadmus found that lighting leakage rates were an average of roughly 5.1 percentage points higher than predicted by the RSAT, with a confidence level of 90% and precision of ± 5.3%.

Methodology

Cadmus targeted 20 Utah stores for intercept surveys—15 stores in Rocky Mountain Power's service territory and five stores outside its territory. Of the 15 stores in the service territory, Cadmus established targets of eight stores with RSAT scores greater than or equal to 96% and seven stores with RSAT scores less than 96%, which included 34 nonparticipating stores.

[28] This study did not review internet lighting purchases, only those made at a brick and mortar stores.

The program administrator provided Cadmus with store rosters for each state. These included retailer addresses, phone numbers, and RSAT scores, and indicated each store's location within the service territory. For stores outside of the territory, Cadmus created a roster for each state, using Pacific Power's and Rocky Mountain Power's service area maps[29] to select cities/territories near the service territory. Cadmus then used Google Maps to identify all relevant retailers in the specified areas, supplemented by phone calls to the stores to verify they were outside of Rocky Mountain Power's territory.

To set up store visits, a Cadmus representative called a targeted store and asked for a manager or another employee in charge of daily operations. Representatives then used a script as a guide in explaining the study's purpose and Cadmus' intention in conducting intercept surveys at their stores. By calling ahead, Cadmus sought to ensure store visits by Cadmus field technicians would not only be authorized but welcome. From late October to early December (depending on contact availability), Cadmus attempted to contact each store's manager or owner until it was able to confirm whether the store manager would or would not participate (consequently, the study contacted many stores more than once). For each store authorizing the intercept surveys, Cadmus used phone contacts to schedule two-day visits, and, field technicians followed up with each store in advance of the visit to remind them of the appointments.

Cadmus achieved more success in scheduling visits with independent retailers or independently owned franchises than with big-box home and hardware stores. Managers of large retail chains (e.g., Home Depot, Lowe's, Bed Bath & Beyond, Walmart, Target, Albertson's, Dollar Tree) frequently redirected Cadmus to their corporate offices, which most commonly resulted in rejections or nonresponses to the contact attempts. This is explored further in the section: Leakage Survey Results by Store Size.

This difficulty gaining cooperation of big-box stores limited the number of surveys Cadmus could complete, given the extensive foot traffic large retailers draw. Further, Cadmus observed that stores' agreed participation rates—about one in eight stores contacted—would likely prevent achievement of the original targets.

[29] https://www.rockymountainpower.net/content/dam/pacificorp/doc/About_Us/Company_Overview/PC-10k-ServiceAreaMap-2015-v2.pdf

Table 57. Store Contact Summary

State	Stores on Roster	Stores Contacted*	Rocky Mountain Power/Pacific Power Stores Visited**	Non-Rocky Mountain Power/Pacific Power Stores Visited
Washington	57 (21 in, 36 out)	57 (100%)	5 / 21 (24%)	5 / 36 (14%)
Idaho	50 (19 in, 31 out)	50 (100%)	5 / 19 (26%)	1 / 31 (3%)
Utah	345 (295 in, 50 out)	244 (71%)	19 / 194 (10%)	8 / 50 (16%)
Total	**452 (335 in, 117 out)**	**351 (78%)**	**29 / 234 (12%)**	**14 / 117 (12%)**

*Cadmus did not further contact stores in Utah by phone if corporate offices rejected solicitation in all stores.

**Percentages expressed as a percentage of stores contacted. Among all Utah stores in Rocky Mountain Power's territory, regardless of contact, 8% agreed to participate. Among all Rocky Mountain Power or Pacific Power stores in all states, 10% agreed to participate.

Using all valid survey responses, Cadmus calculated leakage rates for each store and state. A valid survey for leakage calculations was defined as one in which the respondent identified the utility serving the location where their bulbs would be installed. Interviewers asked respondents that did not wish to complete the entire survey if they would at least identify the utility.[30] Thus, some respondents answered the key question that determines leakage, while not providing data about bulbs they purchased. For respondents with determined leakage status but no recorded light bulb counts, Cadmus used the mean number of light bulbs for all survey respondents (i.e., five light bulbs). The following equation calculated leakage scores:

$$Leakage\ Rate = \frac{\#\ Bulbs\ Installed\ Outside\ Utility\ Territory}{Total\ Bulbs\ Purchased\ within\ Utility\ Territory}$$

$$Reverse\ Leakage\ Rate = \frac{\#\ Bulbs\ Installed\ Inside\ Utility\ Territory}{Total\ Bulbs\ Purchased\ Outside\ of\ Utility\ Territory}$$

Summary of Stores Visited in Utah

Cadmus visited 27 stores in Salt Lake City and its surrounding suburbs. Field technicians completed 377 surveys with customers who purchased lightbulbs.

[30] The total number of valid surveys used for leakage calculations is 601, which differs from the total number of completed surveys which is 595. The difference is due to some respondents identifying their utility without completing the survey (valid for leakage calculation but not a completed survey) and some respondents completing the survey without identifying their utility (completed survey but not valid for leakage calculation).

Table 58. Utah Summary

Territory	Stores Visited*	Surveys Administered
Rocky Mountain Power	19	287 completed, 22 refused
Other Utility Territory	8	90 completed, 5 refused
Total	**27**	**377 completed, 27 refused**

*Includes three stores (two within Rocky Mountain Power territory, one outside) in which Cadmus administered zero surveys.

The 19 stores visited within Rocky Mountain Power's service territory each had corresponding RSAT scores that were estimated by the program administrator. To diversify the sample of stores and to reduce the possibility of bias in the data collection process, Cadmus sought to visit eight stores with RSAT scores of 96% or higher and seven stores with scores lower than 96%. Table 59 shows the distribution of RSAT scores among the 295 stores within Rocky Mountain Power's Utah territory.

Table 59. Distribution of RSAT Scores for Utah Rocky Mountain Power Stores

RSAT Score Range	Number of Stores	Percentage
0% up to 25%	2	1%
25% up to 50%	2	1%
50% up to 75%	6	2%
75% up to 90%	24	8%
90% up to 100%	261	88%
Total	**295**	**100%**

Roughly 75% of Utah Rocky Mountain Power stores had RSAT scores greater than 96%, and 60% had RSAT scores of 100%. Ultimately, Cadmus visited 14 Rocky Mountain Power stores with RSAT scores of 96% or higher and five with RSAT scores lower than 96%. Among the 14 Rocky Mountain Power stores with RSAT scores of 96% of higher, 10 had RSAT scores of 100%.

Leakage Survey Results

Table 60 shows the results from lighting leakage surveys conducted in 16 participating stores, three nonparticipating stores in Rocky Mountain Power's Utah territory, and eight stores outside of the territory. Of the 27 stores which Cadmus field technicians visited, three stores (one Rocky Mountain Power participant, two outside the territory) yielded no surveys and are not included in the table.

Table 60. Utah Leakage Results Summary

Stores	Valid Surveys for Leakage Calculation	Total Bulbs Purchased by Respondents	Intercept Leakage	Precision at 90% Confidence*	RSAT Based Leakage	Difference Between Intercept and RSAT**
Total for Participating Rocky Mountain Power Stores**	**273**	**1,328**	**6.2%**	**± 5.3%**	**Average 1.1%*****	**-5.1 points**
Participating store #1	22	78	0%	-	0%	0 points
Participating store #2	9	32	0%	-	0.3%	+0.3 points
Participating store #3	6	12	0%	-	4.2%	+4.2 points
Participating store #4	3	9	0%	-	0%	0 points
Participating store #5	117	738	3.4%	± 1.9%	6.5%	+3.1 points
Participating store #6	49	239	12.6%	± 5.9%	1.3%	-11.3 points
Participating store #7	13	48	0%	-	0%	0 points
Participating store #8	6	18	0%	-	0%	0 points
Participating store #9	1	2	0%	-	0%	0 points
Participating store #10	1	2	100%	-	0%	-100 points
Participating store #11	2	2	0%	-	2.4%	+2.4 points
Participating store #12	2	8	75%	± 50.2%	0%	-25.0 points
Participating store #13	2	5	0%	-	0%	0 points
Participating store #14	28	88	4.5%	± 3.8%	0.6%	-3.9 points
Participating store #15	12	47	0%	-	1.0%	+1.0 points
Total for Nonparticipating Stores in Rocky Mountain Power Territory	**23**	**252**	**29.0%**	**± 12.7%**	**Average 20.4%**	**-8.6 points**
Nonparticipating store #1	5	19	73.7%	± 35.7%	17.8%	-55.9 points
Nonparticipating store #2	10	203	28.1%	± 16.6%	18.5%	-9.6 points
Nonparticipating store #3	8	30	6.7%	± 5.7%	24.9%	18.2 points
Total for Stores Not in Rocky Mountain Power Territory	**89**	**478**	**49.8%**	**± 8.6%**	**NA**	**NA**
Non-Rocky Mountain Power store #1	16	102	100%	-	NA	NA
Non-Rocky Mountain Power store #2	11	47	0%	-	NA	NA
Non-Rocky Mountain Power store #3	10	81	7.4%	± 6.0%	NA	NA
Non-Rocky Mountain Power store #4	10	78	65.4%	± 25.5%	NA	NA
Non-Rocky Mountain Power store #5	41	169	46.2%	± 12.2%	NA	NA

Stores	Valid Surveys for Leakage Calculation	Total Bulbs Purchased by Respondents	Intercept Leakage	Precision at 90% Confidence*	RSAT Based Leakage	Difference Between Intercept and RSAT**
Non-Rocky Mountain Power store #6	1	1	100%	-	NA	NA

*Precision cannot be calculated for stores with 0% or 100% leakage due to a zero variance.

**The calculation used: (RSAT Based Leakage) - (Intercept Leakage). A negative difference between RSAT-based leakage and intercept leakage means the RSAT underestimates leakage.

***For combined RMP participating stores, intercept leakage and precision are weighted by sample stratification. The two strata are stores with RSAT scores greater than 96% and stores with RSAT scores of 96% or less. The survey samples for other groups of stores were not stratified, and intercept leakage is not weighted.

****Due to the variables input into the RSAT score calculation described in Appendix F, averaging the RSAT-based leakage scores does not provide a statistically significant result. This simple average of the RSAT-based leakage scores does not include any sampling weights that represent retail customer drive time, retailer locations, retailer trade areas, customer purchasing power, or retail sales allocation. Therefore, the average is a qualitative estimate. However, the variance of the RSAT score of the sampled stores is low, so a simple average is likely a reasonable approximation of the weighted RSAT-based leakage.

Cadmus surveyed fewer than 10 customers for nine of the 15 participating stores, an indication that these stores sold a relatively small number of bulbs. Leakage scores for stores with small numbers of survey respondents present low precision and little impact on overall leakage rates for the category. One participating store (#5 in the table above) accounted for nearly one-half of the total number of bulbs sold in our sample, indicating a very high light bulb sales volume. The store's RSAT-based leakage of 6.5% overestimated the 3.4% leakage rate measured through the intercept survey.

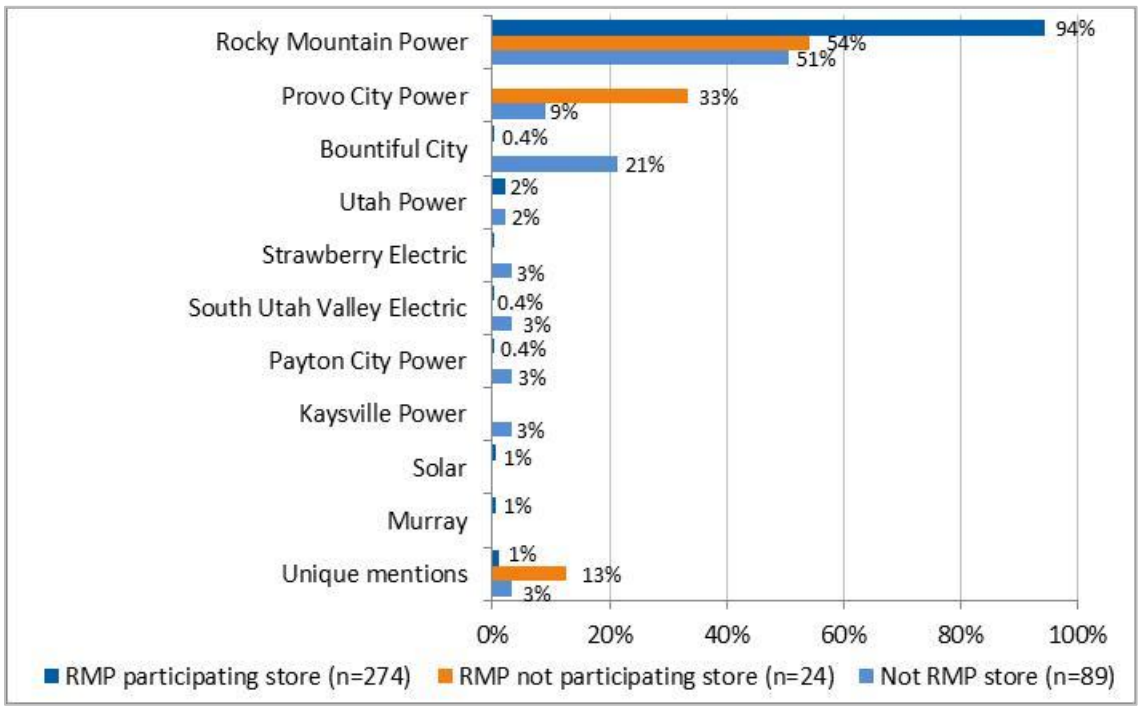
For surveyed stores with more than 10 survey responses, the study found a highest leakage rating of 12.6% for a store with RSAT-based leakage of 1.3%. When combining results for all stores, the overall leakage rate was 6.2% of bulbs sold in participating stores.

The survey also addressed three nonparticipating stores within Rocky Mountain Power's territory. These stores had RSAT-based leakage ranging from 17.8% to 24.9%; the light bulb leakage rate for these stores ranged from 6.7% (much lower than the RSAT would predict) to 73.7% (much higher than the RSAT would predict). When all nonparticipating stores' results were combined, an overall leakage rate of 29.0% resulted—an amount comparable to the average RSAT-based leakage of 20.4% among these stores.

The survey addressed six stores outside of Rocky Mountain Power's territory, finding leakage at five, including one store where all 16 survey respondents were Rocky Mountain Power customers, resulting in 100% leakage. A leakage rate of 49.8% was calculated across all surveyed stores, indicating that one-half of the bulbs purchased at these stores likely were installed within Rocky Mountain Power's territory.

In computing leakage rates, the distribution of store customers served by utilities presents a key component. As shown in Figure 10, 94% of customers intercepted in participating stores intended to install purchased bulbs within Rocky Mountain Power territory, while 54% of those surveyed at nonparticipating stores and 51% of those surveyed outside of Rocky Mountain Power's territory intended to install bulbs inside of Rocky Mountain Power territory.

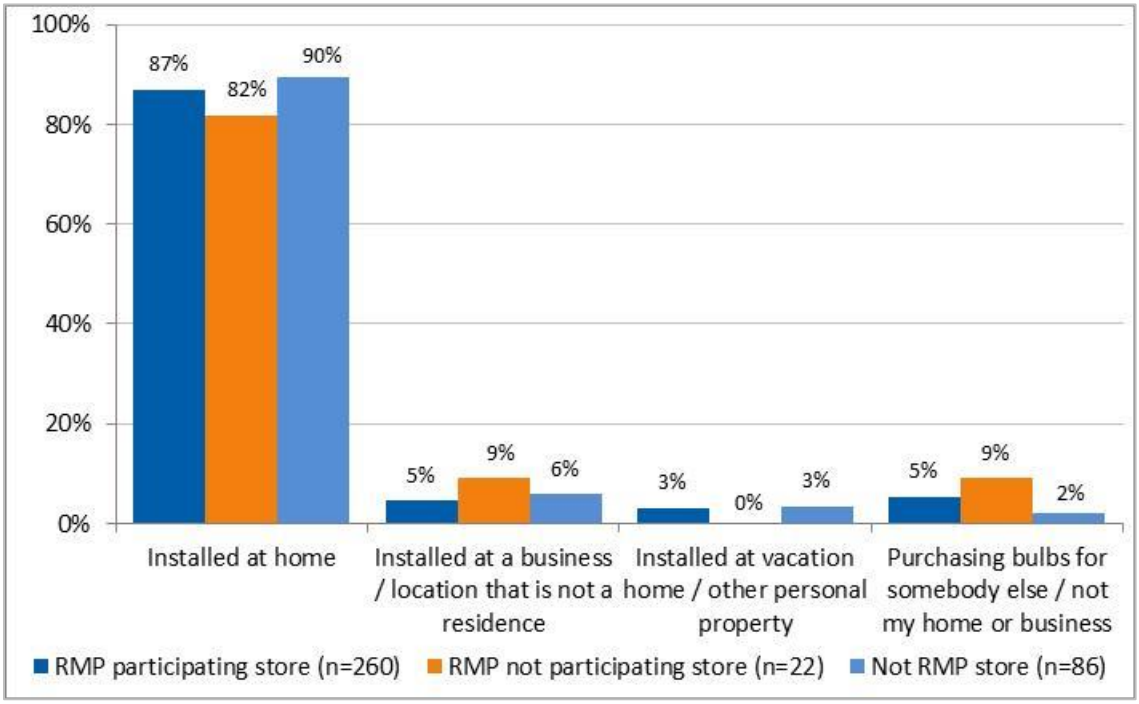
Figure 10. Respondent's Utility by Store Type



Installation Location

Most survey respondents confirmed where they intended to install bulbs they purchased. As shown in Figure 11 a large majority of respondents purchased bulbs for their homes (82% to 90% depending on the survey group), while business locations accounted for 5% to 9%, vacation or other non-primary properties accounted for up to 3%. Bulbs installed outside of homes are included in the Leakage estimates if the customer knew which utility served the location of installation. A range of 2% to 9% purchased bulbs for "somebody else" (i.e., not their home, business, or other property).

Figure 11. Installation Location for Bulbs Purchased

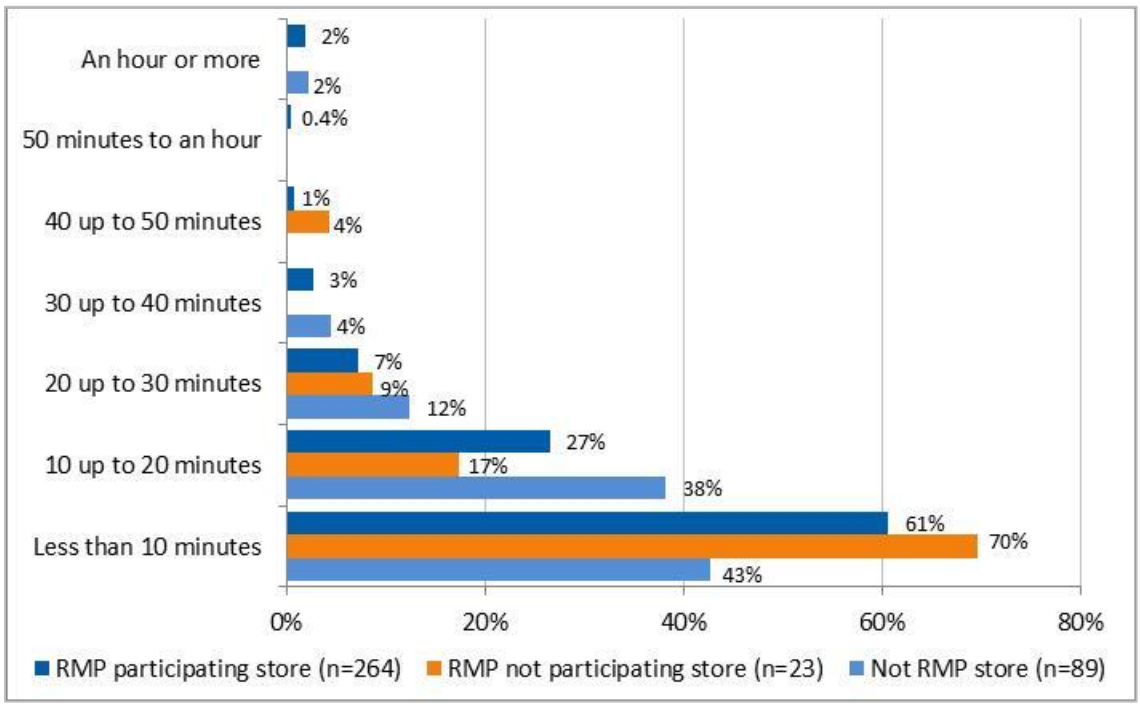


Distance Traveled

As travel distances are a key component in calculating RSAT scores, surveys asked respondents to indicate how far away their intended installation location was from the store where they purchased their bulbs.

Figure 12 shows more than four out of five respondents in participating stores (87%) and nonparticipating stores (87%) intended to install bulbs within a 20-minute drive of the store, much like the 81% rate for respondents surveyed in stores outside of Rocky Mountain Power territory. Fewer respondents, however, surveyed outside of Rocky Mountain Power territory planned to install their bulbs within a 10-minute drive (43%), compared to those surveyed at participating (61%) and nonparticipating stores (70%). Only 4% to 7% of Utah respondents intended to install their bulbs more than 30 minutes from the store where they purchased them.

Figure 12. Distance from Store to Installation Location

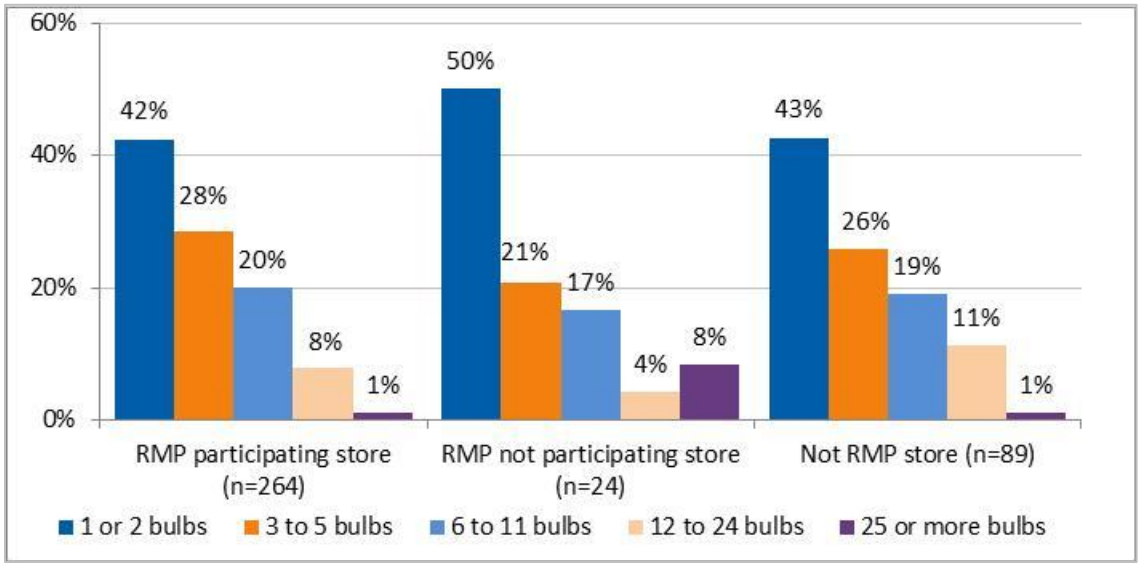


Purchase Quantities

Figure 13 shows the distribution of total bulbs (all types) purchased by survey respondents. Customers surveyed in all three store types purchased similar numbers of bulbs, with nearly one-half (42% to 50% per group) purchasing one or two bulbs and about one-third (29% to 31%) buying at least six bulbs. For participating stores, customers purchased a mean number of 4.9 bulbs, with a median of 4.0 bulbs. For stores outside of Rocky Mountain Power's territory, customers purchased a mean of 5.4 bulbs and a median of 3.0 bulbs. For nonparticipating stores, customers purchased a mean of 4.9 bulbs, with a median of 2.0 bulbs.[31]

[31] One survey respondent purchased six 24-packs of infrared heat lamp bulbs (i.e., 144 bulbs in total), saying they were "for pets." Though the figure includes this respondent Cadmus withheld this response from calculation of the mean and median bulbs purchased by respondents in nonparticipating stores. Had the outlier been included, the mean number of bulbs purchased for this group would have been 11, with a median of three.

Figure 13. Total Bulbs Being Purchased

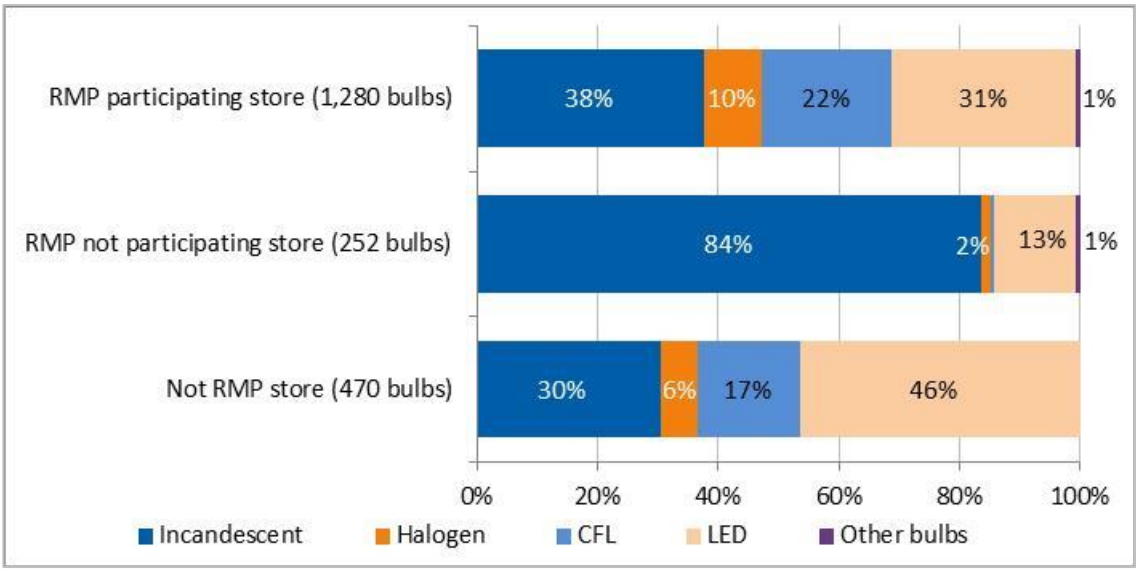


Bulb Type

The largest number of customers purchased LEDs, with 38% purchased at participating stores and 46% purchased outside of the territory. For nonparticipating stores, customers most commonly purchased incandescent bulbs (50%). CFLs represented only the third-most common bulb type purchased in participating stores (22%) and outside the territory (19%); only 4% of respondents purchased incandescent bulbs in nonparticipating stores.

Figure 14 summarize the percentage of bulb types purchased by respondents intercepted in Utah stores. For participating stores and those outside the territory, the distribution of total bulbs purchased tracked very closely with the distribution of respondents purchasing each type, indicating customers purchased a similar number of bulbs for every bulb type. For nonparticipating stores, results skewed due to a single respondent who purchased 144 incandescent light bulbs, resulting in an unusually high incandescent purchasing rate of 84%. Survey respondents in nonparticipating stores purchased only 0.4% CFLs.

Figure 14. Types of Bulbs Being Purchased: Distribution of Bulbs



Purchasing Decisions

Table 61 summarizes respondents' reasons for purchasing energy efficient and standard light bulbs. The most-mentioned reason for those buying efficient bulbs for every survey group is energy efficiency (57% for participating stores, 50% for nonparticipating stores, and 48% for stores outside the territory), while fewer than 10% of those buying standard bulbs give this reason. Respondents in participating stores were also the most likely to mention environmental concerns and the greater longevity of efficient lighting as reasons for purchasing their bulbs.

Table 61. Reasons for Purchasing Bulbs

Reason	RMP Participating Store		RMP Nonparticipating Store		Not RMP Store	
	Purchasing Energy Efficient Bulbs (n=141*)	Purchasing Standard Bulbs (n=97)	Purchasing Energy Efficient Bulbs (n=8)	Purchasing Standard Bulbs (n=14)	Purchasing Energy Efficient Bulbs (n=50)	Purchasing Standard Bulbs (n=32)
Energy efficiency / saving energy	57%**	8%	50%	7%	48%	3%
Environment / "green" reasons	26%	24%	13%	0%	14%	0%
Longevity	21%	0%	0%	0%	8%	0%
Bulb color / light quality	21%	0%	38%	14%	34%	31%
Low bulb price / reduced price / on sale	15%	20%	0%	14%	22%	22%
Appearance / looks good in my fixtures	10%	24%	0%	29%	10%	38%
Bulbs I always buy / I am used to	6%	15%	0%	29%	8%	22%

Reason	RMP Participating Store		RMP Nonparticipating Store		Not RMP Store	
	Purchasing Energy Efficient Bulbs (n=141*)	Purchasing Standard Bulbs (n=97)	Purchasing Energy Efficient Bulbs (n=8)	Purchasing Standard Bulbs (n=14)	Purchasing Energy Efficient Bulbs (n=50)	Purchasing Standard Bulbs (n=32)
Information in the store / store display or advertising	4%	3%	0%	0%	2%	3%
Needed bulbs right away	4%	18%	25%	21%	12%	28%
Someone made a recommendation	2%	1%	50%	0%	4%	0%
Saving money on utility bills	2%	7%	0%	0%	10%	0%
Hard to find bulb / unique fixture	2%	13%	13%	7%	6%	16%
Stocking up / spare bulbs	1%	4%	0%	29%	8%	3%
Problems with old bulb (heat, noise, etc.)	1%	2%	0%	0%	2%	0%
Advertising, online or elsewhere	0%	2%	0%	0%	2%	0%

*Indicates number of respondents answering the question.

**Respondents were allowed to provide multiple reasons, therefore the results do not add up to 100%.

Combined Summary of Stores Visited for Idaho, Washington, and Utah

Given the low number of surveys completed in Washington and Idaho, and that the RSAT algorithm is the same across states, Cadmus combined the results for all states to show key findings for the territory as a whole. For Washington, Idaho, and Utah, Cadmus visited 43 stores and completed 595 intercept surveys. On average, field technicians spent more than 13.5 hours in each store, split between two sequential days. The study set original targets using an expectation that field technicians would successfully administer 1.5 to 1.9 surveys per hour.

Table 62. Overall Summary

State	Stores Visited	Surveys Administered	Complete Rate	Completes per Store
WA	10	175 completed, 3 refused	98.3%	17.5
ID	6	43 completed, 5 refused	89.6%	7.2
UT	27	377 completed, 27 refused	93.3%	14.0
Total	**43**	**595 completed, 35 refused**	**94.4%**	**13.8**

Leakage Survey Results for Idaho, Washington, and Utah Combined

Table 63 shows the leakage rates for all three PacifiCorp states separately and combined. Overall, leakage was 6.1% for all stores surveyed in PacifiCorp territory, and leakage was 34.3% in all stores surveyed outside of the territory. The only nonparticipating stores surveyed inside PacifiCorp territory were in Utah, so there are no results combined across states.

Table 63. Leakage Results Summary for All States

States	Valid Surveys for Leakage Calculation	Total Bulbs Purchased by Respondents	Intercept Leakage	Precision at 90% Confidence	RSAT Based Leakage	Difference Between Intercept and RSAT*
Total for Participating PacifiCorp Stores**	**423**	**2,043**	**6.1%**	**± 4.2%**	**0.8%*** **	**-5.3 points**
Washington	114	558	8.1%	± 3.3%	0.7%	-7.4 points
Idaho	36	157	2.5%	± 2.0%	0%	-2.5 points
Utah	273	1,328	6.2%	± 5.3%	1.1%	-5.1 points
Total for Nonparticipating Stores in PacifiCorp Territory	**23**	**252**	**29.0%**	**± 12.7%**	**20.4%**	**-8.6 points**
Utah	23	252	29.0%	± 12.7%	20.4%	-8.6 points
Total for Stores Not in PacifiCorp Territory	**155**	**708**	**34.3%**	**± 6.0%**	**Not applicable**	**Not applicable**
Washington	60	217	0.9%	± 0.8%	NA	NA
Idaho	6	13	23.1%	± 16.6%	NA	NA
Utah	89	478	49.8%	± 8.6%	NA	NA

*Calculation used: (RSAT Based Leakage) - (Intercept Leakage). A negative difference between RSAT Based Leakage and Intercept Leakage meant the RSAT underestimated leakage.

**For combined RMP participating stores in Utah and the overall total across states, intercept leakage and precision are weighted by sample stratification. The two strata are stores with RSAT scores greater than 96% and stores with RSAT scores of 96% or less. The survey samples for other groups of stores were not stratified, and intercept leakage is not weighted.

***Due to the variables input into the RSAT score described in Appendix F, averaging the RSAT-based leakage scores does not provide a statistically significant result. This simple average of the RSAT-based leakage scores does not include any sampling weights that represent retail customer drive time, retailer locations, retailer trade areas, customer purchasing power, or retail sales allocation. Therefore, the average is a qualitative estimate. However, the variance of the RSAT score of the sampled stores is low, so a simple average is likely a reasonable approximation of the weighted RSAT-based leakage.

In aggregate, RSAT scores slightly underestimated leakage observed in the survey results, with an average RSAT score for all surveyed participating scores of 99.2%, implying 0.8% leakage. Survey results calculated a leakage rate of 6.1% for these stores—a difference of 5.3 points on the RSAT scale. Nonparticipating Utah stores produced an average RSAT score of 79.6%, implying 20.4% leakage, while survey results produced a leakage rate of 29.0%—a difference of 8.6 points on the RSAT scale.

Leakage Survey Results by Store Size

Cadmus categorized stores as "big box[32]" stores or "other stores," enabling leakage result comparisons between the two types. There is only one big box store in PacifiCorp's Idaho territory, which we were not allowed to visit; and all big box stores in Washington were participating stores in PacifiCorp's territory. All Utah big box stores were participating stores in PacifiCorp's territory, but both store types were surveyed among those outside PacifiCorp's territory and among participating stores within the territory. Overall, Cadmus interviewed 57% (n=601) of survey respondents in big box stores, with these surveys accounting for 56% (n=3,003) of the total bulbs purchased by all respondents. Table 64 shows big box stores usually exhibited leakage rates that were slightly higher than other stores, though comparisons within states are not statistically significant.

Table 64. Leakage Results by Size of Store

States	Big Box Stores*			Other Stores**		
	Valid Surveys for Leakage Calculation	Total Bulbs Purchased	Intercept Leakage	Valid Surveys for Leakage Calculation	Total Bulbs Purchased	Intercept Leakage
Total for Participating PacifiCorp Stores* **	**291**	**1,447**	**7.7%**	**132**	**596**	**3.2%**
Washington	72	287	11.5%	42	271	4.4%
Idaho	0	0	NA	36	157	2.5%
Utah	219	1,160	6.6%	54	168	3.9%
Total for Nonparticipating Stores in PacifiCorp Territory	**0**	**0**	NA	**23**	**252**	**29.0%**
Utah	0	0	NA	23	252	29.0%
Total for Stores Not in PacifiCorp Territory	**51**	**247**	**52.2%**	**104**	**461**	**24.7%**
Washington	0	0	NA	60	217	0.9%
Idaho	0	0	NA	6	13	23.1%
Utah	51	247	52.2%	38	231	47.2%

*Twelve big box stores total: nine in Utah, three in Washington, zero in Idaho.
**Twenty-seven other stores total: 15 in Utah, six in Washington, six in Idaho.
***For combined RMP participating stores in Utah and the overall total across states, intercept leakage and precision are weighted by sample stratification. The two strata are stores with RSAT scores greater than 96% and stores with RSAT scores of 96% or less. The survey samples for other groups of stores were not stratified, and intercept leakage is not weighted.

[32] Large retail chains such as Home Depot, Lowe's, Walmart, Target, Sutherland's, and Big Lots.

Intercept Survey Spillover

Of PacifiCorp customers in all states, 17 respondents surveyed in participating stores purchased energy-saving items in addition to light bulbs (7%, n=257 answering the question). Seven considered their bulb purchase as "very important" in their decision to purchase the additional items (3%). These respondents were all Rocky Mountain Power customers in Utah and reported that all items purchased would be installed right away. None reported that they were going to receive an incentive for the following items purchased:

- Power strip (n=2)
- Motion sensing light switch
- Light photo controls
- ENERGY STAR room air conditioner
- Showerhead
- Weather Stripping

Cadmus only considered "like" measures as eligible spillover (consistent with the non-lighting spillover analysis). "Like" spillover measures are those offered by the Utah HES program during the evaluation period, and measures for which the participant did not receive a rebate. Of items purchased, only ENERGY STAR room air conditioners qualified as program spillover. Table 65 shows savings associated with this measure.

Table 65. Spillover Measures and Savings Reported

Measure	Quantity	Evaluated Savings (kWh)
ENERGY STAR Room Air Conditioner	1	74.26

Table 66 extrapolates savings from room air conditioners to the 257-customer intercept survey population, generating spillover savings of 0.29 kWh per person purchasing lighting.

Table 66. Spillover Savings per Person

Spillover Savings for Intercept Population (kWh)	Intercept Surveys with Response to Additional Purchase Question	Spillover Savings per Person (kWh)
74.26	257	0.29

Table 67 provides estimated spillover for upstream CFLs and LEDs as 0.3% of program evaluated savings, a determination serving as a lower bound estimate of spillover savings. Cadmus did not apply the spillover estimate to the HES program lighting NTG estimate due to the sampling's nature: intercept surveys primarily sought to gather data for the leakage study, targeting stores by RSAT score. As such sampling did not provide a representative population of customers in Rocky Mountain Power's territory, Cadmus considered the spillover savings results as informative but likely lower than the actual spillover.

Table 67. Spillover Measures and Savings Reported

CFL and LED Estimated Participants	2013-2014 CFL and LED Evaluated Gross Savings (kWh)	CFL and LED Spillover Savings	CFL and LED Spillover %
1,583,018	118,402,600	4,575,427	0.4%

Process Evaluation

This section describes the detailed findings of Cadmus' process evaluation of the HES program. These findings draw upon analysis of data collected through program staff interviews, a participant survey, the general population survey, and secondary research. In conducting the evaluation, Cadmus focused on assessing the following:

- The delivery structure's and implementation strategy's effectiveness;
- Marketing approaches;
- Customer satisfaction; and
- Internal and external communication channels.

Table 68 outlines the primary research questions.

Table 68. Research Areas

Research Areas	Researchable Questions and Topics
Program Status	How did the program perform in 2013–2014, and what opportunities and challenges do program staff foresee for future program years?
Satisfaction	How satisfied are customers with their CFLs/LEDs or incented non-lighting measures? Why?
Awareness	Is the general population of customers aware of Rocky Mountain Power programs? If so, how did they learn about the programs? How did non-lighting participants learn about the HES program?
Motivations	What actions have customers taken to save energy, and what motivated them to purchase a CFL, LED, or non-lighting measure?
Demographics	How do awareness/activities/behaviors vary by demographic characteristics?

Methodology

Cadmus conducted the following process evaluation research:

- Program and marketing materials review
- Utility and administrator staff interviews
- General population survey
- Non-lighting participant survey

Program Materials Review

The program materials review focused on critical program documents, including past evaluation reports, the program logic model, and program marketing and communications materials developed to promote HES program participation and to educate target audiences in Utah about program offerings. In addition to the materials review, Cadmus discussed marketing effectiveness with program stakeholders and considered their insights when analyzing participant survey findings and industry best practices.

The materials review included the following:

- In assessing program progress and analyzing trends across program years, Cadmus considered the findings and conclusions from the *Rocky Mountain Power 2011–2012 Utah Residential Home Energy Savings Evaluation* and the *Rocky Mountain Power 2009-2010 Utah Residential Home Energy Savings Evaluation*.
- Cadmus reviewed the HES program logic model to reflect the 2013–2014 program processes (see Appendix H) and, based on information gathered through program staff interviews, determined that the logic model accurately reflected current program operations.
- Cadmus reviewed Rocky Mountain Power's marketing plans and online materials and compared their messages to the challenges and motivations described by customers, seeking to assess whether the program's marketing has been appropriately targeted. Cadmus reviewed the HES program marketing strategy, executional plans, and online (website) and social media elements.

Utility and Administrator Staff Interviews

Cadmus developed stakeholder interview guides and collected information about key topics from program management staff. The evaluation involved two interviews: one with two program staff at Rocky Mountain Power; and one with two program staff at CLEAResult (the program administrator), which oversees the HES program in five PacifiCorp service territory states.

The interviews covered the following topics:

- Program status and delivery processes;
- Program design and implementation changes;
- Marketing and outreach tactics; and
- Barriers and areas for improvement.

Cadmus conducted the interviews by telephone and contacted the interviewees via e-mail with follow-up questions or clarification requests.

Participant Survey

Cadmus conducted a telephone survey with non-lighting participating customers, designing the survey instrument to collect data regarding the following process topics:

- ***Program process***. Details to inform the following performance indicators:
    - Effectiveness of the program processes;
    - Program awareness;
    - Participation motivations and barriers;
    - Customer satisfaction; and
    - Program strengths and/or areas for improvement.
- ***Customer information***. Demographic information and household statistics.

General Population Survey

Cadmus conducted a telephone survey with customers regarding lighting purchases, designing the survey instrument to collect data regarding the following process topics:

- ***Program process***. Details to inform the following performance indicators:
    - Upstream lighting rebate awareness;
    - Lighting purchase decisions and barriers to purchasing energy-efficient lighting;
    - Customer satisfaction with products purchased; and

Customer information. Demographic information and household statistics.

Program Implementation and Delivery

Drawing on stakeholder interviews and participant survey data, this section discusses HES program implementation and delivery.

Program Overview

Through the 2013-2014 HES program, Rocky Mountain Power provided cash incentives to residential customers for purchases of energy-efficient products, home improvements, and heating and cooling equipment and services. Under the program, customers could install multiple measures to create customized efficiency portfolios, thus lowering their utility bills. Rocky Mountain Power encouraged all its residential customers, including non-homeowners and owners of multifamily buildings and manufactured homes, to participate in the program.

During the evaluation period, Rocky Mountain Power in Utah offered energy efficiency measures in two primary categories, based on the program's two delivery channels: lighting and non-lighting. Only internal program staff referred to these two categories; the company did not market the program this way to customers. The lighting component used an upstream incentive mechanism that may not be apparent to customers, whereas the non-lighting component operated using a mail-in or online (for select measures) incentive approach, which requires participant awareness and action. All incentives were prescriptive. In 2015, program staff expanded the program by adding a mail-order energy efficiency kit option.

Tariff Changes

Each year, Rocky Mountain Power files program modifications (i.e., tariff changes) with the Utah Public Utilities Commission. Two key program changes during 2013 and 2014 included the addition of direct-install duct sealing for customers in manufactured homes and a realignment of incentives for comprehensive whole-home upgrades. Program staff also made minor adjustments to the efficiency level required for several measures eligible for program incentives, such as clothes washers, refrigerators, and freezers.

Delivery Structure and Processes

Per program staff, the HES program saw minimal changes to its customer delivery method since 2009. Program staff coordinated with participating distributors, retailers, and trade allies to deliver the program's different components. For most program-qualifying measures customers received cash-back incentives. For qualifying light bulbs, program staff paid incentives directly to manufacturers, who provided high efficiency bulbs to retailers at a discount; retailers, sales associates, and trade allies supported the program by encouraging customers to purchase higher-efficiency equipment that qualifies for an incentive.

Data Tracking

The program administrator reported that data tracking systems in place met, and in some cases exceeded, its needs, allowing meaningful use of data collected. Program administrator staff reported entering program data into their Key What You See (KWYS) system, a Microsoft Access-based tool. Some KWYS data were transferred into a Salesforce database. Weekly aggregation of participant databases allowed the program administrator to monitor incentives paid and goal achieved, and each month the program administrator provided Rocky Mountain Power with a report which allows program staff to evaluate and diagnose the causes of program activity changes, enabling program delivery adjustments, if needed.

In 2013, the program administrator began transitioning rebate data entry to a third-party vendor, National Business Systems (NBS), because the program administrator reported dissatisfaction with the previous vendor. The transition began with the program administrator providing NBS access to one measure at a time until it could prove it could operate under all program rules. Program staff reported the transition a success.

The program processed upstream lighting invoices through a system called Sprocket. The program administrator received invoices from the manufacturer, verified the information's accuracy, and entered data into a tool. The data flowed through a validation and quality control (QC) process before entering Sprocket.

While upstream lighting data tracking effectively served the program administrator's and Rocky Mountain Power's needs and expectations, Cadmus experienced some challenges when using the data for evaluation purposes. Specifically, significant issues emerged when matching lighting tracking data (Sprocket) to price scheduling data for linking bulb prices and incentives to lighting products sold. These data issues included the following:

1. Inconsistent bulb types for each SKU.
2. Inconsistent use of SKUs vs. model numbers to track products.
3. Inconsistent use of "posted," "reconciled," and "posted-reconciled" tags to track the final quantities of bulbs sold through the program.
4. Very limited tracking of product merchandising and promotional events.

Most of these issues, generated from 2013 tracking data, had been resolved in 2014 data with the exception of the product merchandising and promotional events tracking.

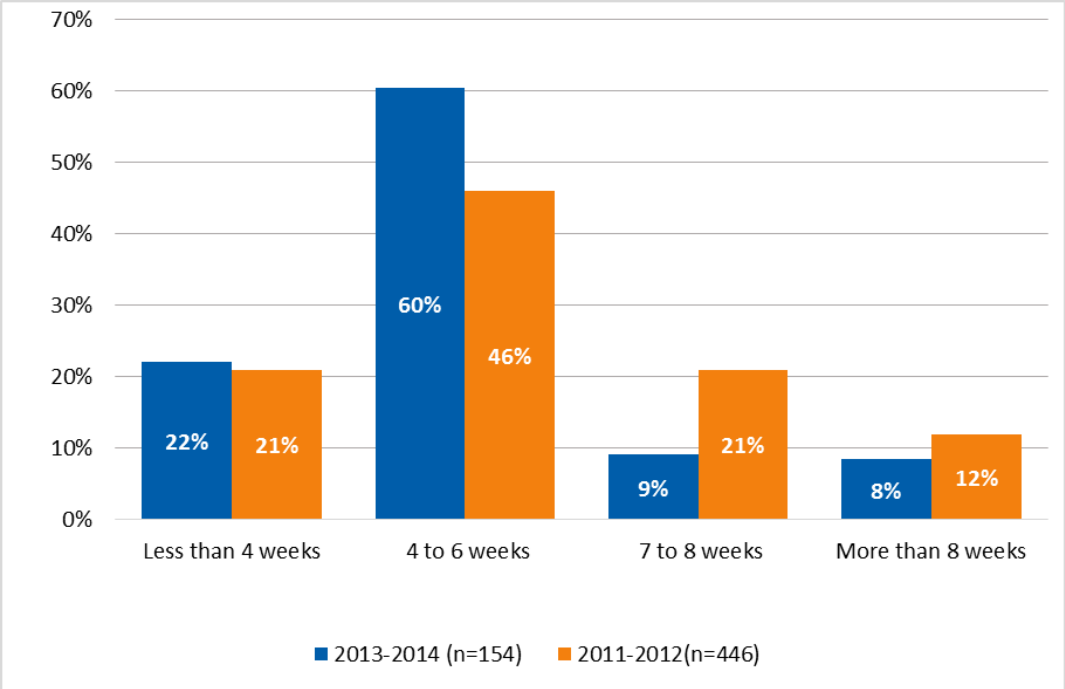
Application Processing

Application processing largely remained unchanged during the 2013 and 2014 program years, with online applications covering most qualifying products. As discussed in the Data Tracking section, program staff contracted with a new vendor, NBS, to process the data measure by measure.

In 2013, the program administrator reported that they made an effort to update the customer application to make it more efficient for customers and trade allies. In 2013, the application had every measure type which proved to be inefficient. In order to mitigate these issues, in 2014 the program administrator developed an application for each measure type. As a result of these efforts, the program administrator reported they experienced a reduction in errors and missing information on applications.

As shown in Figure 15, 82% of non-lighting customers reported it took less than six weeks to receive their incentive in 2013–2014, representing an improvement from the previous evaluation period when 67% reported they received their incentive in six weeks. Notably, this question gauged participants' perceptions of the time required to receive the rebate, and their responses likely included the time required to resubmit their applications if missing or incorrect information had been provided.

Figure 15. Time from Non-Lighting Application Submission and Incentive Receipt



Source: Rocky Mountain Power Utah HES Residential Non-Lighting Survey (QF6, 2011–2012; QE7, 2013–2014). "Don't know", "refused", and "have not received the incentive yet" responses removed.

Cadmus also analyzed participants' reported wait times by measure. For example, in 2013–2014, 85% of insulation participants reported receiving their incentives within six weeks, compared to 59% in 2011–2012. Similarly, 80% of window participants reported receiving their incentives within six weeks, compared to 67% in 2011–2012.[33] Only duct sealing and insulation exhibited poor performance, with 42% of customers reported a wait of seven or more weeks (n=12).

Eighty-eighty percent of non-lighting customers expressed satisfaction with the time required to receive the incentive. Among the 12% of customers who expressed dissatisfaction (19 total customers), four reported having to resubmit paperwork.

Overall, 64% of non-lighting customers expressed high satisfaction rates ("very satisfied") with the application process. Thirty-two percent said they were somewhat satisfied, 1% said they were not very satisfied, and 2% said they were not at all satisfied. Dissatisfied customers offered the following reasons for their discontent:

- "The application process was easy, but they kept asking questions of the contract process they didn't need [to]."
- "I have not received the incentive check yet."
- "We never got the rebate."/"I didn't receive the incentive."
- "The length, and the frustration, and the rejection of a completely filled out application."/ "It was too much to do."
- "It didn't do what it was supposed to do."
- "Filling out the application was too complicated."
- "[Our contractor] tried to get us to pay because they can't work with [Rocky Mountain Power] and couldn't get the paperwork they needed."

Retailers and Trade Allies

Program staff continued using the tiered account management system, developed in earlier program years to streamline the process of working with trade allies and retailers: the program administrator divides trade allies into two tiers for internal tracking purposes only. Program staff estimated that Tier 1 trade allies accounted for 80% of the program savings and tended to conduct the most work with customers. Tier 2 trade allies do fewer projects per year than Tier 1 trade allies.

The program administrator regularly (at least three times per year) offered training to distributors, retailers, and their associates. Program administrator staff reported the regular training necessary due to the following reasons:

- Addressing rapid turnover in the industry;
- Keeping trade allies abreast of program changes; and

[33] Statistically significant change (p-value <0.10).

- Working toward the program administrators' goal to use trade ally education to reduce the number of applications with errors.

For example, at the beginning of heating season, the program administrator contacted retailer account managers to discuss products in demand in that season. For the upstream lighting component, the program administrator focused on delivering training to Home Depot and Lowes to educate each sales associate about the program and to train them on how to sell energy-efficient products to a customer. The program administrator reported the trainings resulted in increased retailer participation between 2013 and 2014, especially during the summer cooling season.

The program administrator also reported focusing its Tier 1 trade ally training and communication efforts on technology and tariff changes. For example, following the 2014 state tariffs update in Utah, the program administrator conducted trainings with trade allies to ensure they understood the changes and their implications. The efforts sought to aid in seamless tariff implementation without failures in customer service.

Marketing

Approach

To operate as efficiently as possible, program staff reported streamlining the Utah marketing and outreach approaches to maximize the delivery of direct energy-saving opportunities. According to the 2014 Marketing Plan, this strategy resulted in a shift of resources toward targeted marketing and away from mass marketing. Staff used bill inserts, social media, sell sheets, and website features that employed tailored messages.

For 2014, the following five key strategies emerged:

1. Focus on priority measures during key seasonal selling windows (e.g., heating season, cooling season, and lighting season).
2. Shift the marketing mix to more cost-effective, flexible, and measureable delivery.
3. Simplify and enhance the customer experience to increase participation.
4. Streamline basic program processes, leverage opportunities, and track results to reduce cost of marketing
5. Strategically support unplanned opportunities.

Materials and Website Review

The 2014 Marketing Communications Plan developed by the program administrator clearly outlines a broad marketing strategy for the HES program. While the plan effectively maps out major strategic focus areas, it lacks details regarding the tactics program staff intended to use and over what time period to execute the marketing strategy.

Primarily, the plan identifies a need to shift most program marketing and application processes to an online format. By the end of 2014, the program website reflected a simple, easy-to-understand

structure (by measure category), allowing customers to apply online and to check an application's status for most measure categories. These changes, meant to simplify the process for customers, likely contributed to program satisfaction discussed in this report. The website, however, lacks language to motivate a customer to participate (i.e., a "call to action").

Effectiveness

The program administrator tracks marketing effectiveness on a limited basis, with the marketing team tracking click-through statistics for the program website. In 2015, the team began tracking time spent on the website, how customers reached the website, and materials they viewed.

The program administrator staff also noted that the guerrilla (marketing in an unconventional way) tool kit developed for lighting and appliances effectively engaged retailers. The tool kit provided talking points that educated retail employees about the business case for energy efficiency and its contribution to retailer profits.

Program Challenges and Successes

HES program staff reported the program faced a primary challenge: communicating tariff changes to trade allies. For example, when the Utah tariff changed, trade allies had difficulty understanding the tariff, its changes, and the way it was written. The program administrator mitigated confusion over future tariff changes by providing education and training opportunities to trade allies once a tariff changed.

In 2013, increased U.S. DOE and the ENERGY STAR program standards for clothes washers and refrigerators eliminated a majority of program-qualifying models, causing challenges with retailers. Program staff reported this change stressed relationships with retailers, but offered staff an opportunity to contact and begin a dialogue with retail partners.

Program staff reported that the program's requirement of using an eligible contractor to allow the customer to qualify for rebates presented challenges in 2013 and 2014 as many trade allies did not know about the program and had not yet become a part of the trade ally network. Some customers expressed frustration that their upgrades did not qualify as they did not use an eligible contractor. To mitigate this, program staff began reaching out to new trade allies, encouraging them to enroll with the program within 90 days of a customer submitting a rebate application to permit the customer's application processing.

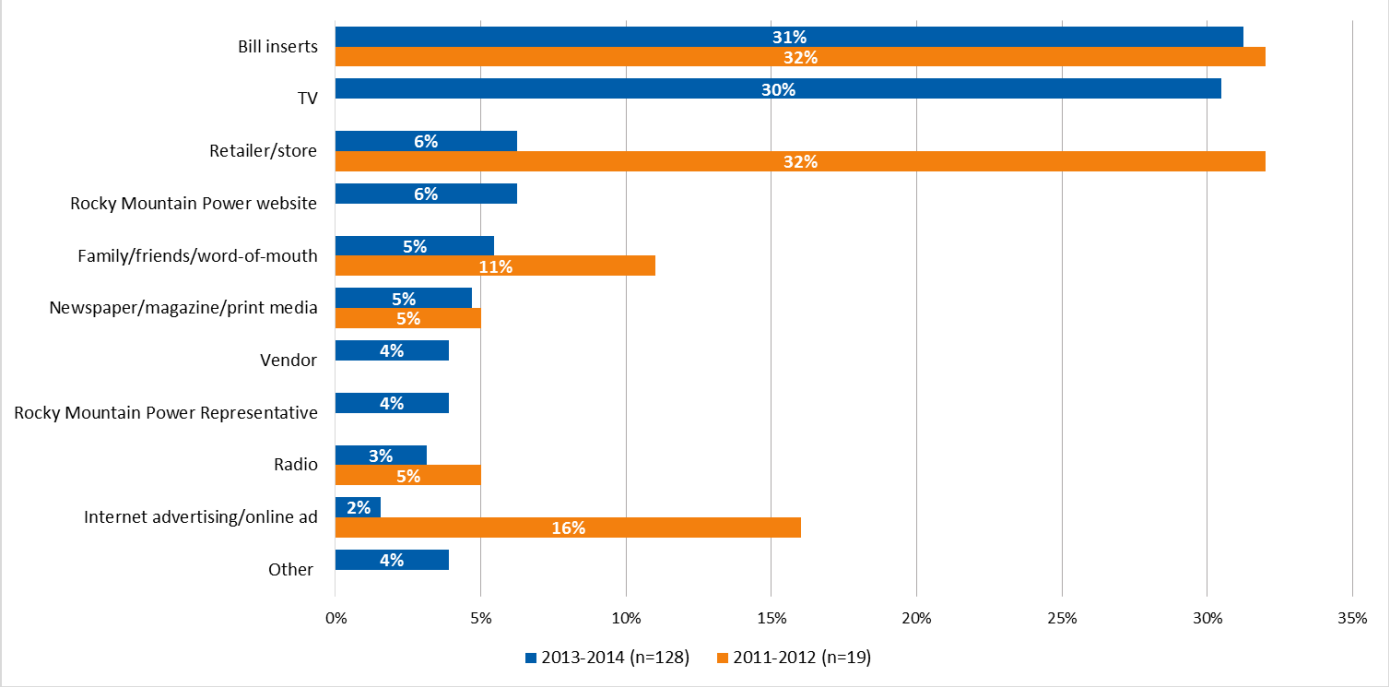
The Utah market's rural customer population also presented significant challenges. As rural Rocky Mountain Power customers did not frequent a participating retailer's store, where they would have seen program advertisements or would have been able to purchase some HES products, program staff began rethinking their marketing and outreach approach with these customers. These conversations ultimately led to the development of the energy efficiency kits, introduced in 2015 (and hence not covered by this evaluation).

Customer Response

Awareness

The general population of Rocky Mountain Power's customers learned of the wattsmart HES program through a variety of means. The most common sources in 2013–2014 changed from the 2011–2012 program years: bill inserts (31%) and TV (30%) were most frequently mentioned in 2013-2014 while bill inserts (32%) and retailers (32%) were most common in 2011-2012.[34] Six percent of customers also learned of the HES program through the Rocky Mountain Power website in 2013–2014, while no customers cited this source in previous years. Figure 16 presents awareness sources over these time periods.[35]

Figure 16. General Population Survey Source of wattsmart Awareness



Source: Rocky Mountain Power Utah HES Residential General Population Survey (QB2, 2011–2012; QD3, 2013–2014). Don't know and refused responses removed.

As shown in Figure 17, non-lighting participants most commonly reported learning of the program through a retailer (32%). Customers also reported learning of the program through bill inserts more often than in previous program years, with 16% of respondents saying they learned of HES from a bill insert during 2013–2014.[36]

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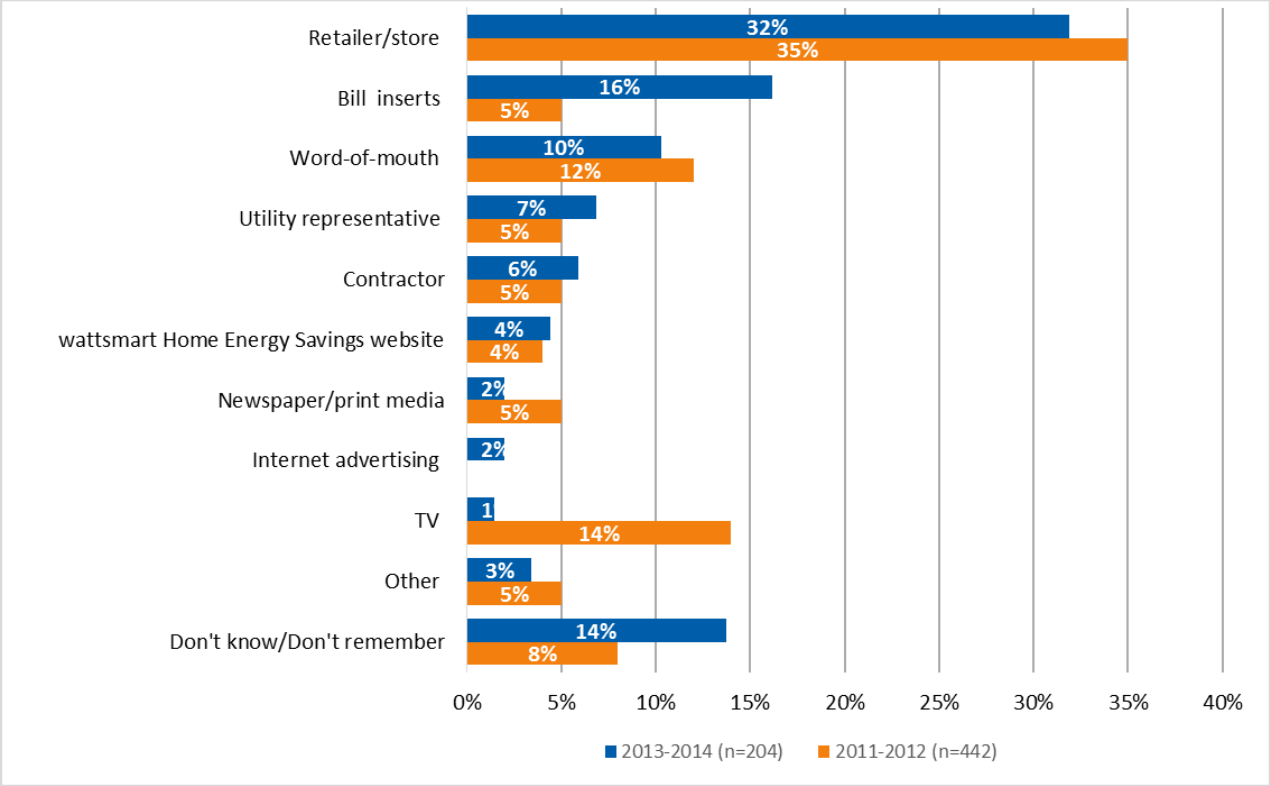
[34] Statistically significant change (p-value <0.10).

[35] Ibid.

[36] Ibid.

Figure 17. Non-Lighting Participant Source of Awareness



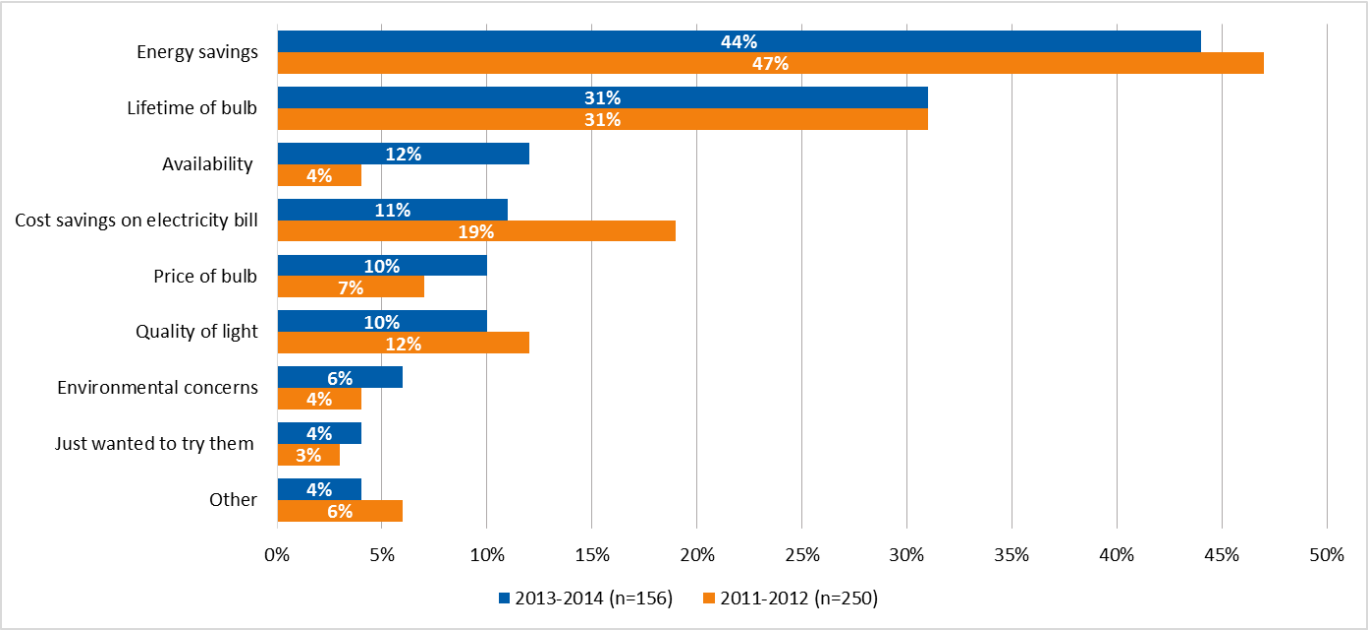
Source: Rocky Mountain Power Utah HES Residential Non-lighting Survey (QM1, 2011–2012; QC1, 2013–2014). Refused responses removed.

Lighting Purchasing Decisions

In the General Population Survey, Rocky Mountain Power Utah customers expressed a variety of reasons for purchasing energy-efficient bulbs (i.e., CFLs or LEDs). Customers most commonly cited energy savings (44%) and bulb lifetimes (31%) as the main reasons for purchasing CFLs over other bulb types. As shown in Figure 18, these reasons remained consistent with 2011–2012 findings, excepting one key difference: 12% of respondents said the wide availability of bulbs influenced their decisions in 2013–2014, whereas just 4% specified this reason in 2011–2012.[37]

[37] Ibid.

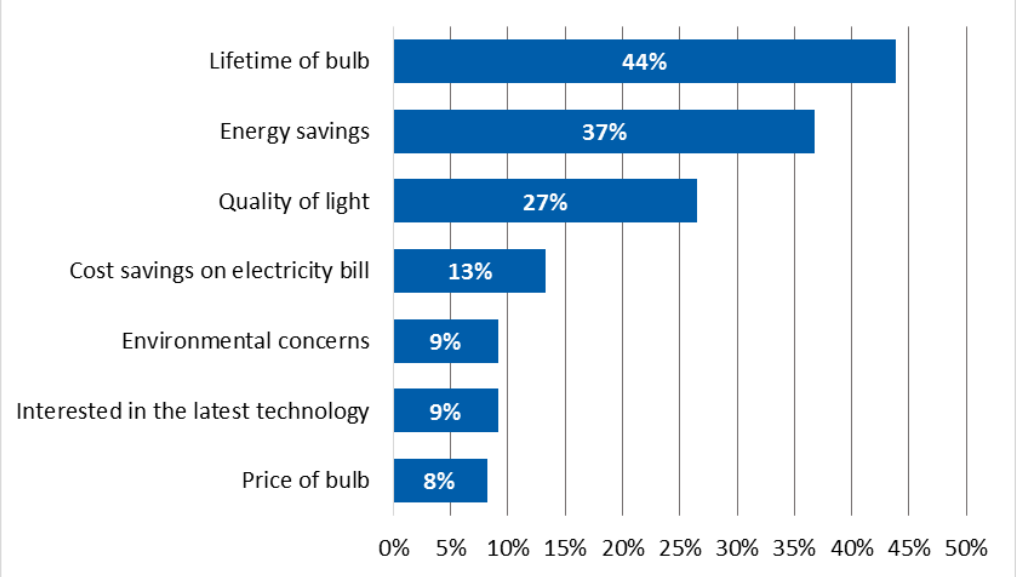
Figure 18. General Population Reasons for Purchasing CFLs over Other Bulb Types



Source: Rocky Mountain Power Utah HES Residential General Population Survey (QE8, 2011–2012; QB8, 2013–2014). Don't know and refused responses removed.

In contrast, LED purchasers' exhibited the inverse motivations of CFL purchasers: these respondents most commonly cited the bulb's lifetime (44%), followed by energy savings (37%), and light quality (27%). Figure 19 shows reasons customers cited for purchasing LEDs over other bulbs.

Figure 19. General Population Reasons for Choosing to Buy LEDs



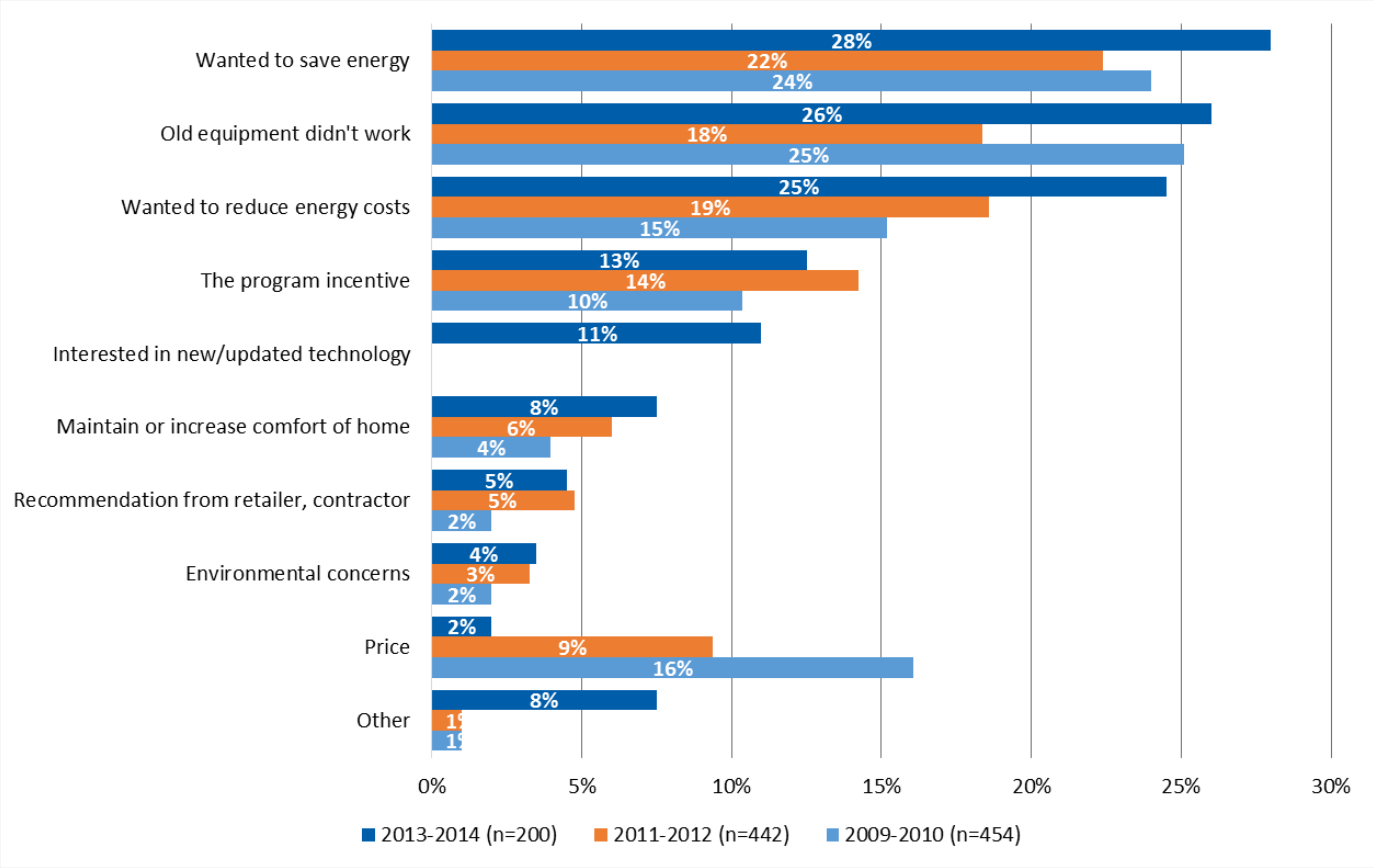
Source: Rocky Mountain Power Utah HES Residential General Population Survey (QC7, 2013–2014) (n=98). Don't know and refused responses removed.

Customers exhibited limited awareness about the bulbs they purchased possibly being part of a sponsored sale, which a very common finding for upstream delivery models. For example, 8% of CFL purchasers and 25% of LED purchasers stated that bulbs they purchased were part of a utility-sponsored sale. Still, those exhibiting awareness of the utility sponsorship found a discount highly influential in their decision to purchase the bulb: 92% of CFL purchasers and 81% of LED purchasers said a discount influenced their decision to buy the bulbs.

Non-Lighting Participation Decisions

As shown in Figure 20, Rocky Mountain Power non-lighting participants described a number of different factors influencing their decisions to participate in the program. Most commonly, participants cited a desire to save energy (28%), followed by replacing old equipment that did not work or worked poorly (26%) and reducing energy costs (25%). These motivations closely matched those participants cited in previous years, except for price.[38] While an important consideration in the past, only 2% of participants mentioned price as a factor in 2013–2014.

Figure 20. Non-Lighting Reasons for Participation



Source: Rocky Mountain Power Utah HES Residential Non-lighting Survey (QC5, 2013–2014) (n=200). Don't know and refused responses removed.

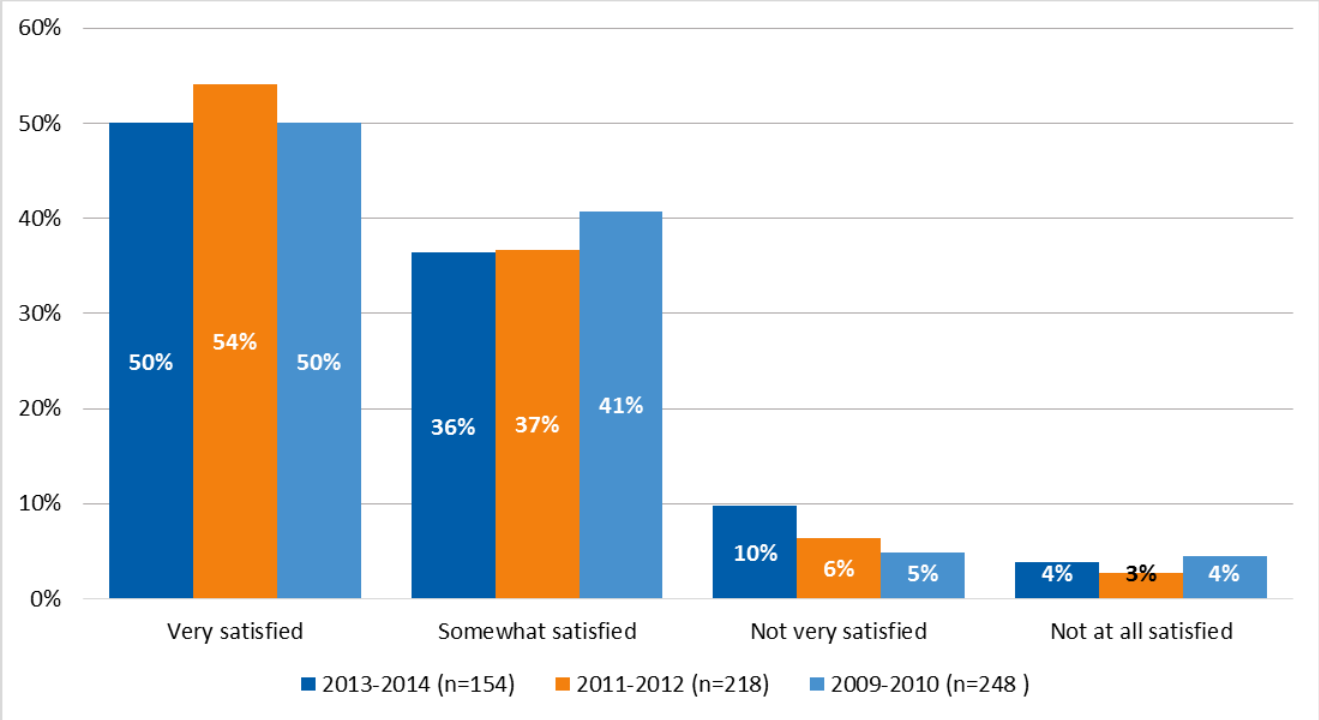
[38] Ibid.

Satisfaction

Lighting

Customers differed somewhat in their satisfaction levels with products they purchased, depending on whether they purchased CFLs or LEDs. Consistent with prior years, 50% of CFL customers said they were very satisfied with their purchase and 36% said they were somewhat satisfied, as shown in Figure 21.

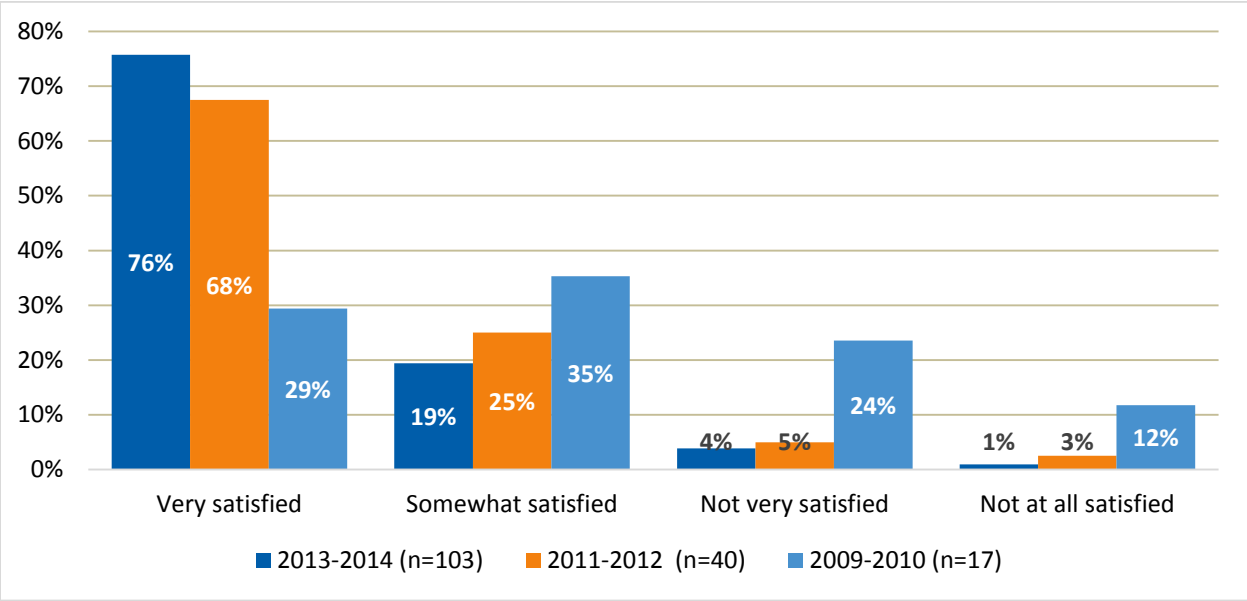
Figure 21. General Population CFL Satisfaction



Source: Rocky Mountain Power Utah HES Residential General Population Survey (QG1, 2011–2012, QB15, 2013–2014). Don't know and refused responses removed.

Customers purchasing LEDs expressed higher satisfaction, with 76% very satisfied and 19% somewhat satisfied. As shown in Figure 22, LED satisfaction levels appear to have increased over the evaluation periods.

Figure 22. General Population LED Satisfaction



Source: Rocky Mountain Power Utah HES Residential General Population Survey (QM8, 2011–2012, QC14, 2013–2014). Don't know and refused responses removed.

Non-lighting

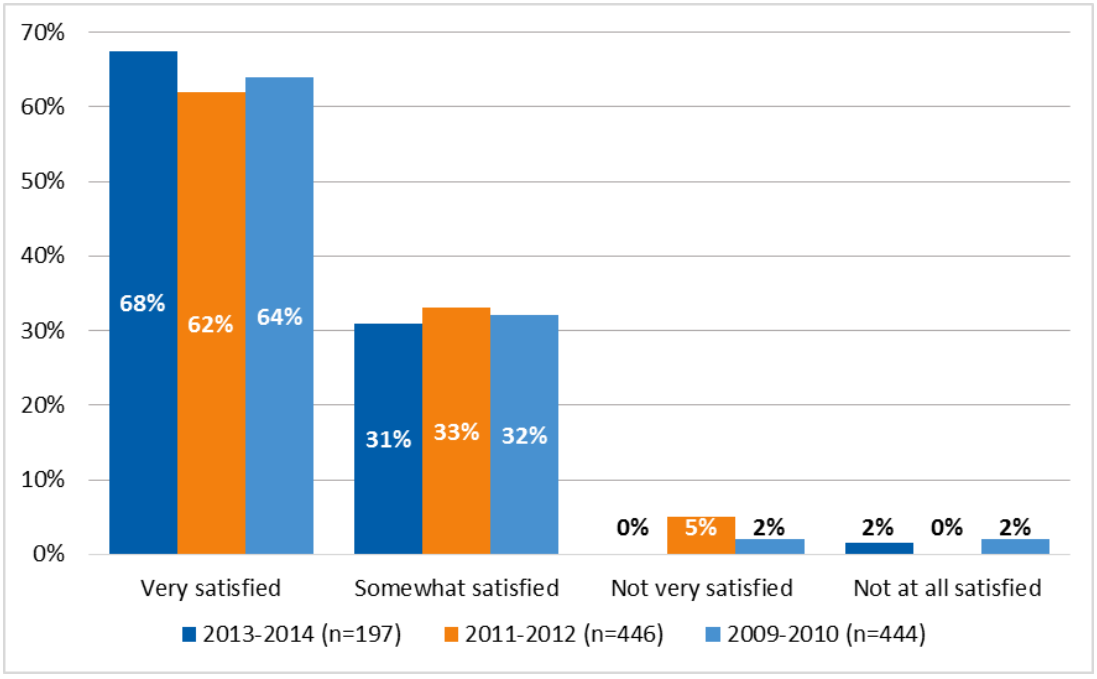
Non-lighting customers overwhelmingly expressed satisfaction with the HES program, with 99% of participants reporting they were very satisfied or somewhat satisfied with the program. Participants provided the following reasons for their satisfaction:

- "Once you found what you [were] looking for it was easy to follow through."
- "The amount of money I received was $20 per LED [fixture]. It was a great reward, and it was easy to apply and track on the website."
- "Good help from the contractors who helped with the application, and I think it's a good program overall."

Most dissatisfied customers could not provide a clear reason for their dissatisfaction. Those that could expressed concerns that the energy-efficient improvements did not lower their utility bills (notably, these were mostly appliance customers).

Satisfaction levels remained fairly stable since 2009, with the 2013–2014 program year demonstrating the highest level of "very satisfied" responses for any program year (68%). Figure 23 illustrates the year-over-year trends.

Figure 23. Non-Lighting Satisfaction with the wattsmart HES Program

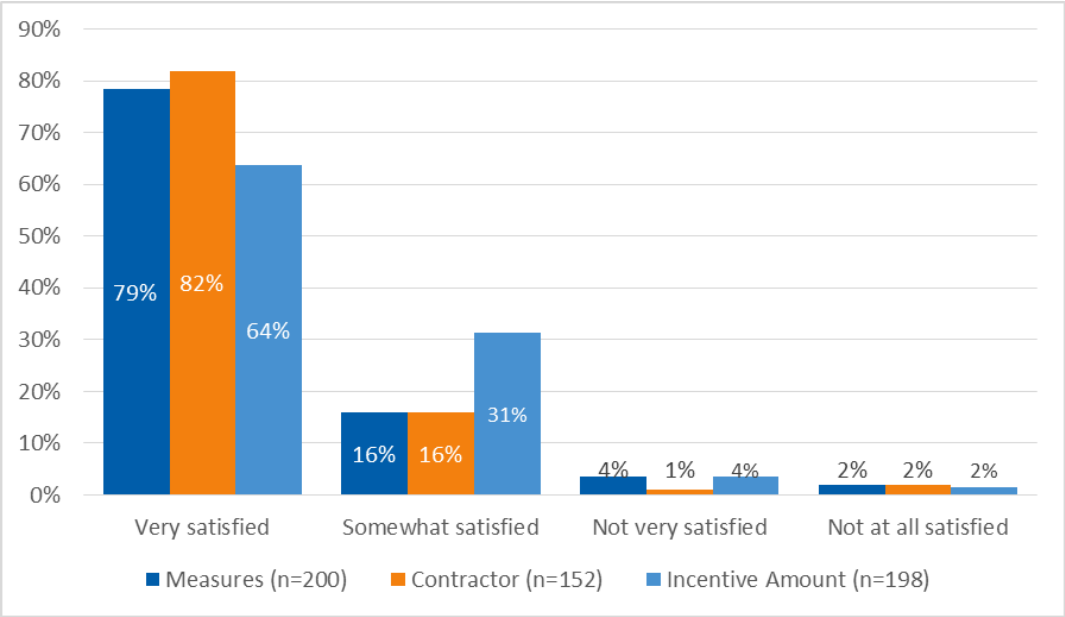


Source: Rocky Mountain Power Utah HES Residential Non-lighting Survey (QF9, 2011–2012, QE10, 2013–2014). Don't know and refused responses removed.

When asked whether their HES program participation caused their satisfaction with Rocky Mountain Power to change, 34% of non-lighting customers said it increased their satisfaction, 58% said it stayed the same, and 8% said it decreased.

In addition to their overall satisfaction with the HES program, non-lighting customers expressed high satisfaction levels with the measures they installed, their contractors, and the incentive amounts they received. As shown in Figure 24, 79% of non-lighting customers said they were very satisfied with measures installed, and 16% said they were somewhat satisfied.

Figure 24. Non-Lighting Satisfaction with Measures, Contractors, Incentive Amounts



Source: Rocky Mountain Power Utah HES Residential Non-lighting Survey (QE1, E3, E6 2013–2014). Don't know and refused responses removed.

About three-quarters of participants hired contractors to install measures for which they received program incentives; 82% of these participants reported being very satisfied with their contractors and 16% were somewhat satisfied. A slightly smaller share of participants expressed satisfaction with the incentive amounts they received, with 64% reporting they were very satisfied with the incentive amounts. An additional 31% said they were somewhat satisfied, and just 6% said they were not very or not at all satisfied.

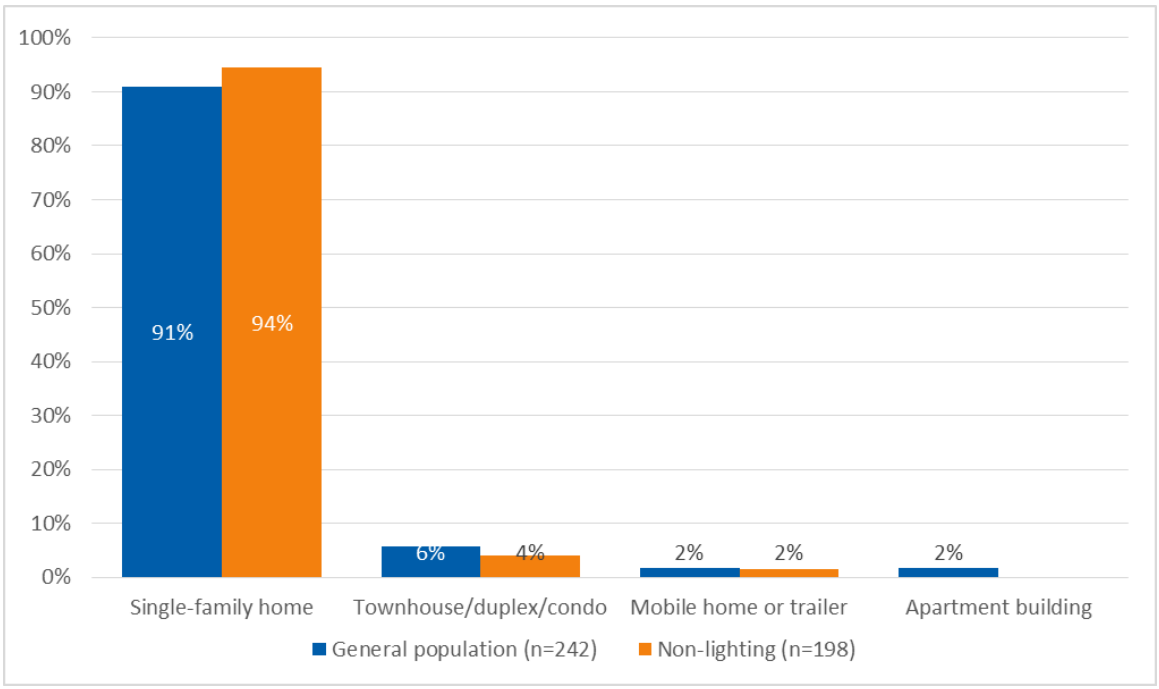
Non-lighting customers also found the HES program incentive application easy to fill out, with 71% of respondents reporting it very easy to fill out, 25% reporting it somewhat, 1% reporting it not very easy, and 3% reporting it not at all easy. Participants experiencing difficulty with filling out the application noted the following challenges:

- "I just wasn't able to navigate it very well."
- "It was repetitive."
- "Because I had to get copies of forms for every [online] window."
- "It was too long and requested info that no user would ever have on hand; I had to go back to the dealer for more information."

Customer Demographics

As shown in Figure 25, most of the general population surveyed and non-lighting participants lived in single-family homes, with a small percentage of customers residing in condominiums, townhomes, apartments, or mobile homes.

Figure 25. General Population and Non-Lighting Residence Types

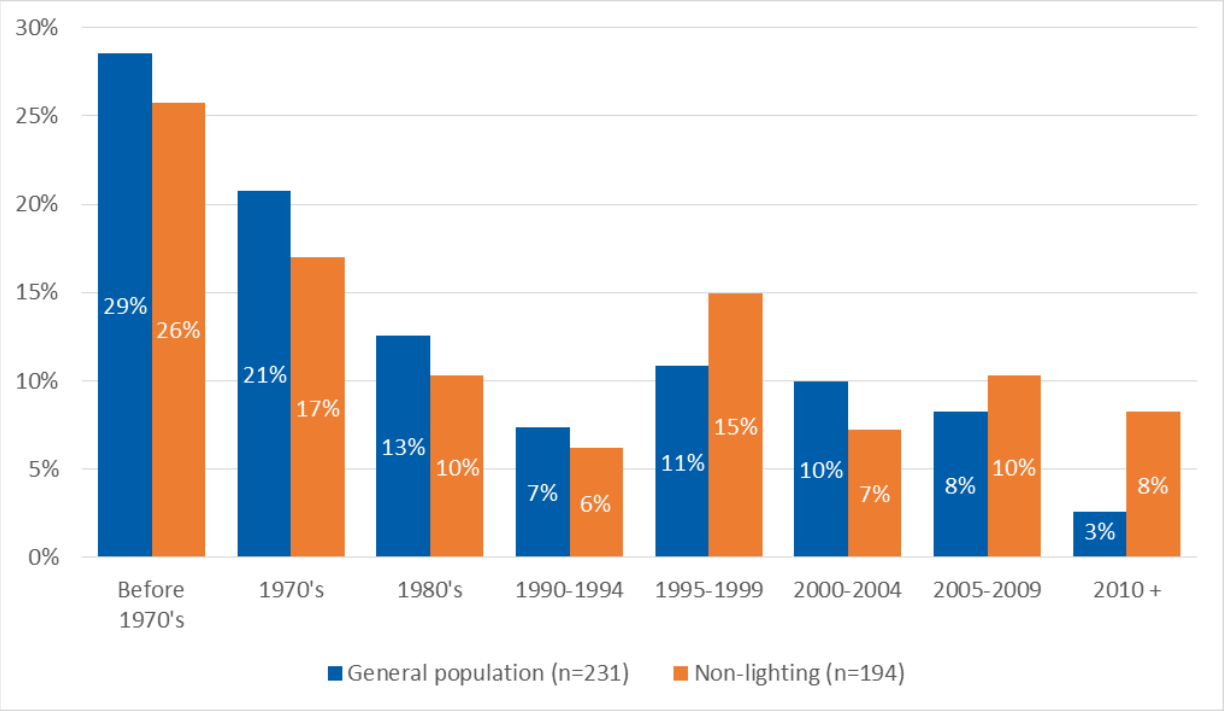


Source: Rocky Mountain Power Utah HES Residential General Population and Non-lighting Surveys
Don't know and refused responses removed.

Ninety-five percent of the general population surveyed and 98% of non-lighting participants reported owning their own homes. Both survey respondent groups reported similar home vintages, with one exception: more non-lighting participants owned homes built within the last five years (8%) than the general population (3%), as shown in Figure 26. Non-lighting participants also tended to live in larger homes, with 42% of participants reporting they lived in a home of 2,500 square feet or greater.

Customer demographics did not appear to greatly influence how customers learned of the program or the reasons they chose to participate. Single-family home residents (29%) appeared slightly more motivated to save energy than townhome or condominium residents (12%), while townhome or condominium residents were slightly more motivated to participate due to their interest in new technology (25%) as opposed to single-family home residents (11%).

Figure 26. General Population and Non-Lighting Home Age



Source: Rocky Mountain Power Utah HES Residential General Population and Non-lighting Surveys
Don't know and refused responses removed.

Cost-Effectiveness

In assessing HES program cost-effectiveness, Cadmus analyzed program costs and benefits from five different perspectives, using Cadmus' DSM Portfolio Pro[39] model. The California Standard Practice Manual for assessing DSM program cost-effectiveness describes the benefit/cost ratios Cadmus used for the following five tests:

1. **PacifiCorp Total Resource Cost (PTRC) Test:** This test examined program benefits and costs from Rocky Mountain Power's and Rocky Mountain Power customers' perspectives (combined). On the benefit side, it included avoided energy costs, capacity costs, and line losses, plus a 10% adder to reflect non-quantified benefits. On the cost side, it included costs incurred by both the utility and participants.
2. **Total Resource Cost (TRC) Test:** This test also examined program benefits and costs from Rocky Mountain Power's and Rocky Mountain Power customers' perspectives (combined). On the benefit side, it included avoided energy costs, capacity costs, and line losses. On the cost side, it included costs incurred by both the utility and participants.
3. **Utility Cost Test (UCT):** This test examined program benefits and costs solely from Rocky Mountain Power's perspective. The benefits included avoided energy, capacity costs, and line losses. Costs included program administration, implementation, and incentive costs associated with program funding.
4. **Ratepayer Impact Measure (RIM) Test:** All ratepayers (participants and nonparticipants) may experience rate increases designed to recover lost revenues. The benefits included avoided energy costs, capacity costs, and line losses. Costs included all Rocky Mountain Power program costs and lost revenues.
5. **Participant Cost Test (PCT):** From this perspective, program benefits included bill reductions and incentives received. Costs included a measure's incremental cost (compared to the baseline measures), plus installation costs incurred by the customer.

Table 69 summarizes the five tests' components.

[39] DSM Portfolio Pro has been independently reviewed by various utilities, their consultants, and a number of regulatory bodies, including the Iowa Utility Board, the Public Service Commission of New York, the Colorado Public Utilities Commission, and the Nevada Public Utilities Commission.

Table 69. Benefits and Costs Included in Various Cost-Effectiveness Tests

Test	Benefits	Costs
PTRC	Present value of avoided energy and capacity costs,* with a 10% adder for non-quantified benefits	Program administrative and marketing costs, and costs incurred by participants
TRC	Present value of avoided energy and capacity costs*	Program administrative and marketing costs, and costs incurred by participants
UCT	Present value of avoided energy and capacity costs*	Program administrative, marketing, and incentive costs
RIM	Present value of avoided energy and capacity costs*	Program administrative, marketing, and incentive costs, plus the present value of lost revenues
PCT	Present value of bill savings and incentives received	Incremental measure and installation costs

*Includes avoided line losses.

Table 70 provides selected cost analysis inputs for each year, including evaluated energy savings, discount rated, line loss, inflation rated, and total program costs. Rocky Mountain Power provided all of these values, except for energy savings and the discount rate, which Cadmus derived from Rocky Mountain Power's 2013 *Integrated Resource Plan*.

Table 70. Selected Cost Analysis Inputs

Input Description	2013	2014	Total
Evaluated Gross Energy Savings (kWh/year)*	92,323,042	71,864,261	164,187,303
Discount Rate	6.88%	6.88%	N/A
Line Loss	9.32%	9.32%	N/A
Inflation Rate**	1.9%	1.9%	N/A
Total Program Costs	$20,792,304	$26,170,674	46,962,978

*Savings are realized at the meter, while benefits account for line loss.

**Future retail rates determined using a 1.9% annual escalator.

HES program benefits included energy savings and their associated avoided costs. For the cost-effectiveness analysis, Cadmus used this study's evaluated energy savings and measure lives from sources such as the RTF.[40] For all analyses, Cadmus used avoided costs associated with Rocky Mountain Power's 2013 *IRP Eastside Class 2 DSM Decrement Values*.[41]

Cadmus analyzed HES program cost-effectiveness for net savings with evaluated freeridership and spillover incorporated.

[40] See Appendix G for detailed cost-effectiveness inputs and results at the measure category level.

[41] Appendix N of PacifiCorp's *2013 Integrated Resource Plan* details the IRP decrements: http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Integrated_Resource_Plan/2013IRP/PacifiCorp-2013IRP_Vol2-Appendices_4-30-13.pdf

Table 71 presents the 2013–2014 program cost-effectiveness analysis results, including the evaluated NTG (but not accounting for non-energy benefits [except those represented by the 10% conservation adder included in the PTRC]). For this scenario, the HES program proved cost-effective from all perspectives, except the RIM test. The primary criterion for assessing cost-effectiveness in Utah is the UCT, which achieved a 2.04 benefit/cost ratio for the combined years' net savings.

The RIM test measures program impacts on customer rates. Many programs do not pass the RIM test because, while energy efficiency programs reduce costs, they also reduce energy sales. As a result, the average rate per unit of energy may increase. A passing RIM test indicates that rates, as well as costs, will go down as a result of the program. Typically, this only happens for demand response programs or programs that are targeted to the highest marginal cost hours (when marginal costs are greater than rates).

Table 71. HES Program Cost-Effectiveness Summary for 2013–2014 (Evaluated Net)

Cost-Effectiveness Test	Levelized $/kWh	Costs	Benefits	Net Benefits	Benefit/ Cost Ratio
PTRC (TRC + 10% Conservation Adder)	$0.096	$82,583,696	$101,696,330	$19,112,634	1.23
TRC No Adder	$0.096	$82,583,696	$92,451,645	$9,867,950	1.12
UCT	$0.053	$45,282,677	$92,451,645	$47,168,968	2.04
RIM		$137,344,020	$92,458,047	($44,885,972)	0.67
PCT		$95,113,688	$162,472,086	$67,358,398	1.71
Lifecycle Revenue Impacts ($/kWh)					$0.000113657
Discounted Participant Payback (years)					4.17

Table 72 presents the 2013 program cost-effectiveness analysis results, including the evaluated NTG, but not accounting for non-energy benefits (except those represented by the 10% conservation adder included in the PTRC). For this scenario, the HES program proved cost-effective from all perspectives except for RIM.

Table 72. HES Program Cost-Effectiveness Summary for 2013 (Evaluated NTG)

Cost-Effectiveness Test	Levelized $/kWh	Costs	Benefits	Net Benefits	Benefit/ Cost Ratio
PTRC (TRC + 10% Conservation Adder)	$0.097	$42,916,759	$50,655,816	$7,739,057	1.18
TRC No Adder	$0.097	$42,916,759	$46,050,742	$3,133,983	1.07
UCT	$0.047	$20,792,304	$46,050,742	$25,258,439	2.21
RIM		$67,112,029	$46,050,742	($21,061,287)	0.69
PCT		$48,884,330	$81,989,613	$33,105,283	1.68
Lifecycle Revenue Impacts ($/kWh)					$0.000054127
Discounted Participant Payback (years)					3.60

Table 73 presents the 2014 program cost-effectiveness analysis results, including evaluated NTG, but not accounting for non-energy benefits (except those represented by the 10% conservation adder included

in the PTRC). For this scenario, again, the HES program proved cost-effective from all perspectives except the RIM test.

Table 73. HES Program Cost-Effectiveness Summary for 2014 (Evaluated NTG)

Cost-Effectiveness Test	Levelized $/kWh	Costs	Benefits	Net Benefits	Benefit/ Cost Ratio
PTRC (TRC + 10% Conservation Adder)	$0.096	$42,396,815	$54,553,122	$12,156,307	1.29
TRC No Adder	$0.096	$42,396,815	$49,594,213	$7,197,398	1.17
UCT	$0.059	$26,175,801	$49,594,213	$23,418,412	1.89
RIM		$75,065,356	$49,601,056	($25,464,300)	0.66
PCT		$49,410,863	$86,021,277	$36,610,414	1.74
Lifecycle Revenue Impacts ($/kWh)					$0.000064096
Discounted Participant Payback (years)					3.90

Conclusions and Recommendations

Based on the findings previously presented, Cadmus offers the following conclusions and recommendations.

Measure Categorization

Some measure categories were assigned based on delivery channels rather than end uses (e.g., light fixtures were assigned as appliances while in the downstream delivery channel). For cost-effectiveness purposes, measure categories should be allocated by end use to ensure employing the most appropriate load shape.

Recommendation

Assign measure categories by end use to ensure use of the most appropriate cost-effectiveness results. Ensure consistent applications of measure categories in all data tracking and reporting efforts (including annual reports, evaluations, and participant databases).

Upstream Lighting Tracking Database

While Cadmus was able to match the quantities and savings in the lighting tracking database to annual reports, the data proved challenging to use for evaluation purposes. Specifically, Cadmus encountered difficulties in mapping the lighting tracking database to the price scheduling database.

The tracking database contained several inconsistences: bulb types were inconsistently defined for each SKU; SKUs and model numbers were used interchangeably; and reconciled quantities were inconsistently labeled. The program administrator also could not provide detailed tracking information on product merchandising or promotional events. Data tracking, however, improved significantly between 2013 and 2014. Many of the inconsistencies were changes due to manufacturers updating descriptions between price schedules (the negotiated period for which prices and incentives are agreed upon between manufacturers/retailers and the program implementer). The 2014 tracking data included the schedule name in both the pricing data as well as the sales data, which improved the accuracy in matching prices to sales rather than having to rely on inconsistent secondary descriptions. If the data continues to be collected in the same way for 2015-2016 as it was in 2014, Cadmus will not face as many challenges in the next evaluation.

Recommendation

Track all data in a consistent manner across each program period. This specifically includes the following:

- Provide consistently defined bulb types for each SKU;
- Provide consistent SKUs or model numbers;
- Provide tracking data with final and reconciled quantities; and

- Track all product merchandising and promotional events (was not tracked in either 2013 or 2014).

Lighting Cross-Sector Sales

Cadmus estimated that 3.9% of efficient bulbs purchased at retail store ultimately would be installed in commercial applications, which is a similar result to findings in other jurisdictions that also implement upstream lighting programs. Bulbs installed in commercial spaces produce more first-year savings than bulbs installed in a residential space as commercial locations typically have a higher daily use of bulbs than residential locations (i.e., higher HOU). Currently, Rocky Mountain Power does not account for cross-sector sales from the upstream lighting incentives.

Recommendation

Other jurisdictions around the country increasingly have accommodated cross-sector sales factors in calculating reported lighting savings. Cadmus recommends that Rocky Mountain Power explore accounting for commercial installation of upstream bulbs in the reported savings.

Accounting for these installations can be complex due the nature of the split between residential and nonresidential programs within the wattsmart portfolio. One option would be to calculate savings values for each bulb, accounting for the different HOUs for residential and nonresidential installations weighted by the cross-sector sales factor. This option would also require calculating a lower measure life to account for commercial bulbs burning out faster. Finally, Rocky Mountain Power would then need to decide if all of the lighting savings from the program would fall under the residential wattsmart portfolio or if some of the savings would be transferred onto the nonresidential side.

Nonparticipant Spillover

Nonparticipant spillover results in energy savings caused by, but not rebated through, utilities' demand-side management activities. Effective program marketing and outreach generates program participation and increases general energy efficiency awareness among customers. The cumulative effect of sustained utility program marketing can affect customers' perceptions of their energy usage and, in some cases, motivate customers to take efficiency actions outside of the utility's program.

Through responses to the general population survey, Cadmus estimated nonparticipant spillover as 1% of HES program savings. Due to the introduction of this type of spillover to the evaluation, Cadmus did not apply this adjustment.

Recommendation

Consider allowing nonparticipant spillover to be an integral component of NTG estimations for all programs.

Lighting Leakage

Through intercept surveys conducted with customers purchasing light bulbs at 15 participating retail stores, Cadmus found that lighting leakage rates were an average of roughly 5.1 percentage points

higher than predicted by the RSAT, with a confidence level of 90% and precision of ± 5.3%, indicating that the RSAT is performing well as a predictor of bulb leakage.

Cadmus estimated a leakage rate of 49.8% across all surveyed stores outside of (but bordering) Rocky Mountain Power's territory, indicating that one-half of the bulbs purchased at these stores likely were installed within Rocky Mountain Power's territory. These stores did not have RSAT scores to compare against.

Customers were more likely to purchase CFLs and LEDs at participating stores (53% of bulbs purchased were CFLs or LEDs) than at nonparticipating stores (13% of bulbs purchased were CFLs or LEDs) in Utah.

Recommendation

The RSAT allocation score is performing well in Utah. Rocky Mountain Power should continue using the RSAT to determine which stores in its territory should be included as participating stores in the program.

Lighting Spillover

This evaluation examined a portion of spillover found from the upstream lighting leakage survey through store intercepts, however, it was not an exhaustive view of spillover since sufficient time could not pass for customers to implement measures. Also, the store intercept sampling plan was primarily designed to support the RSAT calculations, meaning that most sampled stores either were on the edges or outside of Rocky Mountain Power's territory. Therefore, the 0.4% spillover calculated is likely a low estimate and further studies are needed to estimate lighting spillover.

Recommendation

Consider additional studies to quantify spillover (and potentially market transformation) for use in lighting NTG calculations.

Customer Outreach

Bill inserts and retailers constituted the most commonly cited program awareness sources for non-lighting participants. While the program website was an influential source of general wattsmart awareness for the general population, it did not serve as a main participation driver for the non-lighting program.

Recommendation

Continue to pursue a multi-touch marketing strategy, using a mix of bill inserts and retailer/contractor training. Given the large percentage of customers who learned of wattsmart offerings through bill inserts, examine the proportion of customers selecting to receive online bills and ensure these online channels proportionately advertise the programs with the messages that motivated customers to participate: long-lasting products, saving energy, replacing equipment and reducing costs.

Application Processing

Efforts to improve the ease of completing the non-lighting incentive application appear to have succeeded: non-lighting participants reported faster incentive check processing times and relative ease in filling out applications. Ninety-six percent of survey respondents found it very easy to fill out the incentive application.

Despite these substantive improvements, participant-reported application processing times remained lengthy for duct sealing and insulation customers and also attic, floor, and wall insulation, indicating opportunities for improvements regarding specific measures.

Recommendation

Continue to review methods for simplifying the applications, particularly for duct sealing and insulation applications which have been prone to greater data entry errors. Implement additional training for HVAC and weatherization contractors to help mitigate this issue by reviewing the criteria required for a complete application and how to best support a customer who chooses to fill out the application. Explore making duct sealing and insulation an online application to reduce errors.

Satisfaction with Program Experience

Customers generally expressed satisfaction with their program experiences, including high satisfaction levels with contractors. While Cadmus was not able to verify the efficacy of the program administrator's efforts to reach out to non-registered contractors who worked with rebate-seeking participants, the program's efforts to mitigate contractor confusion regarding tariff changes appeared to support the customers' reported satisfaction.

Recommendation

Continue regular trainings with trade allies (e.g., distributors, retailers, sales associates, contractors), updating them on tariff changes and, where appropriate, supporting them with sales and marketing training. Analyze success of efforts to register non-registered contractors who worked with rebate participants within 90 days to determine whether the additional outreach mitigated the number of rejected applications due to non-qualified contractors.

Appendices

A separate volume contains the following appendices:

Appendix A. Survey and Data Collection Forms

Appendix B. Lighting Impacts

Appendix C. Billing Analysis

Appendix D. Self-Report NTG Methodology

Appendix E. Nonparticipant Spillover

Appendix F. Lighting Retailer Allocation Review

Appendix G. Measure Category Cost-Effectiveness

Appendix H. Logic Model

Appendix A. Survey Instruments and Data Collection Tools

Management Staff and Program Partner Interview Guide A-1
Rebate Participant Survey A-5
Upstream Lighting Survey A-32
Lighting Leakage Survey A-57

CADMUS

PacifiCorp HES Program PM Staff Interview Guide
PY 2013 - 2014

Name:

Title:

Interviewer:

Date of Interview:

Introduction

The purpose of the interview is to explore your experience with the HES Program. We use input from a variety of staff involved with the program to describe how the program worked during 2013 and 2014, what made it successful, and where there may be opportunities for improvement. Please feel free to let me know if there are questions that may not apply to your role so that we can focus on the areas with which you have worked most closely.

Program Overview, Management Roles and Responsibilities:

1. To start, please tell me about your role and associated responsibilities with the HES Program.

a. How long have you been involved?

b. Who are the other key PacifiCorp staff involved in the 2013 and 2014 program period and what are their roles?

Program Goal and Objectives:

2. How would you describe the main objective of the 2013 and 2014 HES Program?

3. What were the savings and participation goals of the program for 2013 and 2014? How did the program do with respect to those goals?

4. Did the program have any informal or internal goals/Key Performance Indicators for this year, such as level of trade ally engagement, participant satisfaction, participation in certain regions, etc.?

a. How or why were these goals developed?

b. How did the program perform in terms of reaching the internal goals (for each state)?

5. Please walk me through how the program worked from a customer perspective. For example, how would a customer hear about the program, how would participation be initiated, and what steps would I go through as a customer? (for all delivery channels – upstream, rebate and kits).

6. How did this customer experience differ among the five states?

7. [If not covered above] Please tell me about how the program worked with trade allies. What types of trade allies did you work with? What are their roles and responsibilities?

Program Design:

Thank you. Now I'd like to ask you about the program design.

8. [If not answered above] Who is your target market for this program?

9. How well did the current program design meet customer needs? (Probe: measures, incentive levels, documentation required, etc.)

10. Were any major changes made to the program since 2012? (incentives, program components (kits), etc) [Probe: Simple Steps, kits]?

a. What was the reason kits were introduce to ID, CA and WA? Are there plans to provide the kits in UT and WY too?

b. Are the kits a standard set of measures or can customers choose which components they want? How is this tracked? [Cadmus will request the specifications for each kit item during a follow-up data request]

c. Were any changes made to the rebate application forms (recommendation from last evaluation)?

d. Have there been any tariff changes since 2012?

11. What worked well in the 2013-2014 period?

12. Conversely, what was not working as well as anticipated?

13. What barriers or challenges did the program face in 2013-2014? What was done/what is planned to address them?

14. What changes are planned or now in place for the HES program (by state)?

15. What was the program's QA/QC process like in 2013-2014? Would you please describe that?

16. In your opinion, what other ways can the program design be improved? (Probe: What? Why?)

Program Marketing

17. [If not covered above] Please describe how the program was marketed (through the website, one-on-one outreach, through trade allies, etc.)?

18. Do you have a marketing plan from 2013-2014 you could share with me? What were the primary marketing activities during that time period?

a. Did all five states use the same marketing plan and tactics?

b. How did the messaging differ in the five states?

c. How much of the marketing is wattsmart vs program specific (HES)?

d. Who is the primary target audience for the program?

19. Did you track marketing effectiveness? What did you track?

a. What was the most effective marketing approach? (Why do you say this?)

Customer Experience:

20. Did you have a process by which you receive customer feedback about the program? (Probe: What is that process and how frequently does it happen, what happens to the information, if a response is required who does that?)

21. What feedback did you receive from customers about the program? What did they say? (Probe: incentive levels, timing for project approvals, incentive payments, satisfaction with studies, trade allies, etc.)

Trade Ally Experience:

22. How did the program recruit trade allies (contractors and retailers)?

23. Do you feel you had sufficient trade allies to support the program? Why or why not?

24. What barriers have the trade allies said they encounter with the program?

    a. What steps have been taken to address these?

    b. What remains to be done to remove these barriers?

25. What kind of training was required and/or offered for trade allies? How frequently and on what topics?

26. Did the program provide marketing resources or sales training to trade allies?

Data Tracking and Savings

27. Please tell us about program data tracking and reporting. How were rebate forms processed? (Probe: What systems did they use, how well did systems communicate, how did trade allies and other stakeholders submit information to the program?). Please describe for all delivery mechanisms (rebates, upstream, kits).

28. Did the data tracking systems in place meet your needs? Why or why not?

29. How were savings deemed for each program measure? How often were the unit energy savings values updated? [Cadmus will request unit energy saving calculators/assumptions during a follow-up data request]

Closing

30. Are there specific topics you are interested in learning more about from our evaluation this year?

31. For the purposes of our customer survey, what should we call the program? Will customers recognize Home Energy Savings, or should we use wattsmart/bewattsmart?

Thank you very much for your time today!

CADMUS

PacifiCorp Home Energy Savings Participant Survey

[UTILITY]

Washington: Pacific Power

Utah, Wyoming, and Idaho: Rocky Mountain Power

Audience: This survey is designed for PacifiCorp residential customers in Utah, Idaho, Washington, and Wyoming that applied for an incentive through the incentive application process in 2013 or 2014. The primary purpose of this survey is to collect information on measure installation, program awareness, motivations to participate, satisfaction, freeridership and spillover effects. This survey will be administered through telephone calls.

Quota: 204 completed surveys for each state (UT, ID, WA, and WY)

Topics	Researchable Questions	Survey Questions
Measure Verification	Did program measure(s) get installed in the household?	Section B
Program Awareness and Purchase Decisions	How did the customer learn about the program? Has the customer been to the wattsmart website (feedback)? Why did the customer purchase the program measure?	Section C
Measure Usage	How is the customer using certain common household appliances and equipment? What was replaced when the new measure was installed?	Section D
Satisfaction	How satisfied is the customer with the measure? With the contractor? With the incentive amount and time it took to receive it? With the overall application process? With the program overall?	Section E
Net-to-Gross	Self-reported freeridership and spillover batteries	Section F and G
Demographics	Customer household information for statistical purposes	Section H

- Interviewer instructions are in green.
- CATI programming instructions are in red.

[MEASURE]

["MEASURE TYPES" TO BE USED IN THE INTERVIEWER INSTRUCTIONS/SKIP PATTERN ARE INCLUDED IN GREEN FONT IN THE TABLE OF MEASURES]

Measure Name	Measure Type for Interviewer Instructions/ Skip Pattern
Air sealing	SEALING
Duct Sealing	SEALING
Duct Sealing and Insulation	SEALING
Ceiling Fan	OTHER
Central Air Conditioner	COOLING
Central Air Conditioner Best Practice Installation	SERVICE
Central Air Conditioner Proper Sizing	SERVICE
Clothes Washer	CLOTHES WASHER
Computer Monitor	OTHER
Desktop Computer	OTHER
Dishwasher	OTHER
Ductless Heat Pump	HEATING/COOLING
Evaporative Cooler	COOLING
Portable Evaporative Cooler	COOLING
Flat Panel TV	OTHER
Freezer	OTHER
Furnace	HEATING
Ground Source Heat Pump	HEATING/COOLING
Heat Pump	HEATING/COOLING
Heat Pump Service	SERVICE
Heat Pump Water Heater	OTHER
Light Fixture	LIGHTING
Refrigerator	OTHER
Room Air Conditioner	ROOM AC
Electric Water Heater	OTHER
Attic Insulation	INSULATION
Wall Insulation	INSULATION
Floor Insulation	INSULATION
Windows	WINDOWS

A. Introduction

A1. **[TO RESPONDENT]** Hello, I'm **[INSERT FIRST NAME]** I am calling from **[INSERT SURVEY FIRM]** on behalf of **[INSERT UTILITY].** We are exploring the impacts of energy efficiency programs offered in your area. I'm not selling anything; I just want to ask you some questions about your energy use and the impact of promotions that have been run by **[INSERT UTILITY]**.

Responses to Customer Questions [IF NEEDED]

(**Timing**: This survey should take about 15 minutes of your time. Is this a good time for us to speak with you?

(**Who are you with**: I'm with **[INSERT SURVEY FIRM]**, an independent research firm that has been hired by **[INSERT UTILITY]** to conduct this research. I am calling to learn about your experiences with the **[INSERT MEASURE]** that you received through **[INSERT UTILITY]**'s wattsmart Home Energy Savings program. [IF NEEDED] You may have received other equipment or benefits through **[INSERT UTILITY]**'s wattsmart Home Energy Savings program, however, we are interested in focusing on the **[INSERT MEASURE]** that you received.

(**Sales concern**: I am not selling anything; we would simply like to learn about your experience with the products you bought and received an incentive for through the program. Your responses will be kept confidential. If you would like to talk with someone from the wattsmart Home Energy Savings Program about this study, feel free to call 1-800-942-0266, or visit their website: http://www.homeenergysavings.net)

(**Who is doing this study: [INSERT UTILITY]**, your electric utility, is conducting evaluations of several of its efficiency programs, including the Home Energy Savings program.)

(**Why you are conducting this study:** Studies like this help **[INSERT UTILITY]** better understand customers' needs and interests in energy programs and services.)

A2. Our records show that in **[INSERT YEAR]** your household received an incentive from **[INSERT UTILITY]** for purchasing **[IF QUANTITY =1; "A OR AN"] [INSERT MEASURE NAME]** through the wattsmart Home Energy Savings program. We're talking with customers about their experiences with the incentive program. Are you the best person to talk with about this?

1. Yes
2. No, not available **[SCHEDULE CALLBACK]**
3. No, no such person **[THANK AND TERMINATE]**

98. Don't Know **[TRY TO REACH RIGHT PERSON; OTHERWISE TERMINATE]**
99. Refused **[THANK AND TERMINATE]**

A3. Were you the primary decision-maker when deciding to purchase the **[INSERT MEASURE](S)]**?

1. Yes
2. No **[REQUEST TO SPEAK TO THE PRIMARY DECISION MAKER, IF AVAILABLE START OVER, IF NOT, SCHEDULE TIME TO CALL BACK]**
98. Don't Know **[THANK AND TERMINATE]**
99. Refused **[THANK AND TERMINATE]**

A4. Have you, or anyone in your household, ever been employed by with **[INSERT UTILITY]** or any of its affiliates?

1. Yes **[THANK AND TERMINATE]**
2. No **[CONTINUE]**
98. Don't Know **[THANK AND TERMINATE]**
99. Refused **[THANK AND TERMINATE]**

B. Measure Verification

Now I have a few questions to verify my records are correct.

[FOR SECTION B "MEASURE VERIFICATION, FOLLOW THE RULES BELOW TO DETERMINE WHICH QUESTIONS TO ASK BEFORE CONTINUING TO SECTION C:
IF MEASURE TYPE = SEALING OR SERVICE SKIP TO B7 AND ASK QUESTIONS B7 TO B8;
IF MEASURE TYPE = INSULATION OR WINDOWS SKIP TO B9 AND ASK QUESTIONS B9 TO B14;
ALL REMAINING MEASURE TYPES, CONTINUE TO B1 AND ASK QUESTIONS B1 TO B6]

B1. **[INSERT UTILITY]** records show that you applied for an incentive for **[IF MEASURE QUANTITY = 1 SAY "A"] [IF MEASURE QUANTITY >1 INSERT MEASURE QUANTITY] [INSERT MEASURE](S)** in **[YEAR OF PARTICIPATION]**. Is that correct? **[DO NOT READ RESPONSES]**

[IF NEEDED SAY: "WE KNOW YOU MAY HAVE APPLIED FOR OTHER INCENTIVES, BUT FOR THIS SURVEY, WE'D LIKE TO FOCUS ON JUST THIS ONE TYPE OF EQUIPMENT."]

1. Yes **[SKIP TO B4]**
2. No, quantity is incorrect **[CONTINUE TO B2]**
3. No, measure is incorrect **[SKIP TO B3]**
4. No, both quantity and measure are incorrect **[SKIP TO B3]**
98. Don't Know **[SKIP TO B3]**
99. Refused **[TERMINATE]**

B2. **[ASK IF B1 = 2]** For how many **[INSERT MEASURE](S)** did you apply for an incentive? **[NUMERIC OPEN ENDED. DOCUMENT AND USE AS QUANTITY FOR REMAINDER OF SURVEY]**

1. **[RECORD] [SKIP TO B4]**
98. Don't Know **[SKIP TO B4]**
99. Refused **[SKIP TO B4]**

B3. **[ASK IF B1 = 3 OR 4 OR 98]** Please tell me for what type of equipment you applied for an incentive? **[PROBE FOR MEASURE AND QUANTITY THEN SAY: "Thanks for your time, but unfortunately you do not qualify for this survey." THEN THANK AND TERMINATE]**

1. **[RECORD VERBATIM] [IF RESPONSE = SAME MEASURE, GO BACK TO B1]**
98. Don't Know **[THANK AND TERMINATE]**
99. Refused **[THANK AND TERMINATE]**

B4. Did **[IF MEASURE QUANTITY >1 SAY "ALL OF"]** the **[INSERT MEASURE](S)** get installed in your home? **[DO NOT READ RESPONSES]**

1. Yes **[SKIP TO C1]**
2. No **[CONTINUE TO B5]**
98. Don't know **[SKIP TO C1]**
99. Refused **[SKIP TO C1]**

[ASK B5 IF B4 = 2 AND MEASURE QUANTITY > 1 OTHERWISE SKIP TO B6]

B5. How many **[INSERT MEASURE](S)** were installed?

1. **[RECORD # 1-100] [CONTINUE TO B6]**
98. Don't Know **[CONTINUE TO B6]**
99. Refused **[CONTINUE TO B6]**

B6. **[ASK IF B4 = 2]** Why haven't you installed the **[INSERT MEASURE](S)** **[MULTIPLE RESPONSE UP TO 3; DO NOT READ, THEN SKIP TO C1]**

1. Failed or broken unit **[SKIP TO C1]**
2. Removed because did not like it **[SKIP TO C1]**
3. Have not had time to install it yet **[SKIP TO C1]**
4. In-storage **[SKIP TO C1]**
5. Back up equipment to install when other equipment fails **[SKIP TO C1]**
6. Have not hired a contractor to install it yet **[SKIP TO C1]**
7. Purchased more than was needed **[SKIP TO C1]**
8. Other **[RECORD]** **[SKIP TO C1]**

98. Don't Know **[SKIP TO C1]**
99. Refused **[SKIP TO C1]**

B7. **[INSERT UTILITY]** records show that you applied for an incentive for **[INSERT MEASURE]** in **[YEAR OF PARTICIPATION]**. Is that correct? **[DO NOT READ RESPONSES]**

[IF NEEDED SAY: "WE KNOW YOU MAY HAVE APPLIED FOR OTHER INCENTIVES, BUT FOR THIS SURVEY, WE'D LIKE TO FOCUS ON JUST THIS ONE TYPE OF EQUIPMENT."]

1. Yes **[SKIP TO C1]**
2. No, measure is incorrect **[SKIP TO B8]**

98. Don't Know **[SKIP TO B8]**
99. Refused **[TERMINATE]**

B8. **[ASK IF B7 = 2 OR 98]** Please tell me for what type of equipment you applied for an incentive? **[PROBE FOR MEASURE AND QUANTITY THEN SAY: "Thanks for your time, but unfortunately you do not qualify for this survey." THEN THANK AND TERMINATE]**

1. **[RECORD VERBATIM]** **[IF RESPONSE =SAME MEASURE, GO BACK TO B7]**

98. Don't Know **[THANK AND TERMINATE]**
99. Refused **[THANK AND TERMINATE]**

B9. **[INSERT UTILITY]** records show that you applied for an incentive for **[INSERT MEASURE QUANTITY]** square feet of **[INSERT MEASURE](S)** in **[YEAR OF PARTICIPATION]**. Is that correct? **[DO NOT READ RESPONSES; IF CORRECTED YEAR IS NOT 2013 OR 2014, THANK AND TERMINATE,]**

[IF NEEDED SAY: "WE KNOW YOU MAY HAVE APPLIED FOR OTHER INCENTIVES, BUT FOR THIS SURVEY, WE'D LIKE TO FOCUS ON JUST THIS ONE TYPE OF EQUIPMENT."]

1. Yes **[SKIP TO B12]**
2. No, quantity is incorrect **[CONTINUE TO B10]**
3. No, measure is incorrect **[SKIP TO B11]**
4. No, both quantity and measure are incorrect **[SKIP TO B11]**

98. Don't Know **[SKIP TO B11]**
99. Refused **[TERMINATE]**

B10. **[ASK IF B9 = 2]** How many square feet of **[INSERT MEASURE](S)** did you apply for an incentive? **[NUMERIC OPEN ENDED. DOCUMENT AND USE AS QUANTITY FOR REMAINDER OF SURVEY]**

1. **[RECORD] [SKIP TO B12]**

98. Don't Know **[SKIP TO B12]**
99. Refused **[SKIP TO B12]**

B11. **[ASK IF B9 = 3 OR 4 OR 98]** Please tell me for what type of equipment you applied for an incentive? **[PROBE FOR MEASURE AND QUANTITY THEN SAY: "Thanks for your time, but unfortunately you do not qualify for this survey." THEN THANK AND TERMINATE]**

1. **[RECORD VERBATIM] [IF RESPONSE = SAME MEASURE, GO BACK TO B9]**

98. Don't Know **[THANK AND TERMINATE]**
99. Refused **[THANK AND TERMINATE]**

B12. Did all of the **[INSERT MEASURE QUANTITY]** square feet of **[INSERT MEASURE](S)** get installed in your home? **[DO NOT READ RESPONSES]**

1. Yes **[SKIP TO C1]**
2. No **[CONTINUE TO B13]**

98. Don't know **[SKIP TO C1]**
99. Refused **[SKIP TO C1]**

B13. What percentage of the **[INSERT MEASURE](S)** was installed?

1. **[RECORD 0-100%] [CONTINUE TO B14]**

98. Don't Know **[CONTINUE TO B14]**
99. Refused **[CONTINUE TO B14]**

B14. Why haven't you had a chance to install all **[INSERT MEASURE QUANTITY]** square feet of **[INSERT MEASURE] (S)**? **[MULTIPLE RESPONSE UP TO 3; DO NOT READ, THEN SKIP TO C1]**

1. Failed or broken unit **[SKIP TO C1]**
2. Removed because did not like it **[SKIP TO C1]**
3. Have not had time to install it yet **[SKIP TO C1]**
4. In-storage **[SKIP TO C1]**
5. Back up equipment to install when other equipment fails **[SKIP TO C1]**
6. Have not hired a contractor to install it yet **[SKIP TO C1]**
7. Purchased more than was needed **[SKIP TO C1]**
8. Other **[RECORD]** **[SKIP TO C1]**

98. Don't Know **[SKIP TO C1]**
99. Refused **[SKIP TO C1]**

C. Program Awareness & Purchase Decisions

C1. How did you first hear about **[INSERT UTILITY]**'s wattsmart Home Energy Savings program? **[DO NOT PROMPT. RECORD ONLY THE FIRST WAY HEARD ABOUT THE PROGRAM.]**

1. Bill Inserts
2. Billboard/outdoor ad
3. Family/friends/word-of-mouth
4. Home Energy Reports
5. Home Shows/Trade Shows (Home and Garden Shows)
6. Internet Advertising/Online Ad
7. Newspaper/Magazine/Print Media
8. Northwest Energy Efficiency Alliance (NEEA)
9. Other website
10. Radio
11. Retailer/Store
12. Rocky Mountain Power/Pacific Power Representative
13. Rocky Mountain Power/Pacific Power website
14. Social Media
15. Sporting event
16. TV
17. wattsmart Home Energy Savings website
18. Other **[RECORD VERBATIM]**
98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

C2. **[ASK IF C1 <> 13 0R 17, OTHERWISE SKIP TO C3]** Have you been to the **[INSERT UTILITY]** wattsmart Home Energy Savings program website? **[DO NOT READ RESPONSES]**

1. Yes
2. No

C3. **[ASK IF C1 = 13 OR 17, OR IF C2 = 1, OTHERWISE SKIP TO C5]** Was the website… **[READ]**

1. Very helpful **[SKIP TO C5]**
2. Somewhat helpful
3. Somewhat unhelpful
4. Very unhelpful
98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

C4. **[ASK IF C3= 2, 3, OR 4. OTHERWISE SKIP TO C5]** What would make the website more helpful for you? **[DO NOT READ RESPONSES, MARK ALL THAT APPLY]**

1. Nothing, it is already very helpful for me.
2. Make the website easier to navigate or more user-friendly (clear hierarchy)
3. Make program information more clear and concise
4. Incorporate more visual information (charts, graphs, images) and less text
5. Provide easier access to customer service or FAQs
6. Other **[RECORD]**

C5. Please think back to the time when you were deciding to buy the energy saving **[INSERT MEASURE](S)**. What factors motivated you to purchase the **[INSERT MEASURE](S)? [DO NOT READ. INDICATE ALL THAT APPLY. ONCE THEY RESPONDENT HAS FINISHED, SAY: "ARE THERE ANY OTHER FACTORS?"]**

1. Old equipment didn't work
2. Old equipment working poorly
3. The program incentive
4. A program affiliated contractor
5. Wanted to save energy
6. Wanted to reduce energy costs
7. Environmental concerns
8. Recommendation from other utility **[PROBE: "WHAT UTILITY?" RECORD]**
9. Recommendation of dealer/retailer **[PROBE: "FROM WHICH STORE?" RECORD]**
10. Recommendation from friend, family member, or colleague
11. Recommendation from a contractor
12. Advertisement in newspaper **[PROBE: "FOR WHAT PROGRAM?" RECORD]**
13. Radio advertisement **[PROBE: "FOR WHAT PROGRAM?" RECORD]**
14. Health or medical reasons
15. Maintain or increase comfort of home
16. Interested in new/updated technology
17. Other **[RECORD]**
98. Don't Know
99. Refused

D. Measure Usage

[SAY "I HAVE SOME QUESTIONS ABOUT YOUR GENERAL HOUSEHOLD ENERGY USE AND COMMON HOUSEHOLD APPLIANCES"]

D1. **[IF MEASURE TYPE = CLOTHES WASHER, SKIP TO D2]** Do you have a clothes washer installed in your home?

1. Yes
2. No **[SKIP TO D9]**
98. Don't Know **[SKIP TO D9]**
99. Refused **[SKIP TO D9]**

D2. Approximately how many loads of clothes does your household wash in a typical week?

1. **[RECORD]**
98. Don't Know
99. Refused

D3. **[ASK IF MEASURE TYPE = CLOTHES WASHER, OTHERWISE SKIP TO D5]** How does the number of wash loads you do now compare to the number that you did with your old clothes washer? **[DO NOT READ RESPONSES]**

1. Same **[SKIP TO D5]**
2. Different **[CONTINUE TO D4]**
98. Don't Know **[SKIP TO D5]**
99. Refused **[SKIP TO D5]**

D4. **[ASK IF D3 = 2]**Do you do more or fewer loads now than you did before? Could you estimate a percentage?

1. More loads now, Record percentage **[MUST BE GREATER THAN 100%, EG 125% FOR 25% MORE]**
2. Fewer loads now, Record percentage **[MUST BE LESS THAN 100%, EG 75% FOR 25% LESS THAN BEFORE]**
98. Don't Know
99. Refused

D5. On what percentage of loads do you use a high-speed spin cycle? **[IF NEEDED: HIGH-SPEED SPIN CYCLES REMOVE MORE WATER FROM THE LOAD, RESULTING IN SHORTER DRYING TIMES]**

1. Never
2. LESS THAN 25%
3. 25-50%
4. 50-75%
5. 75-99%
6. Always or 100% **[SKIP TO D7]**
98. **[DO NOT READ]** Don't know **[SKIP TO D7]**
99. **[DO NOT READ]** Refused **[SKIP TO D7]**

D6. **[ASK IF D5 = 1-5]** When you do not use the high spin cycle, what is your reason? **[DO NOT READ. INDICATE ALL THAT APPLY]**

1. Noise/vibration
2. Impact on clothing
3. Always use high spin
4. Other **[RECORD]**
98. **[DO NOT READ]**Don't know
99. **[DO NOT READ]** Refused

D7. What percentage of your loads do you dry using a clothes dryer? **[READ CATEGORIES IF NEEDED]**

1. Never **[SKIP TO D9]**
2. LESS THAN 25%
3. 25-50%
4. 50-75%
5. 75- 99%
6. Always or 100%
98. Don't know **[SKIP TO D9]**
99. Refused **[SKIP TO D9]**

D8. When you dry your clothes do you… **[READ]**

1. Use a timer to determine drying times.
2. Use the dryer's moisture sensor to determine when the load is dry.
3. Other **[SPECIFY]**
98. **[DO NOT READ]** Don't know
99. **[DO NOT READ]** Refused

D9. How many times a week do you use a dishwasher?

1. **[RECORD]**
2. Don't have a dishwasher
98. Don't Know
99. Refused

[IF MEASURE TYPE= HEATING SKIP TO D13 OR HEATING/COOLING SKIP TO D20]

D10. What type of heating system do you primarily use… **[READ]**

1. Furnace
2. Boiler
3. Air Source Heat Pump
4. Ground Source Heat Pump
5. Ductless Heat Pump
6. Stove
7. Baseboard
8. No heating system **[SKIP TO D13]**
9. Other **[SPECIFY]**
98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

D11. How many years old is the heating system?

1. **[RECORD]**
98. Don't Know
99. Refused

D12. What type of fuel does the heating system use… **[READ]**

1. Gas
2. Electric
3. Oil
4. Propane
5. Coal
6. Wood
7. Other **[SPECIFY]**
98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

D13. **[IF MEASURE TYPE= COOLING SKIP TO D23]** What type of cooling system do you primarily use **[IF MEASURE TYPE = ROOM AC THEN SAY "BESIDES THE ROOM AIR CONDITIONER"]**? A… **[READ, MULTIPLE CHOICES ALLOWED]**

1. Central Air Conditioner
2. Evaporative Cooler
3. Air Source Heat Pump
4. Ground Source Heat Pump
5. Ductless heat pump
6. Whole house fan
7. No central cooling system **[SKIP TO D15]**
8. Other **[SPECIFY]**

98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

D14. How many years old is your current cooling system?

1. **[RECORD]**

98. Don't Know
99. Refused

D15. **[ASK IF MEASURE TYPE = LIGHTING]** in which room(S) [is/are] the lighting fixture(s) installed? **[MULTIPLE RESPONSES ALLOWED]**

1. Living/family room
2. Bedroom
3. Unoccupied bedroom
4. Bathroom
5. Kitchen
6. Garage
7. Office
8. Attic
9. Closet/storage
10. Hallway
11. Exterior

98. Don't Know
99. Refused

[FOR QUESTIONS D16 - D24 USE THE FOLLOWING SKIP PATTERN
FOR MEASURE TYPES OTHER, CLOTHES WASHER, ROOM AC, AND LIGHTING: READ QUESTIONS D16 TO D17 THEN SKIP TO E1;
FOR MEASURE TYPE WINDOWS: READ QUESTIONS D18 AND D19 THEN SKIP TO E1;

FOR MEASURE TYPE HEATING: READ QUESTIONS D20 TO D22 THEN SKIP TO E1
FOR MEASURE TYPE COOLING: READ QUESTIONS D23 TO D24 THEN SKIP TO E1;
FOR MEASURE TYPE HEATING/COOLING: READ QUESTIONS D20 TO D24 THEN SKIP TO E1;
FOR MEASURE TYPES SEALING, INSULATION AND SERVICE: SKIP TO E1]

D16. Was the purchase of your new **[INSERT MEASURE](S)** intended to replace **[AN]** old **[INSERT MEASURE TYPE]**?

1. Yes **[CONTINUE TO D17]**
2. No **[SKIP TO E1]**
98. Don't Know **[SKIP TO E1]**
99. Refused **[SKIP TO E1]**

D17. **[ASK IF D16 = 1]** What did you do with the old **[INSERT MEASURE TYPE]** after you got your new **[INSERT MEASURE](S)**? **[READ CATEGORIES IF NEEDED]**

1. Sold or given away **[SKIP TO E1]**
2. Recycled **[SKIP TO E1]**
3. Installed in another location in the home **[SKIP TO E1]**
4. Still in home but permanently removed [stored in garage, etc.] **[SKIP TO E1]**
5. Thrown away **[SKIP TO E1]**
98. **[DO NOT READ]** Don't Know **[SKIP TO E1]**
99. **[DO NOT READ]** Refused **[SKIP TO E1]**

D18. **[ASK IF MEASURE TYPE= WINDOWS AND (B9 = 1 OR B13.1>0%). OTHERWISE SKIP TO E1]** What type of windows did you have before the new windows were installed?

1. Single pane **[OLDER WINDOWS]**
2. Double Pane **[NEWER WINDOWS]**
3. Triple Pane **[RARE]**
98. Don't Know
99. Refused

D19. **[ASK IF MEASURE = WINDOWS AND (B9= 1 OR B13.1>0%), OTHERWISE SKIP TO E1]** What type of window frames (not window trim, which is almost always wood) did you have before the new windows were installed?

1. Wood
2. Vinyl
3. Metal
98. Don't Know
99. Refused

[ASK D20 TO D22 IF MEASURE TYPE = HEATING OR HEATING/COOLING. OTHERWISE SKIP TO E1]

D20. What type of heating system did you have before the new **[INSERT MEASURE]** was installed?

1. Furnace
2. Boiler
3. Air Source Heat Pump
4. Ground Source Heat Pump
5. Ductless Heat Pump
6. Stove
7. Baseboard
8. No heating system before **[SKIP TO E1]**
9. Other **[SPECIFY]**
98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

D21. How many years old was the previous heating system?

1. **[RECORD]**
98. Don't Know
99. Refused

D22. What type of fuel does the new heating system use**… [READ]**

1. Gas
2. Electric
3. Oil
4. Propane
5. Coal
6. Wood
7. Other **[SPECIFY]**
98. **[DO NOT READ]** Don't Know
99. [do not read] Refused

[ASK D23 TO D24 IF MEASURE TYPE = COOLING OR HEATING/COOLING]

D23. What type of cooling system did you have before the new **[INSERT MEASURE]** was installed? **[READ]**

1. Central Air Conditioner
2. Room Air Conditioner
3. Evaporative Cooler
4. Air Source Heat Pump
5. Ground Source Heat Pump
6. Ductless Heat Pump
7. Whole house fan
8. No cooling system before **[SKIP TO E1]**
9. Other **[SPECIFY]**
98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

D24. How many years old was the previous cooling system?

1. **[RECORD]**
98. Don't Know
99. Refused

E. Satisfaction

E1. Overall, how satisfied are you with your **[INSERT MEASURE](S)** Would you say you are…? **[READ CATEGORIES; RECORD FIRST RESPONSE ONLY]**

1. Very Satisfied
2. Somewhat Satisfied
3. Not Very Satisfied
4. Not At All Satisfied
98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

E2. Did a contractor install the **[INSERT MEASURE](S)** for you?

1. Yes
2. No
98. Don't Know
99. Refused

E3. **[ASK IF E2=1]** How satisfied were you with the contractor that installed the **[INSERT MEASURE](S)** for you? **[READ CATEGORIES; RECORD FIRST RESPONSE ONLY]**

1. Very Satisfied
2. Somewhat Satisfied
3. Not Very Satisfied
4. Not At All Satisfied
98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

E4. **[IF E3 = 3 OR 4]** Why were you not satisfied with the contractor that installed the **[INSERT MEASURE](S)**?

1. **[RECORD]**
98. Don't know
99. Refused

E5. How easy did you find filling out the wattsmart Home Energy Savings Program incentive application? **[READ CATEGORIES; RECORD FIRST RESPONSE ONLY]**

1. Very Easy
2. Somewhat Easy
3. Not Very Easy **[PROBE FOR REASON AND RECORD]**
4. Not At All Easy **[PROBE FOR REASON AND RECORD]**
98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

E6. How satisfied were you with the amount of the incentive you received for the **[INSERT MEASURE](S)?**

1. Very Satisfied
2. Somewhat Satisfied
3. Not Very Satisfied **[PROBE FOR REASON AND RECORD]**
4. Not At All Satisfied **[PROBE FOR REASON AND RECORD]**
98. Don't Know
99. Refused

E7. After you submitted the incentive application for the **[INSERT MEASURE](S)**, how long did it take to receive the incentive check from **[INSERT UTILITY]**? Was it… **[READ CATEGORIES IF NEEDED, RECORD ONLY FIRST RESPONSE]**

1. Less than 4 weeks
2. Between 4 and 6 weeks
3. Between 7 and 8 weeks
4. More than 8 weeks
5. Have not received the incentive yet
98. **[DO NOT READ]** Don't Know **[SKIP TO E9]**
99. **[DO NOT READ]** Refused **[SKIP TO E9]**

E8. **[ASK IF E7<> 5]** Were you satisfied with how long it took to receive the incentive?

1. Yes
2. No **[PROBE FOR REASON AND RECORD]**
98. Don't Know
99. Refused

E9. How satisfied were you with the entire application process?

1. Very Satisfied
2. Somewhat Satisfied
3. Not Very Satisfied **[PROBE FOR REASON AND RECORD]**
4. Not At All Satisfied **[PROBE FOR REASON AND RECORD]**

E10. Overall, how satisfied are you with the wattsmart Home Energy Savings program? **[READ CATEGORIES; RECORD ONLY FIRST RESPONSE]**

1. Very Satisfied **[PROBE FOR REASON AND RECORD]**
2. Somewhat Satisfied **[PROBE FOR REASON AND RECORD]**
3. Not Very Satisfied **[PROBE FOR REASON AND RECORD]**
4. Not At All Satisfied **[PROBE FOR REASON AND RECORD]**
98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

E11. Did your participation in **[INSERT UTILITY]**'s wattsmart Home Energy Savings Program cause your satisfaction with **[INSERT UTILITY]** to…

1. Increase
2. Stay the same
3. Decrease
98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

F. Freeridership

Now I'd like to talk with you a little more about the **[INSERT MEASURE](S)** you purchased.

F1. When you first heard about the incentive from **[INSERT UTILITY]**, had you already been planning to purchase the **[INSERT MEASURE](S)**?

1. Yes
2. No **[SKIP TO F4]**
98. Don't Know **[SKIP TO F4]**
99. Refused **[SKIP TO F4]**

F2. Ok. Had you already purchased or installed the new **[INSERT MEASURE](S)** before you learned about the incentive from the wattsmart Program?

1. Yes
2. No **[SKIP TO F4]**
98. Don't Know **[SKIP TO F4]**
99. Refused **[SKIP TO F4]**

F3. Just to confirm, you learned about the **[INSERT UTILITY]** rebate program after you had already purchased or installed the **[INSERT MEASURE](S)** ?

1. Yes **[SKIP TO F13]**
2. No
98. Don't Know
99. Refused

[IF F3= 1 SKIP TO F13]

F4. Would you have purchased the same **[INSERT MEASURE](S)** without the incentive from the wattsmart Home Energy Savings program?

1. Yes **[SKIP TO F6]**
2. No
98. Don't Know
99. Refused

[IF F4 = 1 THEN SKIP TO F6]

F5. **[ASK IF F4 = 2, -98 OR -99]** Help me understand, would you have purchased something without the wattsmart Home Energy Savings program incentive? **[DO NOT READ RESPONSES]**

1. Yes, I would have purchased something
2. No, I would not have purchased anything **[SKIP TO F9]**
98. Don't Know **[SKIP TO F13]**
99. Refused **[SKIP TO F13]**

[IF F5 = 2 SKIP TO F9. IF F5 = -98 OR -99 SKIP TO F13]

F6. **[ASK IF F4= 1 OR F5 = 1]** Let me make sure I understand. When you say you would have purchased **[A] [MEASURE](S)** without the program incentive, would you have purchased **[A] [INSERT MEASURE](S)] THAT [WAS/WERE] JUST AS ENERGY EFFICIENT"**?

1. Yes
2. No
98. Don't Know
99. Refused

F7. **[ASK IF F4= 1 OR F5 = 1 AND MEASURE QUANTITY >1]** Without the program incentive would you have purchased the same amount of **[INSERT MEASURE](S)**?

1. Yes, I would have purchased the same amount
2. No, I would have purchased less
98. Don't Know
99. Refused

F8. **[ASK IF F4= 1 OR F5 = 1]** Without the program incentive would you have purchased the **[INSERT MEASURE](S)… [READ]**

1. At the same time
2. Within one year?
3. In more than one year?
98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

[SKIP TO F13]

F9. **[ASK IF F5=2]** To confirm, when you say you would not have purchased the same **[INSERT MEASURE](S)** without the program incentive**,** do you mean you would not have purchased the **[INSERT MEASURE](S)** <u>at all</u>?

1. Yes
2. No
98. Don't Know
99. Refused

[IF F9 = 1 SKIP TO F13]

F10. **[ASK IF F9 = 2, -98, -99]** Again, help me understand. Without the program incentive, would you have purchased the same type of **[INSERT MEASURE](S)** but **[A] [[INSERT MEASURE](S)] THAT [WAS/WERE] NOT AS ENERGY EFFICIENT?**

1. Yes
2. No
98. Don't Know
99. Refused

F11. **[ASK IF F9= 2, -98, -99 AND QTY MEASURE>1]** Without the program incentive would you have purchased the same amount of **[INSERT MEASURE](S)**?

1. Yes, I would purchase the same amount
2. No, I would have purchased less
98. Don't Know
99. Refused

F12. **[ASK IF F9 = 2, -98, -99]**And, would you have purchased the **[INSERT MEASURE](S)… [READ]**

1. At the same time
2. Within one years?
3. In more than one year?
98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

F13. In your own words, please tell me the influence the Home Energy Saving incentive had on your decision to purchase **[INSERT MEASURE](S)?**

1. _____ **[RECORD RESPONSE]**

G. Spillover

G1. Since participating in the program, have you added any other energy efficient equipment or services in your home that were not incentivized through the wattsmart Home Energy Savings Program?

1. Yes
2. No
98. Don't Know
99. Refused

[IF G1 = 2, -98 OR -99 SKIP TO H1]

G2. What high-efficiency energy-saving equipment or services have you purchased since applying for the incentive, not including the **[INSERT MEASURE]** that we have been discussing today? **[LIST OF OTHER ELIGIBLE APPLIANCES AND MEASURES OTHER THAN THOSE LISTED IN PROGRAM RECORDS. PROMPT IF NEEDED]**

1. Clothes Washer **[RECORD QUANTITY]**
2. Refrigerator **[RECORD QUANTITY]**
3. Dishwasher **[RECORD QUANTITY]**
4. Windows **[RECORD QUANTITY IN SQ FT]**
5. Fixtures **[RECORD QUANTITY]**
6. Heat Pump **[RECORD QUANTITY]**
7. Central Air Conditioner **[RECORD QUANTITY]**
8. Room Air Conditioner **[RECORD QUANTITY]**
9. Ceiling Fans **[RECORD QUANTITY]**
10. Electric Storage Water Heater **[RECORD QUANTITY]**
11. Electric Heat Pump Water Heater **[RECORD QUANTITY]**
12. CFLs **[RECORD QUANTITY]**
13. LEDs **[RECORD QUANTITY]**
14. Insulation **[RECORD QUANTITY IN SQ FT]**
15. Air Sealing **[RECORD QUANTITY IN CFM REDUCTION]**
16. Duct Sealing **[RECORD QUANTITY IN CFM REDUCTION]**
17. Programmable thermostat **[RECORD QUANTITY]**
18. Other **[RECORD]** **[RECORD QUANTITY]**
19. None
98. Don't Know
99. Refused

[IF G2 = 12 (ONLY), -98 OR -99 SKIP TO H1. REPEAT G3 THROUGH G5 FOR ALL RESPONSES TO G2]

G3. In what year did you purchase **[INSERT MEASURE TYPE FROM G2]**?

1. 2013
2. 2014
3. Other **[RECORD YEAR]**
98. Don't Know
99. Refused

G4. Did you receive an incentive for **[INSERT MEASURE TYPE FROM G2]?**

1. Yes **[PROBE AND RECORD]**
2. No
98. Don't Know
99. Refused

G5. How influential would you say the wattsmart Home Energy Savings program was in your decision to add the **[INSERT MEASURE FROM G2]** to your home? Was it… **[REPEAT FOR EACH MEASURE LISTED IN G2]**

1. Highly Influential
2. Somewhat Influential
3. Not very influential
4. Not at all influential
98. Don't Know
99. Refused

H. Demographics

I have just a few more questions about your household. Again, all your answers will be strictly confidential.

H1. Which of the following best describes your house? **[READ LIST]:**

1. Single-family home
2. Townhouse or duplex
3. Mobile home or trailer
4. Apartment building with 4 or more units
5. Other **[RECORD]**
98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** refused

H2. Do you rent or own your home?

1. Own
2. Rent
3. Other **[RECORD]**
98. Don't Know
99. Refused

H3. Including yourself and any children, how many people currently live in your home?

1. **[RECORD]**
98. Don't Know
99. Refused

H4. About when was this building first built? **[READ LIST IF NEEDED]**

1. Before 1970's
2. 1970's
3. 1980's
4. 1990-94
5. 1995-99
6. 2000-2004
7. 2005-2009
8. 2010 +
9. OTHER **[RECORD]**
98. **[DO NOT READ]** don't know
99. **[DO NOT READ]** refused

H5. What type of foundation does your home have? **[READ LIST IF NEEDED]**

1. Full finished basement
2. Unfinished Basement
3. Crawlspace
4. Slab on Grade
5. OTHER **[RECORD]**
98. **[DO NOT READ]** don't know
99. **[DO NOT READ]** refused

H6. Approximately how many square feet is the home in which the **[INSERT MEASURE](S)** was installed or purchased for? **[READ LIST IF NEEDED]**

1. Under 1,000 square feet
2. 1,000 – 1,500 square feet
3. 1,501 – 2,000 square feet
4. 2,001 – 2,500 square feet
5. Over 2,500 square feet
98. **[DO NOT READ]** don't know
99. **[DO NOT READ]** refused

H7. **[SKIP IF MEASURE = ELECTRIC WATER HEATER OR HEAT PUMP WATER HEATER]** What is the fuel used by your primary water heater?

1. Electricity
2. Natural gas
3. Fuel oil
4. Other **[RECORD]**
98. Don't know
99. refused

I. Conclusion

I1. That concludes the survey. Do you have any additional feedback or comments?

1. Yes **[RECORD VERBATIM]**
2. No
98. Don't know
99. refused

Thank you very much for your time and feedback. Have a great day.

CADMUS

PacifiCorp HES Upstream Lighting Survey

Audience: This survey is designed for PacifiCorp residential customers in Utah, Idaho, Washington, Wyoming and California (pending). The primary purpose of this survey is to collect information on awareness, satisfaction, installation of energy efficient lighting and energy efficient equipment purchases and motivations. This survey will be administered through telephone calls.

Quota: 250 completed surveys for each state (UT, ID, WA, WY and CA [pending])

Topics	Researchable Questions	Survey Questions
Awareness	Are respondents aware of CFL and LED lighting products?	B1, B2, C1
Installation	What percent of CFLs and LEDs purchased in the past 12 months were installed in the home? Where were the purchased CFLs and LEDs installed (room)?	B4, B9, C3, C8
Disposal and Storage	What percent of CFLs/LEDs purchased in the past 12 months were removed and why? What percent of CFLs/LEDs purchased in the past 12 months are in storage for future use?	**Error! Reference source not found.**-B12, C9-C11
Satisfaction with CFLs and LEDs	How satisfied are residents with their CFLs and LEDs? What do they like or dislike about them?	B8, B15, B16, C7, C14, C15
PacifiCorp Programs	Are respondents aware of the PacifiCorp programs? How did they hear about them? Have respondents visited the Home Energy Savings Website?	Section D
Participant Decisions	What actions are residents taking to save energy? Did they receive a rebate from PacifiCorp during the 2013-2014 program period? How influential were the PacifiCorp programs in their decision to install the equipment?	Section E
Demographics	How do awareness /activities/behaviors vary by demographic characteristics?	Section F

- Interviewer instructions are in green.
- CATI programming instructions are in red.

[UTILITY]

Washington and California: Pacific Power

Utah, Wyoming, and Idaho: Rocky Mountain Power

A. Introduction

A1. **[TO RESPONDENT]** Hello, I'm **[INSERT FIRST NAME]**, calling from **[INSERT SURVEY FIRM],** on behalf of **[UTILITY]**. May I please speak with **[INSERT NAME]**?

Hello, we are conducting a survey about household lighting and home energy use and would like to ask you some questions about your household's lighting and energy use. We would greatly appreciate your opinions.

[IF NOT AVAILABLE, ASK FOR AN ADULT IN THE HOUSEHOLD WHO IS RESPONSIBLE FOR PURCHASING THE LIGHT BULBS. IF NO ONE APPROPRIATE IS AVAILABLE, TRY TO RESCHEDULE AND THEN TERMINATE. IF TRANSFERRED TO ANOTHER PERSON, REPEAT INTRO AND THEN CONTINUE.]

Responses to Customer Questions [IF NEEDED]

(**Timing:** This survey should take about 10 to 15 minutes of your time. Is this a good time for us to speak with you?)

(**Who are you with**: I'm with **[INSERT SURVEY FIRM]**, an independent research firm that has been hired by **[UTILITY]** to conduct this research. I am calling to learn about your household lighting and home energy use)

(**Sales concern:** I am not selling anything; we would simply like to learn about your household lighting and home energy use. Your responses will be kept confidential. If you would like to talk with someone from the Home Energy Savings Program about this study, feel free to call 1-800-942-0266, or visit their website: http://www.homeenergysavings.net/.)

(**Who is doing this study: [INSERT UTILITY]**, your electric utility, is conducting evaluations of several of its efficiency programs.)

(**Why are you conducting this study:** Studies like this help **[INSERT UTILITY]** better understand customers' need and interest in energy programs and services.)

A2. This call may be monitored for quality assurance. First, are you the person who usually purchases light bulbs for your household?

1. Yes
2. No, but person who does can come to phone **[START OVER AT INTRO SCREEN WITH NEW RESPONDENT]**
3. No, and the person who does is not available **[SCHEDULE CALLBACK]**

98. Don't Know **[THANK AND TERMINATE]**
99. Refused **[THANK AND TERMINATE]**

A3. Have you, or anyone in your household, ever been employed by or affiliated with **[INSERT UTILITY]** or any of its affiliates?

1. Yes **[THANK AND TERMINATE]**
2. No **[CONTINUE]**
98. Don't Know **[CONTINUE]**
99. Refused **[THANK AND TERMINATE]**

B. CFL Awareness and Purchases

B1. Before this call today, had you ever heard of a type of energy-efficient light bulb called a "compact fluorescent light bulb", or CFL, for short?

1. Yes **[SKIP TO B3]**
2. No

B2. CFLs usually do not look like traditional incandescent light bulbs. The most common type of CFL has a spiral shape, resembling soft-serve ice cream, and it fits in a regular light bulb socket. Before today, had you heard of CFLs?

1. Yes
2. No **[SKIP TO C1]**

B3. I have some questions about your lighting purchases during the last twelve months. Did you purchase any CFLs in the last twelve months?

1. Yes
2. No **[SKIP TO C1]**
98. Don't Know **[SKIP TO C1]**
99. Refused **[SKIP TO C1]**

B4. During the last twelve months, how many *CFLs* did you or your household purchase? Please try to estimate the total number of *individual CFL bulbs*, as opposed to packages. **[IF "DON'T KNOW," PROBE: "IS IT LESS THAN OR MORE THAN FIVE BULBS?" WORK FROM THERE TO GET AN ESTIMATE]**

1. **[RECORD # OF CFLS: NUMERIC OPEN END] [IF QUANTITY=0, SKIP TO C1]**
98. Don't Know **[PROBE: "IS IT LESS THAN OR MORE THAN FIVE BULBS?" WORK FROM THERE TO GET AN ESTIMATE] [IF UNABLE TO GET AN ANSWER, SKIP TO C1]**
99. Refused **[SKIP TO C1]**

B5. Where did you purchased the **[B4.1]** CFLs? **[PROBE FOR RETAIL CHAINS OR ONLINE] [DO NOT READ, MULTIPLE REPSONSES ALLOWED]**

1. Ace Hardware **[CITY, STATE, # PURCHASED]**
2. Broulim's Fresh Foods **[CITY, STATE, # PURCHASED]**
3. Barrett's Foodtown **[CITY, STATE, # PURCHASED]**
4. Batteries Plus **[CITY, STATE, # PURCHASED]**
5. Bi-Mart **[CITY, STATE, # PURCHASED]**
6. Big Lots **[CITY, STATE, # PURCHASED]**
7. Corner Grocery & Hardware **[CITY, STATE, # PURCHASED]**
8. Costco **[CITY, STATE, # PURCHASED]**
9. Delta Jubilee Foods **[CITY, STATE, # PURCHASED]**
10. Do It Best **[CITY, STATE, # PURCHASED]**
11. Dollar Tree **[CITY, STATE, # PURCHASED]**
12. Family Dollar **[CITY, STATE, # PURCHASED]**
13. Fresh Markets **[CITY, STATE, # PURCHASED]**
14. Kamas Foodtown **[CITY, STATE, # PURCHASED]**
15. Kroger – Fred Meyer **[CITY, STATE, # PURCHASED]**
16. Griffith Foodtown **[CITY, STATE, # PURCHASED]**
17. Gunnison Market **[CITY, STATE, # PURCHASED]**
18. Hess Lumber Co **[CITY, STATE, # PURCHASED]**
19. Habitat for Humanity **[CITY, STATE, # PURCHASED]**
20. Harmons **[CITY, STATE, # PURCHASED]**
21. Lowe's **[CITY, STATE, # PURCHASED]**
22. Menards **[CITY, STATE, # PURCHASED]**
23. Petersons Fresh Market **[CITY, STATE, # PURCHASED]**
24. Rancho Markets **[CITY, STATE, # PURCHASED]**
25. Ream's Foods **[CITY, STATE, # PURCHASED]**
26. Ridley's **[CITY, STATE, # PURCHASED]**
27. Safeway **[CITY, STATE, # PURCHASED]**
28. Sam's Club **[CITY, STATE, # PURCHASED]**
29. Smith's **[CITY, STATE, # PURCHASED]**
30. Stokes Market Place **[CITY, STATE, # PURCHASED]**
31. Sutherlands **[CITY, STATE, # PURCHASED]**
32. Thomas Market **[CITY, STATE, # PURCHASED]**
33. Target **[CITY, STATE, # PURCHASED]**
34. Home Depot **[CITY, STATE, # PURCHASED]**
35. The Market **[CITY, STATE, # PURCHASED]**
36. True Value Hardware **[CITY, STATE, # PURCHASED]**
37. Walgreens **[CITY, STATE, # PURCHASED]**
38. Walmart **[CITY, STATE, # PURCHASED]**

39. Winegar's Supermarkets **[CITY, STATE, # PURCHASED]**
40. Online **[WEBSITE, # PURCHASED]**
98. Other **[RECORD STORE NAME, CITY, STATE, # PURCHASED]**
98. Don't Know
99. Refused

B6. Do you recall if any of the **[B4.1]** CFLs you purchased part of a **[INSERT UTILTY]** sponsored sale?

1. Yes
2. No
98. Don't Know
99. Refused

B7. **[ASK IF B6 = 1, OTHERWISE SKIP TO B8]** Did the **[INSERT UTILTY]** discount influence your decision to purchase CFLs over another type of bulb?

1. Yes
2. No
98. Don't Know
99. Refused

B8. What **[IF B7=1 SAY "OTHER"]** factors were important for your decision to buy CFLs over other types of bulbs? **[DO NOT READ. MULTIPLE RESPONSES ALLOWED]**

1. Energy savings
2. Cost savings on electricity bill
3. Price of bulb
4. Environmental concerns
5. Quality of light
6. Lifetime of bulb
7. Other **[RECORD]**
98. Don't Know
99. Refused

B9. Now I'd like to ask you a few questions about the **[B4.1]** CFLs you purchased in the last twelve months. How many did you install in your home since you purchased them?

1. **[RECORD # OF CFLS]**
2. None **[SKIP TO B12]**
98. Don't Know **[SKIP TO B15]**
99. Refused **[SKIP TO B15]**

B10. Have you since removed any of those CFL bulbs from the sockets?

1. Yes **[ASK "HOW MANY DID YOU REMOVE?" RECORD # OF CFLS]**
2. No **[SKIP TO B12]**
98. Don't Know
99. Refused

B11. What were the reasons you removed the **[B10.1]** purchased CFLs from the sockets? **[QUANTITIES SHOULD ADD TO B10.1, IF NOT, ASK "WHAT ABOUT THE REMAINING BULBS YOU REMOVED?] [DO NOT READ, MULTIPLE RESPONSES ALLOWED]**

1. Bulb burned out **[ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF CFLS]**
2. Bulbs were too bright **[ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF CFLS]**
3. Bulbs were not bright enough **[ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF CFLS]**
4. Delay in light coming on **[ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF CFLS]**
5. Did not work with dimmer/3-way switch **[ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF CFLS]**
6. Didn't fit properly **[ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF CFLS]**
7. Stuck out of fixture **[ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF CFLS]**
8. Light color **[ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF CFLS]**
9. Concerned about mercury **[ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF CFLS]**
10. Replaced with LEDs for better efficiency **[ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF CFLS]**
11. Other **[RECORD VERBATIM] [ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF CFLS]**
98. Don't Know
99. Refused

B12. Are any of the **[B4.1]** CFLs you purchased in the last twelve months currently in storage for later use?

1. Yes **[ASK: "HOW MANY ARE NOW IN STORAGE?" RECORD # OF CFLS]**
2. No
98. Don't Know
99. Refused

B13. **[SKIP TO C1 IF B9= 2, 98 OR 99]** Of the **[B9.1]** bulbs that you installed in your home that were purchased during the last twelve months, can you tell me how many CFLs were installed in each room in your house?

1. Bedroom **[RECORD]**
2. Bedroom (unoccupied) **[RECORD]**
3. Basement **[RECORD]**
4. Bathroom **[RECORD]**
5. Closet **[RECORD]**
6. Dining **[RECORD]**
7. Foyer **[RECORD]**
8. Garage **[RECORD]**
9. Hallway **[RECORD]**
10. Kitchen **[RECORD]**
11. Office/Den **[RECORD]**
12. Living Space **[RECORD]**
13. Storage **[RECORD]**
14. Outdoor **[RECORD]**
15. Utility **[RECORD]**
16. Other **[RECORD VERBATIM]**

98. Don't Know
99. Refused

B14. **[ASK ONLY IF TOTAL BULBS IN B13 <QUANTITY FROM B9.1 (IF TOTAL NUMBER OF BULBS LISTED IN EACH ROOM DOES NOT MATCH THE NUMBER OF BULBS INSTALLED STATED IN B9.1, OTHERWISE SKIP TO B15]** Thanks, that accounts for **[TOTAL BULBS IN B13]** of the total quantity that were installed in your home. Can you tell me where the **[B9.1 MINUS TOTAL BULBS IN B13]** other bulbs were installed?

1. **[RECORD VERBATIM]**

98. Don't Know
99. Refused

B15. How satisfied are you with the compact fluorescent light bulb(s) that you purchased during the last twelve months? Would you say you are… **[READ]**

1. Very Satisfied
2. Somewhat Satisfied
3. Not Very Satisfied
4. Not At All Satisfied

98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

B16. **[ASK ONLY IF B15 = 3 OR 4]** Why would you say you are **[INSERT ANSWER FROM B15]** with CFLs? **[DO NOT READ LIST AND RECORD ALL THAT APPLY]**

1. Bulb burned out
2. Bulbs are too bright
3. Bulbs are not bright enough
4. Delay in light coming on
5. Did not work with dimmer/3-way switch
6. Didn't fit properly
7. Stuck out of fixture
8. Light color
9. Too expensive
10. Concerned about mercury
11. Replaced with LEDs for better efficiency
12. Other **[RECORD VERBATIM]**
98. Don't Know
99. Refused

C. LED Awareness and Purchases

C1. Another type of light bulb that is used in homes is called a light emitting diode or L-E-D **[SAY THE LETTERS L-E-D]**. These bulbs have regular screw bases that fit into most household sockets. **[IF NEEDED: LEDS HAVE HISTORICALLY BEEN USED FOR NIGHTLIGHTS, FLASHLIGHTS, AND HOLIDAY LIGHTS. HOWEVER, WE ARE NOT ASKING ABOUT THESE TYPES OF LEDS.]**. Before today, had you heard of LEDs that can be used in regular, screw based light sockets?

1. Yes
2. No **[IF ALSO B2= 2 THANK AND TERMINATE, OTHERWISE CONTINUE]**

C2. Did you purchase any LEDs in the last twelve months?

1. Yes
2. No **[THANK AND TERMINATE IF B2= 2, B3=2, OR B4.1 = 0, OTHERWISE SKIP TO SECTION D]**
98. Don't Know **[THANK AND TERMINATE IF B2= 2, B3=2, OR B4.1 = 0, OTHERWISE SKIP TO SECTION D]**
99. Refused **[THANK AND TERMINATE IF B2= 2, B3=2, OR B4.1 = 0, OTHERWISE SKIP TO SECTION D]**

C3. In the last 12 months, how many screw base *LEDs* did you or your household purchase? Please try to estimate the total number of *individual LED bulbs*, as opposed to packages. **[IF "DON'T KNOW," PROBE: "IS IT LESS THAN OR MORE THAN FIVE BULBS?" WORK FROM THERE TO GET AN ESTIMATE]**

[NUMERIC OPEN END: RECORD NUMBER OF LEDS, NOT A RANGE.] [IF QUANTITY=0 AND (IF B2= 2, B3=2, OR B4.1 = 0) THANK AND TERMINATE, OTHERWISE IF QUANTITY = 0 SKIP TO SECTION D]

1. **[RECORD # OF LEDS]**
98. Don't Know **[PROBE FOR ESTIMATES; IF UNABLE TO GET AN ANSWER, SKIP TO D1]**
99. Refused **[SKIP TO D1]**

C4. Where did you purchased the **[C3.1]** LEDs? **[PROBE FOR RETAIL CHAINS OR ONLINE] [DO NOT READ, MULTIPLE REPSONSES ALLOWED]**

1. Ace Hardware **[CITY, STATE, # PURCHASED]**
2. Broulim's Fresh Foods **[CITY, STATE, # PURCHASED]**
3. Barrett's Foodtown **[CITY, STATE, # PURCHASED]**
4. Batteries Plus **[CITY, STATE, # PURCHASED]**
5. Bi-Mart **[CITY, STATE, # PURCHASED]**
6. Big Lots **[CITY, STATE, # PURCHASED]**
7. Corner Grocery & Hardware **[CITY, STATE, # PURCHASED]**
8. Costco **[CITY, STATE, # PURCHASED]**
9. Delta Jubilee Foods **[CITY, STATE, # PURCHASED]**
10. Do It Best **[CITY, STATE, # PURCHASED]**
11. Dollar Tree **[CITY, STATE, # PURCHASED]**
12. Family Dollar **[CITY, STATE, # PURCHASED]**
13. Fresh Markets **[CITY, STATE, # PURCHASED]**
14. Kamas Foodtown **[CITY, STATE, # PURCHASED]**
15. Kroger – Fred Meyer **[CITY, STATE, # PURCHASED]**
16. Griffith Foodtown **[CITY, STATE, # PURCHASED]**
17. Gunnison Market **[CITY, STATE, # PURCHASED]**
18. Hess Lumber Co **[CITY, STATE, # PURCHASED]**
19. Habitat for Humanity **[CITY, STATE, # PURCHASED]**
20. Harmons **[CITY, STATE, # PURCHASED]**
21. Lowe's **[CITY, STATE, # PURCHASED]**
22. Menards **[CITY, STATE, # PURCHASED]**
23. Petersons Fresh Market **[CITY, STATE, # PURCHASED]**
24. Rancho Markets **[CITY, STATE, # PURCHASED]**
25. Ream's Foods **[CITY, STATE, # PURCHASED]**
26. Ridley's **[CITY, STATE, # PURCHASED]**
27. Safeway **[CITY, STATE, # PURCHASED]**
28. Sam's Club **[CITY, STATE, # PURCHASED]**
29. Smith's **[CITY, STATE, # PURCHASED]**
30. Stokes Market Place **[CITY, STATE, # PURCHASED]**
31. Sutherlands **[CITY, STATE, # PURCHASED]**
32. Thomas Market **[CITY, STATE, # PURCHASED]**
33. Target **[CITY, STATE, # PURCHASED]**
34. Home Depot **[CITY, STATE, # PURCHASED]**
35. The Market **[CITY, STATE, # PURCHASED]**
36. True Value Hardware **[CITY, STATE, # PURCHASED]**
37. Walgreens **[CITY, STATE, # PURCHASED]**
38. Walmart **[CITY, STATE, # PURCHASED]**

39. Winegar's Supermarkets **[CITY, STATE, # PURCHASED]**
40. Online **[WEBSITE, # PURCHASED]**
98. Other **[RECORD STORE NAME, CITY, STATE, # PURCHASED]**
98. Don't Know

C5. RefusedWere any of the **[C3.1]** LEDs you purchased part of a **[INSERT UTILTY]** sponsored sale?

1. Yes
2. No
98. Don't Know
99. Refused

C6. **[ASK IF C5 = 1, OTHERWISE SKIP TO C7]** Did the **[INSERT UTILTY]** discount influence your decision to purchase LEDs over another type of bulb?

1. Yes
2. No
98. Don't Know
99. Refused

C7. What **[IF C6=1 SAY "OTHER"]** factors were important for your decision to buy LEDs over other types of bulbs? **[DO NOT READ. MULTIPLE RESPONSES ALLOWED]**

1. Energy savings
2. Cost savings on electricity bill
3. Price of bulb
4. Environmental concerns
5. CFL disposal concerns
6. Quality of light
7. Lifetime of bulb
8. Interested in the latest technology
9. Other **[RECORD]**
98. Don't Know
99. Refused

C8. Now I'd like to ask you a few questions about the **[C3.1]** LED(s) you acquired in the last twelve months. How many did you install in your home since you purchased them?

1. **[RECORD # OF LEDS]**
2. None **[SKIP TO C11]**
98. Don't Know **[SKIP TO D1]**
99. Refused **[SKIP TO D1]**

C9. Have you since removed any of those LED bulbs from the sockets?

1. **YES [ASK "HOW MANY DID YOU REMOVED?" RECORD # OF LEDS]**
2. No **[SKIP TO C11]**
98. Don't Know **[SKIP TO C11]**
99. Refused **[SKIP TO C11]**

C10. What were the reasons you removed the **[C9.1]** purchased LEDs from the sockets? **[QUANTITIES SHOULD ADD TO B10.1, IF NOT, ASK "WHAT ABOUT THE REMAINING BULBS YOU REMOVED?] [DO NOT READ, MULTIPLE RESPONSES ALLOWED]**

1. Bulb burned out **[ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF LEDS]**
2. Bulbs were too bright **[ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF LEDS]**
3. Bulbs were not bright enough **[ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF LEDS]**
4. Delay in light coming on **[ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF LEDS]**
5. Did not work with dimmer/3-way switch **[ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF LEDS]**
6. Didn't fit properly **[ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF LEDS]**
7. Stuck out of fixture **[ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF LEDS]**
8. Light color **[ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF LEDS]**
9. Light is too pointed/narrow **[RECORD VERBATIM] [ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF LEDS]**
10. Other **[RECORD VERBATIM] [ASK: "HOW MANY DID YOU REMOVE BECAUSE OF THIS?" RECORD # OF LEDS]**
98. Don't Know
99. Refused

C11. Are any of the **[C3.1]** LEDs you purchased in the last twelve months currently in storage for later use?

1. Yes **[ASK: "HOW MANY ARE NOW IN STORAGE?" RECORD # OF LEDS]**
2. No
98. Don't Know
99. Refused

C12. **[SKIP TO C14 IF C8= 2, 99, OR 98]** Of the **[C8.1]** bulbs that are currently installed in your home that were purchased during the last twelve months, can you tell me how many LEDs are installed in each room in your house?

1. Bedroom **[RECORD]**
2. Bedroom (unoccupied) **[RECORD]**
3. Basement **[RECORD]**
4. Bathroom **[RECORD]**
5. Closet **[RECORD]**
6. Dining **[RECORD]**
7. Foyer **[RECORD]**
8. Garage **[RECORD]**
9. Hallway **[RECORD]**
10. Kitchen **[RECORD]**
11. Office/Den **[RECORD]**
12. Living Space **[RECORD]**
13. Storage **[RECORD]**
14. Outdoor **[RECORD]**
15. Utility **[RECORD]**
16. Other **[RECORD VERBATIM]**
98. Don't Know
99. Refused

C13. **[ASK ONLY IF TOTAL BULBS IN C12<C8.1 (IF TOTAL NUMBER OF BULBS LISTED IN EACH ROOM DOES NOT MATCH THE NUMBER OF BULBS INSTALLED STATED IN C8.1)OTHERWISE SKIP TO C13]** Thanks, that accounts for **[TOTAL BULBS IN C12]** of the total quantity that were installed in your home. Can you tell me where the **[C8.1 MINUS TOTAL BULBS IN C12]** other bulbs were installed?

1. **[RECORD VERBATIM]**
98. Don't Know
99. Refused

C14. How satisfied are you with the LEDs that you purchased during the last twelve months? Would you say you are… **[READ]**

1. Very Satisfied
2. Somewhat Satisfied
3. Not Very Satisfied
4. Not At All Satisfied
98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

C15. **[ASK ONLY IF C14= 3 OR 4]** Why would you say you are **[INSERT ANSWER FROM C14]** with LEDs? **[DO NOT READ LIST AND RECORD ALL THAT APPLY]**

1. Light is too pointed/narrow
2. Too expensive
3. Bulbs are too bright
4. Bulbs are not bright enough
5. Delay in light coming on
6. Did not work with dimmer/3-way switch
7. Didn't fit properly
8. Stuck out of fixture
9. Light color
10. Other **[RECORD VERBATIM]**

98. Don't Know
99. Refused

D. Program Awareness

D1. Before this call, were you aware that **[INSERT UTILITY]** offers energy-efficiency programs that provide monetary incentives to customers for installing equipment that will reduce their utility bills?

1. Yes
2. No

98. Don't Know
99. Refused

D2. One of these **[INSERT UTILITY]** programs is the "Wattsmart Home Energy Savings Program" and it provides discounts on CFLs, LEDs light fixtures and room air conditioners at participating retailers in your area as well as incentives for high-efficiency home equipment and upgrades such as appliances and insulation. Before today, were you aware of this program?

1. Yes
2. No **[SKIP TO SECTION E]**

98. Don't Know **[SKIP TO SECTION E]**
99. Refused **[SKIP TO SECTION E]**

D3. How did you first hear about **[INSERT UTILITY]'s** Wattsmart Home Energy Savings program**? [DO NOT READ LIST. RECORD FIRST RESPONSE. ONE ANSWER ONLY]**

1. Newspaper/Magazine/Print Media
2. Bill Inserts
3. Rocky Mountain Power/Pacific Power website
4. Wattsmart Home Energy Savings website
5. Other website
6. Internet Advertising/Online Ad
7. Family/friends/word-of-mouth
8. Rocky Mountain Power/Pacific Power Representative
9. Radio
10. TV
11. Billboard/outdoor ad
12. Retailer/Store
13. Sporting event
14. Home Shows/Trade Shows (Home and Garden Shows)
15. Social Media
16. Home Energy Reports (OPower)
17. Other **[RECORD VERBATIM]**
98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

D4. **[ASK ONLY IF D3<>3 OR 4]** Have you ever visited the Wattsmart Home Energy Savings Website?

1. Yes
2. No

D5. **[ASK ONLY IF D4 = 1 OR D3=3 OR 4, OTHERWISE SKIP TO SECTION E]** Was the website… **[READ]**

1. Very helpful
2. Somewhat helpful
3. Somewhat unhelpful
4. Very unhelpful
98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

D6. What would make the website more helpful for you? **[DO NOT READ RESPONSES. MARK ALL THAT APPLY]**

1. Nothing, it is already very helpful for me.
2. Make the website easier to navigate or more user-friendly (clear hierarchy)
3. Make program information more clear and concise
4. Incorporate more visual information (charts, graphs, images) and less text
5. Provide easier access to customer service or FAQs
6. Other **[RECORD]**

98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

E. Nonparticipant Spillover

E1. **[INSERT UTILITY]'s** Home Energy Reporting (HER) program is designed to generate energy savings by providing residential customers with sets of information about the specific energy use and related energy conservation suggestions and tips. Were you participating in this program in 2013 or 2014?

1. Yes
2. No **[SKIP TO SECTION F]**

98. Don't Know
99. Refused

[ASK SECTION E ONLY IF D1 = 1, OTHERWISE SKIP TO F1] Now, I have a few questions about energy efficient improvements that you made or energy efficient equipment you installed specifically in either 2013 or 2014 that might affect your home's energy use.

Number	Measure	**E1.1** In 2013 and 2014, did you install any of the following items in your home? **[READ MEASURES]** Yes=measure number in far left corner	**[ASK FOR EACH ITEM WHERE E1.1=1]** **E2.1** Did you receive a rebate or discount from **[INSERT UTILITY]** for this purchase? 1=Yes 2=No 98=Don't know 99= Refused	**E3.1** How many did you install? **[RECORD QTY]**
1	High-efficiency Boiler (a)		N/A	
2	High-efficiency Water Heater (b)			
3	High-efficiency heat pump water heater (c)			
4	High-efficiency Furnace (d)			

Number	Measure	**E1.2** In 2013 and 2014, did you install any of the following items in your home? **[READ MEASURES]** Yes=measure number in far left corner	**[ASK FOR EACH ITEM WHERE E1.2=1]** **E2.2** Did you receive a rebate or discount from **[INSERT UTILITY]** for this purchase? 1=Yes 2=No 98=Don't know 99= Refused	**E3.2** How many did you install? **[RECORD QTY]**
5	High-efficiency Air Source Heat Pump (e)			
6	High-efficiency Ground Source Heat Pump (f)			
7	High-efficiency Ductless Heat Pump (g)			
8	High-efficiency Central Air Conditioner *(h)*			
9	High-efficiency Evaporative Cooler (i)			

Number	Measure	**E1.3** In 2013 and 2014, did you install any of the following items in your home? **[READ MEASURES]** Yes=measure number in far left corner	**[ASK FOR EACH ITEM WHERE E1.3=1]** **E2.3** Did you receive a rebate or discount from **[INSERT UTILITY]** for this purchase? 1=Yes 2=No 98=Don't know 99= Refused	**E3.3** How many did you install? **[RECORD QTY]**
10	ENEGY STAR Room Air Conditioner (j)			
11	ENERGY STAR Clothes Washer (k)			
12	ENERGY STAR Dishwasher (l)			
13	ENERGY STAR Freezer (m)			
14	ENERGY STAR Refrigerator (n)			

Number	Measure	**E1.4** In 2013 and 2014, did you install any of the following items in your home? **[READ MEASURES]** Yes=measure number in far left corner	**[ASK FOR EACH ITEM WHERE E1.4=1]** **E2.4** Did you receive a rebate or discount from **[INSERT UTILITY]** for this purchase? 1=Yes 2=No 98=Don't know 99= Refused	**E3.4** How many square feet did you install? **[RECORD QTY IN SQUARE FEET]**
15	Attic insulation (0)			
16	Wall insulation (p)			
17	Duct insulation (q)			
18	Duct sealing (r)			
19	Windows (s)			

Number	Measure	**E1.5** In 2013 and 2014, did you install any of the following items in your home? **[READ MEASURES]** Yes=measure number in far left corner	**[ASK FOR EACH ITEM WHERE E1.5=1]** **E2.5** Did you receive a rebate or discount from **[INSERT UTILITY]** for this purchase? 1=Yes 2=No 98=Don't know 99= Refused	**E3.5** How many did you install? **[RECORD QTY]**
20	High-Efficiency Showerhead (t)			
21	High-Efficiency Faucet aerator (u)			
22	Any other energy-efficient products? [SPECIFY] (v)			
23	Did not install anything (w)		N/A	N/A
24	Don't know (x)		N/A	N/A
25	Refused (y)		N/A	N/A

[ASK E5 SERIES FOR EACH MEASURE WITH E1 FLAGGED IN TABLES ABOVE (E1.1; E1.2; E1.3; E1.4; E1.5]

E5. On a 1 to 4 scale, with 1 meaning "not at all important", to 4, meaning the item was "very important", how important were each of the following on your decision to install energy efficient equipment or make energy-efficiency improvements?

How important was **[INSERT STATEMENT FROM TABLE BELOW]** on your decision to purchase the **[INSERT MEASURE NAME FROM E1.X]**? **[REPEAT SCALE AS NEEDED; REPEAT FOR ALL STATEMENTS AND ALL MEASURES]**

Statement	Not at all important	Not very important	Somewhat Important	Very Important	Don't know	Not applicable
	1	2	4	5	98	96
a. General information about energy efficiency provided by **[INSERT UTILITY]**.						
b. Information from friends or family members who installed energy efficient equipment and received a rebate from **[INSERT UTILITY].**						
c. Your experience with a past **[INSERT UTILITY]** energy efficiency program.						

E6. **[ASK IF E2.1-5 = 2 OTHERWISE SKIP TO SECTION 98]** What are the reasons you did not apply for a rebate from **[INSERT UTILITY]** for these energy efficiency improvements? **[DO NOT READ LIST; RECORD ALL THAT APPLY]**

1. Didn't know/wasn't aware
2. Was going to apply but forgot
3. Not interested
4. Too busy/didn't have time
5. Dollar rebate for rebate was not high enough
6. Application too difficult to fill out
7. Did apply but never received rebate
8. Other **[SPECIFY]**

98. Don't Know
99. Refused

F. Demographics

F1. Next are a few questions for statistical purposes only. Which of the following best describes your house? **[READ LIST]**

1. Single-family home
2. Townhouse or duplex
3. Mobile home or trailer
4. Apartment building with 4 or more units
5. Other **[RECORD]**

98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

F2. Do you or members of your household own this home or do you rent?

1. Own
2. Rent
3. Other **[RECORD]**

98. Don't Know
99. Refused

F3. About when was this building first built? **[READ LIST IF NEEDED]**

1. Before 1970's
2. 1970's
3. 1980's
4. 1990-94
5. 1995-99
6. 2000-2004
7. 2005-2009
8. 2010 +
9. OTHER **[RECORD]**

98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

F4. What is the primary heating source for your home? **[READ LIST IF NEEDED]**

1. Forced air natural gas furnace
2. Forced air propane furnace
3. Air Source Heat Pump **[FUEL SOURCE]**
4. Ground Source Heat Pump **[FUEL SOURCE]**
5. Electric baseboard heat
6. Gas fired boiler/radiant heat
7. Oil fired boiler/radiant heat
8. Passive Solar
9. Pellet stove
10. Wood stove
11. Other **[RECORD]**

98. Don't Know
99. Refused

F5. How old is the primary heating system? **[RECORD RESPONSE IN YEARS]**

1. **[RECORD 1-100]**

98. Don't Know
99. Refused

F6. What type of air conditioning system, if any, do you use in your home? **[INDICATE ALL THAT APPLY]**

1. Central Air Conditioner
2. Room Air Conditioner
3. Evaporative Cooler
4. Air Source Heat Pump
5. Ground Source Heat Pump
6. Whole house fan
7. No cooling system
8. Other **[SPECIFY]**

98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

F7. **[SKIP IF F6= 7,98 OR 99]** How many years old is your primary cooling system? **[RECORD RESPONSE IN YEARS]**

1. **[RECORD]**

98. Don't Know
99. Refused

F8. What type of fuel is the primary source for your water heating? **[INDICATE ALL THAT APPLY]**

1. Electricity
2. Natural Gas
3. Propane
4. Other [RECORD]
98. **[DO NOT READ]** Don't Know
99. **[DO NOT READ]** Refused

F9. Including yourself and any children, how many people currently live in your home?

1. **[RECORD]**
98. Don't Know
99. Refused

F10. **[ASK ONLY IF F9> 1]** Are any of the people living in your home dependent children under the age of 18?

1. Yes
2. No
98. Don't Know
99. Refused

G. Conclusion

G1. Do you have any additional feedback or comments regarding your household lighting?

1. Yes **[RECORD VERBATIM]**
2. No
98. Don't Know
99. Refused

G2. **[SEX; DO NOT READ]**

1. Female
2. Male
98. Don't Know

That concludes the survey. Thank you very much for your time and feedback.

Appendix A: Lighting Leakage Survey

A1 Hello, my name is _____, and we're doing a survey about light bulbs today. This is a short survey that will only take about five minutes to complete, and we will give you a $10 gift card that you can use in this store today for your time. You will remain completely anonymous. Do you have five minutes to answer some questions today?

- ❍ 1. (Yes) (1)
- ❍ 99. (No/Refused) (2)

If 1. (Yes) Is Selected, Then Skip To A3

If 99. (No/Refused) Is Selected

A2 OK, thanks for your consideration. Though if you don't mind answering one question for me, could you please tell me which utility provides electric service to your home? [SHOW UTILITY LOGOS IF NEEDED. THANK THE CUSTOMER AND END SURVEY AFTER THIS QUESTION]

- ❍ 1. Pacific Power (1)
- ❍ 2. Rocky Mountain Power (2)
- ❍ 91. Any other utility (specify) (3) _____
- ❍ 98. Don't know (4)
- ❍ 99. Refused (5)

Then Skip To E1 short

A3 Which utility provides electric service to your home? [SHOW UTILITY LOGOS IF NEEDED]

- ❍ 1. Pacific Power (1)
- ❍ 2. Rocky Mountain Power (2)
- ❍ 91. Any other utility (specify) (3) _____
- ❍ 98. Don't know (4)
- ❍ 99. Refused (5)

A4 Which zip code do you live in?

- ❍ Record response if given (1) _____
- ❍ 98. Don't know (2)
- ❍ 99. Refused (3)

B1 Do you plan to install the bulbs you're purchasing today in your home, at a business, or someplace else? [CHECK ALL THAT APPLY – ONLY CHECK ONE IF ALL BULBS ARE BEING INSTALLED AT THE SAME ADDRESS]

- ❑ 1. (bulbs will be installed at my home) (1)
- ❑ 2. (bulbs will be installed at my vacation home (or other personal property) (2)
- ❑ 3. (bulbs will be installed at a business / location that is not a residence, including non-profits) (3)
- ❑ 4. (purchasing bulbs for somebody else / not my home or business) (4)
- ❑ 98. (Don't know) (5)
- ❑ 99. (Refused) (6)

If (bulbs will be installed at a business / location that is not a residence, including non-profits) Is Selected

B1a What kind of business is this (what do they do)?

- ❍ A: AGRICULTURE, FORESTRY AND FISHING (VETERINARY, CROPS, HUNTING) (1)
- ❍ B: MINING (GRAVEL, COAL, OIL, METAL, CHEMICAL, NONMETALLIC MINERALS) (2)
- ❍ C: CONTRACT CONSTRUCTION (PLUMBING, PAINTING, ELECTRICAL, ROOFING) (3)
- ❍ D: MANUFACTURING (TEXTILES, FURNITURE, FABRICATED METAL, PRODUCTS) (4)
- ❍ E: TRANSPORTATION, COMMUNICATION, ELECTRIC (FREIGHT, COURIER, CABLE) (5)
- ❍ F: WHOLESALE TRADE (GROCERY SUPPLIERS, RAW MATERIALS, APPAREL) (6)
- ❍ G: RETAIL TRADE (MARKETS, CLOTHING STORES, RESTAURANTS, CAR DEALERS) (7)
- ❍ H: FINANCE, INSURANCE AND REAL ESTATE (BANKS, MORTGAGE BROKERS) (8)
- ❍ I: SERVICES (BEAUTY QUALITY) (9)
- ❍ K: NONCLASSIFIABLE ESTABLISHMENTS (OTHERS) [RECORD RESPONSE] (10) _____
- ❍ (98. don't know) (11)
- ❍ (99. refused) (12)

If (bulbs will be installed at a business / location that is not a residence, including non-profits) Is Selected

B1b What zip code or city is this business located in? [RECORD ZIP CODE IF KNOWN]

- ❍ (RECORD RESPONSE IF GIVEN) (1) _____
- ❍ (98. don't know) (2)
- ❍ (99. refused) (3)

If (bulbs will be installed at a business / location that is not a residence, including non-profits) Is Selected

B1c Do you know which utility provides power for this business? [RECORD NAME OF UTILITY IF KNOWN]

- ❍ (1. Pacific Power) (1)
- ❍ (2. Rocky Mountain Power) (2)
- ❍ (3. Any other utility - SPECIFY) (3) _____
- ❍ (98. don't know) (4)
- ❍ (99. refused) (5)

If (purchasing bulbs for somebody else / not my home or business) Is Selected

B1d Do you know where these bulbs that you are purchasing for somebody else will be installed? (Do you know the zip code or city?) [RECORD RESPONSE – ZIP CODE IS IDEAL, OR CITY AND STATE, OR JUST A VERBAL DESCRIPTION IF ADDRESS IS NOT KNOWN – for example “my mother-in-law’s house”]

- ❍ (1. RECORD RESPONSE IF GIVEN) (1) _____
- ❍ (98. don't know) (2)
- ❍ (99. refused) (3)

B2 How many minutes does it take to drive to this store from the place where you intend to install these bulbs?

- ❍ (Less than 10 minutes) (1)
- ❍ (10 up to 20 minutes) (2)
- ❍ (20 up to 30 minutes) (3)
- ❍ (30 up to 40 minutes) (4)
- ❍ (40 up to 50 minutes) (5)
- ❍ (50 minutes up to an hour) (6)
- ❍ (An hour or more) (7)
- ❍ (Other response or multiple locations - record details below) (8) _____
- ❍ (98. don't know) (9)
- ❍ (99. refused) (10)

B3 What kind of light bulbs are you purchasing today? [GO OVER THE LIGHT BULBS IN THE CUSTOMER'S CART AND RECORD HOW MANY OF EACH TYPE – ONLY CONTINUE IF THERE IS AT LEAST ONE LIGHT BULB IN THEIR CART.]

- ❑ (Enter quantity of INCANDESCENT bulbs) (1) _____
- ❑ (Enter quantity of HALOGEN bulbs) (2) _____
- ❑ (Enter quantity of CFL bulbs) (3) _____
- ❑ (Enter quantity of LED bulbs) (4) _____
- ❑ (Enter quantity AND TYPE of OTHER bulbs) (5) _____

B3scan [SCAN THE BARCODES FOR THE LIGHT BULBS IN THEIR CART AND COPY-PASTE THE NUMBERS INTO THE FIELDS BELOW - ONLY NEED TO SCAN ONE PACKAGE OF EACH TYPE OR WATTAGE; DO NOT SCAN MULTIPLE PACKS OF EXACTLY THE SAME BULBS.]

- ❑ First light bulb type (1) _____
- ❑ Second light bulb type (2) _____
- ❑ Third light bulb type (3) _____
- ❑ Fourth light bulb type (4) _____
- ❑ Fifth light bulb type (5) _____
- ❑ Sixth light bulb type (6) _____
- ❑ Seventh light bulb type (7) _____
- ❑ Eighth light bulb type (8) _____

If (Enter quantity of INCANDESCENT bulbs) Is Greater Than or Equal to 1

B3i What type and wattage of light bulb will you replace with the INCANDESCENT bulbs you are purchasing today?

- ❑ (1. Incandescent bulbs) RECORD WATTAGE(S) IF KNOWN (1) _____
- ❑ (2. Halogen bulbs) RECORD WATTAGE(S) IF KNOWN (2) _____
- ❑ (3. CFL bulbs) RECORD WATTAGE(S) IF KNOWN (3) _____
- ❑ (4. LED bulbs) RECORD WATTAGE(S) IF KNOWN (4) _____
- ❑ (5. other type of bulbs) RECORD TYPE AND WATTAGE(S) IF KNOWN (5) _____
- ❑ (6. purchasing bulbs for general use / that will go in storage / not specifically replacing any particular bulbs) (6)
- ❑ (7. no bulbs previously installed / new fixture or previously empty sockets) (7)
- ❑ (98. don't know) (8)
- ❑ (99. refused) (9)

If (Enter quantity of HALOGEN bulbs) Is Greater Than or Equal to 1

B3h What type and wattage of light bulb will you replace with the HALOGEN bulbs you are purchasing today?

- ❑ (1. Incandescent bulbs) RECORD WATTAGE(S) IF KNOWN (1) _____
- ❑ (2. Halogen bulbs) RECORD WATTAGE(S) IF KNOWN (2) _____
- ❑ (3. CFL bulbs) RECORD WATTAGE(S) IF KNOWN (3) _____
- ❑ (4. LED bulbs) RECORD WATTAGE(S) IF KNOWN (4) _____
- ❑ (5. other type of bulbs) RECORD TYPE AND WATTAGE(S) IF KNOWN (5) _____
- ❑ (6. purchasing bulbs for general use / that will go in storage / not specifically replacing any particular bulbs) (6)
- ❑ (7. no bulbs previously installed / new fixture or previously empty sockets) (7)
- ❑ (98. don't know) (8)
- ❑ (99. refused) (9)

If (Enter quantity of CFL bulbs) Is Greater Than or Equal to 1

B3c What type and wattage of light bulb will you replace with the CFL bulbs you are purchasing today?

- ❑ (1. Incandescent bulbs) RECORD WATTAGE(S) IF KNOWN (1) _____
- ❑ (2. Halogen bulbs) RECORD WATTAGE(S) IF KNOWN (2) _____
- ❑ (3. CFL bulbs) RECORD WATTAGE(S) IF KNOWN (3) _____
- ❑ (4. LED bulbs) RECORD WATTAGE(S) IF KNOWN (4) _____
- ❑ (5. other type of bulbs) RECORD TYPE AND WATTAGE(S) IF KNOWN (5) _____
- ❑ (6. purchasing bulbs for general use / that will go in storage / not specifically replacing any particular bulbs) (6)
- ❑ (7. no bulbs previously installed / new fixture or previously empty sockets) (7)
- ❑ (98. don't know) (8)
- ❑ (99. refused) (9)

If (Enter quantity of LED bulbs) Is Greater Than or Equal to 1

B3l What type and wattage of light bulb will you replace with the LED bulbs you are purchasing today?

- ❑ (1. Incandescent bulbs) RECORD WATTAGE(S) IF KNOWN (1) _____
- ❑ (2. Halogen bulbs) RECORD WATTAGE(S) IF KNOWN (2) _____
- ❑ (3. CFL bulbs) RECORD WATTAGE(S) IF KNOWN (3) _____
- ❑ (4. LED bulbs) RECORD WATTAGE(S) IF KNOWN (4) _____
- ❑ (5. other type of bulbs) RECORD TYPE AND WATTAGE(S) IF KNOWN (5) _____
- ❑ (6. purchasing bulbs for general use / that will go in storage / not specifically replacing any particular bulbs) (6)
- ❑ (7. no bulbs previously installed / new fixture or previously empty sockets) (7)
- ❑ (98. don't know) (8)
- ❑ (99. refused) (9)

If (Enter quantity AND TYPE of OTHER bulbs) Is Selected

B3o What type and wattage of light bulb will you replace with the ${q://QID7/ChoiceTextEntryValue/5} you are purchasing today?

- ❑ (1. Incandescent bulbs) RECORD WATTAGE(S) IF KNOWN (1) _____
- ❑ (2. Halogen bulbs) RECORD WATTAGE(S) IF KNOWN (2) _____
- ❑ (3. CFL bulbs) RECORD WATTAGE(S) IF KNOWN (3) _____
- ❑ (4. LED bulbs) RECORD WATTAGE(S) IF KNOWN (4) _____
- ❑ (5. other type of bulbs) RECORD TYPE AND WATTAGE(S) IF KNOWN (5) _____
- ❑ (6. purchasing bulbs for general use / that will go in storage / not specifically replacing any particular bulbs) (6)
- ❑ (7. no bulbs previously installed / new fixture or previously empty sockets) (7)
- ❑ (98. don't know) (8)
- ❑ (99. refused) (9)

B4 Do you know if any of these bulbs are being sold at a discounted price?

- ❍ (Yes, some are discounted) (1)
- ❍ (None are discounted) (2)
- ❍ (98. don't know) (3)
- ❍ (99. refused) (4)

C1 Were you planning to purchase all of these bulbs before you arrived at this store?

- ❍ (All bulbs in their cart are planned purchases) (1)
- ❍ (Some bulbs in their cart are planned purchases, and some are not) (2)
- ❍ (Customer had planned to purchase more bulbs than are in their cart) (3)
- ❍ (Had not been intending to purchase any bulbs before arriving at the store) (4)
- ❍ (98. don't know) (5)
- ❍ (99. refused) (6)

If (Some bulbs in their cart are planned purchases, and some are not) Is Selected Or (Had not been intending to purchase any bulbs before arriving at the store) Is Selected

C2 What made you decide to purchase these bulbs after you got to the store? [CHECK ALL THAT APPLY]

- ❑ (did not know this type of bulb was available / have not seen these bulbs before) (1)
- ❑ (better value of buying in bulk / buying a larger package size) (2)
- ❑ (regular prices were lower than expected – but not "on sale") (3)
- ❑ (in-store promotional price / these bulbs are "on sale") (4)
- ❑ (in-store advertising / displays) (5)
- ❑ (in-store coupon) (6)
- ❑ (rebate offer) (7)
- ❑ (recommendation of store employee) (8)
- ❑ (other reason given) [RECORD RESPONSE] (9) _____
- ❑ (98. don't know) (10)
- ❑ (99. refused) (11)

If (Customer had planned to purchase more bulbs than are in their cart) Is Selected

C3 What kind of bulbs had you been planning to purchase before you got to the store, but then decided not to purchase? [CHECK ALL THAT APPLY - INCLUDING BULBS THAT THEY ARE PURCHASING IF THEY HAD BEEN INTENDING TO PURCHASE MORE OF THAT TYPE THAN THEY DID]

- ❑ (1. Incandescent bulbs) RECORD WATTAGE(S) IF KNOWN (1) _____
- ❑ (2. Halogen bulbs) RECORD WATTAGE(S) IF KNOWN (2) _____
- ❑ (3. CFL bulbs) RECORD WATTAGE(S) IF KNOWN (3) _____
- ❑ (4. LED bulbs) RECORD WATTAGE(S) IF KNOWN (4) _____
- ❑ (5. other type of bulbs) RECORD TYPE AND WATTAGE(S) IF KNOWN (5) _____
- ❑ (98. don't know) (6)
- ❑ (99. refused) (7)

If (Customer had planned to purchase more bulbs than are in their cart) Is Selected

C4 How many of these bulbs that you were planning to purchase before you got to the store did you end up not purchasing? [CHECK ALL THAT APPLY - INCLUDING BULBS THAT THEY ARE PURCHASING IF THEY HAD BEEN INTENDING TO PURCHASE MORE OF THAT TYPE THAN THEY DID]

If (1. Incandescent bulbs) RECORD WATTAGE(S) IF KNOWN Is Selected

- ❑ (1. Incandescent bulbs) RECORD QUANTITY (1) _____

If (2. Halogen bulbs) RECORD WATTAGE(S) IF KNOWN Is Selected

- ❑ (2. Halogen bulbs) RECORD QUANTITY (2) _____

If (3. CFL bulbs) RECORD WATTAGE(S) IF KNOWN Is Selected

- ❑ (3. CFL bulbs) RECORD QUANTITY (3) _____

If (4. LED bulbs) RECORD WATTAGE(S) IF KNOWN Is Selected

- ❑ (4. LED bulbs) RECORD QUANTITY (4) _____

If (5. other type of bulbs) RECORD TYPE AND WATTAGE(S) IF KNOWN Is Selected

- ❑ (5. other type of bulbs) RECORD TYPE AND QUANTITY (5) _____

❑ (98. don't know) (6)

❑ (99. refused) (7)

If (Customer had planned to purchase more bulbs than are in their cart) Is Selected

C5 Why didn’t you purchase these bulbs that you had been planning to buy? [CHECK ALL THAT APPLY]

❑ (the type of bulb was not available / could not find them) (1)

❑ (found a better value) (2)

❑ (saw the deal on the program bulbs) (3)

❑ (saw a deal with different bulbs) (4)

❑ (prices were higher than expected) (5)

❑ (found bulbs that were a better deal) (6)

❑ (found bulbs that were better suited for my purpose) (7)

❑ (decided to go with more efficient bulbs) (8)

❑ (in-store coupon for other bulbs) (9)

❑ (rebate offer for other bulbs) (10)

❑ (recommendation of store employee) (11)

❑ (other) [RECORD RESPONSE] (12) _____

❑ (98. don't know) (13)

❑ (99. refused) (14)

C6 What factors led you to purchase these light bulbs? [CHECK ALL THAT APPLY]

- ❑ 1. (low bulb price / reduced price / on sale) (1)
- ❑ 2. (information in the store / store display or advertising) (2)
- ❑ 3. (information from a utility) (3)
- ❑ 4. (advertising, online or elsewhere) - SPECIFY SOURCE OF AD (radio, TV, online, etc.) (4) _____
- ❑ 5. (someone made a recommendation) - SPECIFY WHO RECOMMENDED (5) _____
- ❑ 6. (energy efficiency / saving energy) (6)
- ❑ 7. (saving money on utility bills) (7)
- ❑ 8. (good for the environment / "green" reasons) (8)
- ❑ 9. (bulb color / light quality) (9)
- ❑ 10. (appearance of the bulb / looks good in my fixtures) (10)
- ❑ 11. (hard to find bulb for a unique fixture) (11)
- ❑ 12. (these are the bulbs I always buy / I am used to) (12)
- ❑ 13. (I needed bulbs right away) (13)
- ❑ 14. (just stocking up / these are spare bulbs) (14)
- ❑ 15. (other reasons given) [RECORD RESPONSE] (15) _____
- ❑ 98. (Don't know) (16)
- ❑ 99. (Refused) (17)

D1 Are you going to purchase any other energy-saving items such as power strips, low-flow showerheads, or any Energy Star products while you are at this store today? [INCLUDING ITEMS THEY INTEND TO PURCHASE WHICH ARE NOT IN THEIR CART YET]

- ❍ (Yes) (1)
- ❍ (No) (2)
- ❍ (98. Don't know) (3)
- ❍ (99. Refused) (4)

If “Are you going to purchase any other energy-saving items such as power strips, low-flow showerheads, or any Energy Star products while you are at this store today?” [INCLUDING ITEMS THEY INTEND... (Yes) Is Selected

D1b What energy-saving items are you going to purchase today? [RECORD A BRIEF DESCRIPTION OF UP TO SIX TYPES OF "ENERGY-SAVING" ITEMS BEING PURCHASED AT THE STORE TODAY (showerhead, insulation, thermostat, etc.)]

- ❑ Record name of first item (1) _____
- ❑ Record name of second item (2) _____
- ❑ Record name of third item (3) _____
- ❑ Record name of fourth item (4) _____
- ❑ Record name of fifth item (5) _____
- ❑ Record name of sixth item (6) _____
- ❑ (99. Refused) (7)

If “What energy-saving items are you going to purchase today? [RECORD A BRIEF DESCRIPTION OF UP TO SIX TYPES OF "ENERGY-SAVING" ITEMS BEING PURCHASED AT THE STORE TODAY” ... Record name of first item Selected

D1b1 How much/many of [D1b] do you plan to use/install right away?

- ❍ (All of it will be installed/used right away) (1)
- ❍ (Some of it will be installed/used right away) - RECORD QUANTITY THAT WILL BE USED RIGHT AWAY (2) _____
- ❍ (None of it will be installed/used right away) (3)
- ❍ (98. Don’t know) (4)
- ❍ (99. Refused) (5)

If What energy-saving items are you going to purchase today? [RECORD A BRIEF DESCRIPTION OF UP TO SIX TYPES OF "ENERGY-SAVING" ITEMS BEING PURCHASED AT THE STORE TODAY” … Record name of first item Is Selected

D2.1 Do you have any rebates or coupons for [D1b]?

- ❍ (Yes) - SPECIFY WHO IS OFFERING REBATE OR COUPON BELOW (1) _____
- ❍ (No) (2)
- ❍ (98. Don’t know) (3)
- ❍ (99. Refused) (4)

If “What energy-saving items are you going to purchase today? [RECORD A BRIEF DESCRIPTION OF UP TO SIX TYPES OF "ENERGY-SAVING" ITEMS BEING PURCHASED AT THE STORE TODAY” ... Record name of second item Is Selected

D1b2 How much/many of [D1b] do you plan to use/install right away?

- ❍ (All of it will be installed/used right away) (1)
- ❍ (Some of it will be installed/used right away) - RECORD QUANTITY THAT WILL BE USED RIGHT AWAY (2) _____
- ❍ (None of it will be installed/used right away) (3)
- ❍ (98. Don’t know) (4)
- ❍ (99. Refused) (5)

If “What energy-saving items are you going to purchase today? [RECORD A BRIEF DESCRIPTION OF UP TO SIX TYPES OF "ENERGY-SAVING" ITEMS BEING PURCHASED AT THE STORE TODAY” ... Record name of second item Is Selected

D2.2 Do you have any rebates or coupons for [DB1]?

- ❍ (Yes) - SPECIFY WHO IS OFFERING REBATE OR COUPON BELOW (1) _____
- ❍ (No) (2)
- ❍ (98. Don’t know) (3)
- ❍ (99. Refused) (4)

If “What energy-saving items are you going to purchase today? [RECORD A BRIEF DESCRIPTION OF UP TO SIX TYPES OF "ENERGY-SAVING" ITEMS BEING PURCHASED AT THE STORE TODAY” ... Record name of second item Is Selected

D1b3 How much/many of [DB1] do you plan to use/install right away?

- ❍ (All of it will be installed/used right away) (1)
- ❍ (Some of it will be installed/used right away) - RECORD QUANTITY THAT WILL BE USED RIGHT AWAY (2) _____
- ❍ (None of it will be installed/used right away) (3)
- ❍ (98. Don’t know) (4)
- ❍ (99. Refused) (5)

[REPEAT FOR UP TO SIX ITEMS]

If What energy-saving items are you going to purchase today? Is Selected

D3.1 Please tell me how important your experience purchasing efficient light bulbs was in your decision to purchase [db1] Would you say it was . . .

- ❍ Very important (1)
- ❍ Somewhat important (2)
- ❍ Not very important, or (3)
- ❍ Not important at all? (4)
- ❍ 98. (Don't know) (5)
- ❍ 99. (Refused) (6)

[REPEAT FOR UP TO SIX ITEMS]

E1 Thank you for your time and feedback today! [GIVE CUSTOMER THE GIFT CARD]

- ❍ ENTER YOUR INITIALS AND CLICK NEXT TO CONFIRM SURVEY COMPLETED _____

E1short Thank you for your time! [DO NOT GIVE CUSTOMER A GIFT CARD]

- ❍ ENTER YOUR INITIALS AND CLICK NEXT TO CONFIRM SURVEY COMPLETED _____

CADMUS

Appendix B. Lighting Impacts

This appendix contains further details on the following lighting topics that are introduced in the main body of the report:

1. Hours of Use (HOU)
2. Delta Watts
3. Cross-Sector Sales
4. Demand Elasticity Modeling

Where applicable, Cadmus followed the Uniform Methods Protocol for lighting impact evaluations.[1]

HOU

Cadmus estimated CFL and LED HOU using a multistate modeling approach, built on light logger data collected from two states: Missouri and Maryland. Missouri and Maryland metering data were also employed in the previous 2011-2012 evaluation, however, since both states continued to meter since the prior evaluation, Cadmus used the most recent data available from these states. The metering dataset consisted of a total of 2,274 loggers.

Cadmus chose these studies for the following reasons:

- The majority of the data used in the 2011-2012 evaluation was collected in 2010. Upstream lighting programs feature customer engagement and educational components as well as providing incentives for efficient lighting products. Updating data sources captures changes in behaviors over time as a result of these components.
- These extended studies also accounted for CFLs and LEDs separately, which allows Cadmus to estimate HOU for each lighting technology. Prior metering data did not account for this breakout as LEDs were much rarer a few years ago.
- Maryland and Missouri are the most representative states as far as latitude, which is important as daylight hours are strongly correlated with HOU.
- These two studies employed a sampling strategy that prioritized rooms where efficient lighting is most likely to be installed.
- The total number of loggers was greater than the five combined studies from the previous evaluation (2,274 compared to 2,106 in 2011-2012). This allowed Cadmus to choose the most representative studies without sacrificing precision with smaller numbers of loggers.

Missouri and Maryland Metering Protocol

Following whole-house lighting audits, Cadmus installed up to 10 light meters on randomly selected lighting fixture groups, targeting incandescents, CFLs, and medium screw-based LEDs. To ensure

[1] Available online at: http://www1.eere.energy.gov/wip/pdfs/53827-6.pdf

unbiased installations, Cadmus used an iPad tool to randomly select fixtures receiving the meters. The iPad tool assigned meter installations based on room priorities, with the first five meters assigned to each of five priority room types (e.g., living area, dining room, kitchen, master bedroom, bathroom). The remaining five meters were randomly assigned to any fixture in any non-priority room (e.g., secondary bedrooms, closet, hall, basement, office, laundry, mechanical). Randomly assigning meters in this manner sought to improve precision around priority rooms (where most lamps are installed).

Data from the removal site visits were incorporated into the iPad tool and database to augment the installation information for each site and meter. As part of the lighting logger removal process, technicians conducted a series of pre-removal meter diagnostics, which included the following:

- Completing a logger state test (which determined if the meter functioned properly and whether ambient light affected the meter's operation);
- A visual review of the total time the logger recorded the fixture switched to on;
- Verbal verification from the customer that they used the light fixture;
- Verbal verification from the customer that the logger remained in place for the study's duration; and
- Recording the condition of the logger and battery status.

Model Specification

To estimate HOU, Cadmus determined the total "on" time for each individual light logger per day, using the following guidelines:

- If a light logger did not record any light for an entire day, the day's HOU was set to zero.
- If a light logger registered a light turned on at 8:30 p.m. on Monday and turned off at 1:30 a.m. on Tuesday morning, 3.5 hours were added to Monday's HOU and 1.5 hours to Tuesday's HOU.

Cadmus modeled daily HOU as a function of room type using an analysis of covariance (ANCOVA) model.

ANCOVA models are regression models that model a continuous variable as a function of a single, continuous, explanatory variable and a set of binary variables. This way, an ANCOVA model simply serves as an analysis of variance (ANOVA) model with a continuous explanatory variable added.

Cadmus chose this specification due to its simplicity, making it suitable in a wide variety of contexts. Though the model lacked the specificity of other methods, it offered estimates not nearly as sensitive to small differences in explanatory variables (compared to more complex methods). Therefore, these models could produce consistent estimates of average daily HOU for a given region, using the specific distribution of bulbs by room.

Cadmus specified final models as cross-sectional, ANCOVA regressions:

$$Average\ Daily\ HOU = \beta_1 * \text{Basement} + \beta_2 * \text{Bathroom} + \beta_3 * \text{Bedroom} + \beta_4 * \text{Closet} + \beta_5 * \text{Dining} + \beta_6 * \text{Foyer} + \beta_7 * \text{Garage} + \beta_8 * \text{Hallway} + \beta_9 * \text{Kitchen} + \beta_{10} * \text{Living Space} + \beta_{11} * \text{Office} + \beta_{12} * \text{Outdoor} + \beta_{13} * \text{Storage} + \beta_{14} * \text{Utility} + \beta_{15} * \text{Other} + \beta_{16} * \text{SinHOU}$$

Where:

Basement	=	a dummy variable equal to 1, if the bulb is in the basement, and 0 otherwise;
Bathroom	=	a dummy variable equal to 1, if the bulb is in the bathroom, and 0 otherwise;
Bedroom	=	a dummy variable equal to 1, if the bulb is in a bedroom, and 0 otherwise;
Closet	=	a dummy variable equal to 1, if the bulb is in the closet, and 0 otherwise;
Dining	=	a dummy variable equal to 1, if the bulb is in the dining room, and 0 otherwise;
Foyer	=	a dummy variable equal to 1, if the bulb is in the foyer, and 0 otherwise;
Garage	=	a dummy variable equal to 1, if the bulb is in the garage, and 0 otherwise;
Hallway	=	a dummy variable equal to 1, if the bulb is in the hallway, and 0 otherwise;
Kitchen	=	a dummy variable equal to 1, if the bulb is in the kitchen, and 0 otherwise;
Living Space	=	a dummy variable equal to 1, if the bulb is in the living space, and 0 otherwise;
Office	=	a dummy variable equal to 1, if the bulb is in an office, and 0 otherwise;
Outdoor	=	a dummy variable equal to 1, if the bulb is outdoors, and 0 otherwise;
Storage	=	a dummy variable equal to 1, if the bulb is in a storage room, and 0 otherwise;
Utility	=	a dummy variable equal to 1, if the bulb is in the utility room, and 0 otherwise;
Other	=	a dummy variable equals to 1, if the bulb is in a low-use room (such as a utility room, laundry room, or closet), and 0 otherwise; and
SinHOU	=	amplitude of sinusoid function.

As not all loggers collected a full year of data, Cadmus estimated an annual average HOU for all lamps, fitting the data to a sinusoidal curve that represented changes in the hours of available daylight per day.[2]

Cadmus tested the potential influences of other demographic and day type variables in model specifications, such as: home characteristics and weekend/weekday. These variables, however, were not

[2] Page 15 of the Uniform Methods Protocol for lighting impact evaluations recommends using the sinusoidal annualization approach due to the strong relationship between daylight hours and lighting usage observed in a large number of studies. Available online at: http://www1.eere.energy.gov/wip/pdfs/53827-6.pdf

included as their estimated coefficients did not differ significantly from zero or produced signs inconsistent with expectations.

Final Estimates and Extrapolation

Cadmus used these model parameters to predict average daily use by taking the sum of the product of each coefficient shown in Table B1 and its corresponding average independent variable.

Table B1. HOU Model Coefficients and Significance

Parm	Estimate	Stderr	LowerCL	UpperCL	Z	ProbZ
Basement	2.01	0.46	1.10	2.93	4.33	<.0001
Bathroom	1.38	0.12	1.14	1.62	11.08	<.0001
Bedroom	1.28	0.08	1.13	1.43	16.42	<.0001
Closet	0.49	0.08	0.34	0.63	6.46	<.0001
Dining	1.40	0.16	1.09	1.71	8.92	<.0001
Foyer	2.02	1.35	-0.63	4.68	1.49	0.1352
Garage	1.47	0.48	0.52	2.41	3.03	0.0024
Hallway	1.21	0.17	0.87	1.55	6.99	<.0001
Kitchen	3.25	0.26	2.74	3.76	12.56	<.0001
Living_Space	2.21	0.16	1.89	2.52	13.64	<.0001
Office_Den	1.36	0.21	0.95	1.77	6.44	<.0001
Other	1.12	0.37	0.40	1.84	3.07	0.0022
Outdoor	2.39	0.43	1.55	3.23	5.58	<.0001
Storage	0.07	0.02	0.03	0.11	3.42	0.0006
Utility	0.95	0.25	0.46	1.43	3.79	0.0001

Table B2 shows independent variables used, calculated from participant survey responses when asked which rooms respondents' installed bulbs in.

Table B2. Weekday HOU Estimation Input Values

Variable	CFL Value	LED Value
Bedroom	21.4%	20.1%
Basement	5.0%	3.6%
Bathroom	10.7%	9.4%
Closet	0.9%	2.1%
Dining	7.2%	8.5%
Foyer	0.4%	0.9%
Garage	1.5%	0.9%
Hallway	3.0%	2.1%
Kitchen	18.6%	18.8%
Office/Den	2.7%	1.5%
Living Space	15.3%	16.7%
Storage	0.7%	0.5%
Outdoor	4.3%	8.2%
Utility	0.6%	0.6%
Other	7.7%	6.1%

Using these values, the equation calculated a 1.87 average daily HOU for CFLs and 1.92 for LEDs.

The lower HOU value of 1.87 for CFLs in 2013-2014, down from 2.27 in 2011-2012, was likely in-part due to increased saturation of efficient bulbs. As the efficient lighting market matures and saturation increases within the average home, efficient lamps are installed not just in high-use sockets but also in lower use sockets, whether in rooms with lower usage or supplemental lighting, such as desk lamps.

The survey responses indicated changes in the proportion of bulbs installed in various rooms between the 2011-2012 cycle and the current evaluation. The share of bulbs installed in living spaces (which have a higher average usage) dropped from 28% in 2011-2012 to 15% for CFLs in 2013-2014 (17% of LEDs were installed in living spaces).

Conversely, the share of bulbs installed into room types designated as “other” in the 2011-2012 cycle (such as utility rooms, closets, hallways) increased from 7% in 2011-2012 to 29% in the current evaluation. These room types tend to have lower average hours of use.

Delta Watts Lumen Bins

Table B3 through Table B11 provide lumen bins by lamp types applied in the gross evaluated lighting evaluation (CFLs, LEDs, and light fixtures). The tables include evaluated baseline wattages by year and total lamp quantities sold in 2013–2014.

Table B3. Lumen Bins and Quantities for Standard Lamps

Lumen Bin	2013 Baseline Wattage	2014 Baseline Wattage	Estimated CFL Efficient Wattage	Estimated LED Efficient Wattage	Lamp Quantity
0–309	25	25	1–5	1-4	0
310–449	25	25	6–7	5-6	0
450–799	40	29	8–12	7-10	241,702
800–1,099	60	43	13–17	11-14	2,743,968
1,100–1,599	53	53	18–24	15-20	348,684
1,600–1,999	72	72	25–30	21-24	806,350
2,000–2,600	72	72	31–38	25-32	0

Table B4. Lumen Bins and Quantities for Globe Lamps

Lumen Bin	2013 Baseline Wattage	2014 Baseline Wattage	Lamp Quantity*
250–349	25	25	1,203
350–499	40	29	3,437
500–574	60	43	373,222
575–649	53	53	8,504
650–1099	72	72	29,415
1100–1300	72	72	0

*Cadmus was unable to evaluate 150 globe lamps with less than 250 lumens

Table B5. Lumen Bins and Quantities for Decorative Lamps

Lumen Bin	2013 Baseline Wattage	2014 Baseline Wattage	Lamp Quantity
70–89	10	10	86
90–149	15	15	87
150–299	25	25	3,715
300–499	40	29	134,819
500–699	60	43	69

Table B6. Lumen Bins and Quantities for EISA-Exempt Lamps

Lumen Bin	2013 Baseline Wattage	2014 Baseline Wattage	Lamp Quantity
310–449	25	25	0
450–799	40	40	0
800–1099	60	60	0
1100–1599	75	75	0
1600–1999	100	100	603
2000–2600	150	150	1,461

Table B7. Lumen Bins and Quantities for D > 20 Reflector Lamps

Lumen Bin	2013 Baseline Wattage	2014 Baseline Wattage	Lamp Quantity
300–639	30	30	6,915
640–739	40	40	138,472
740–849	45	45	43,796
850–1179	50	50	38,488
1180–1419	65	65	35,113
1420–1789	75	75	4
1790–2049	90	90	0
2050–2579	100	100	0
2580–3429	120	120	68

Table B8. Lumen Bins and Quantities for BR30, BR40, ER40 Reflector Lamps

Lumen Bin	2013 Baseline Wattage	2014 Baseline Wattage	Lamp Quantity
300–399	30	30	0
400–449	40	40	0
450–499	45	45	0
500–649	50	50	676
650–1179	65	65	700,851
1180–1419	65	65	0
1420–1789	75	75	0
1790–2049	90	90	0
2050–2579	100	100	0
2580–3429	120	120	0

Table B9. Lumen Bins and Quantities 20 ≥ D > 18 Reflector Lamps

Lumen Bin	2013 Baseline Wattage	2014 Baseline Wattage	Lamp Quantity
300–539	20	20	3,561
540–629	30	30	0
630–719	40	40	0
720–999	45	45	0
1000–1199	50	50	0
1200–1519	65	65	0
1520–1729	75	75	0
1730–2189	90	90	0
2190–2899	100	100	0

Table B10. Lumen Bins and Quantities for R20 Reflector Lamps

Lumen Bin	2013 Baseline Wattage	2014 Baseline Wattage	Lamp Quantity
300–399	30	30	0

400–449	40	40	1,410
450–719	45	45	23,218
720–999	50	50	0
1000–1199	65	65	0
1200–1519	75	75	0
1520–1729	90	90	0
1730–2189	100	100	0
2190–2899	120	120	0

Table B11. Lumen Bins and Quantities for 18 ≥ D Reflector Lamps

Lumen Bin	2013 Baseline Wattage	2014 Baseline Wattage	Lamp Quantity
200-299	20	20	0
300-399	30	30	294
400-449	40	40	0
450-499	45	45	0
500-649	50	50	0
650-1199	65	65	0

Figure B1 displays 2014 baseline wattage plotted as a function of lumen output for standard, globe, decorative, and EISA-exempt lamps, as well as the three most common reflector types. This figure shows this correlation up to 2000 lumens (only 0.03% of lamps had lumen output greater than 2000 lm).

Figure B1: Plot of 2014 Baseline Wattage vs. Lamp Lumens for Various Lamp Types

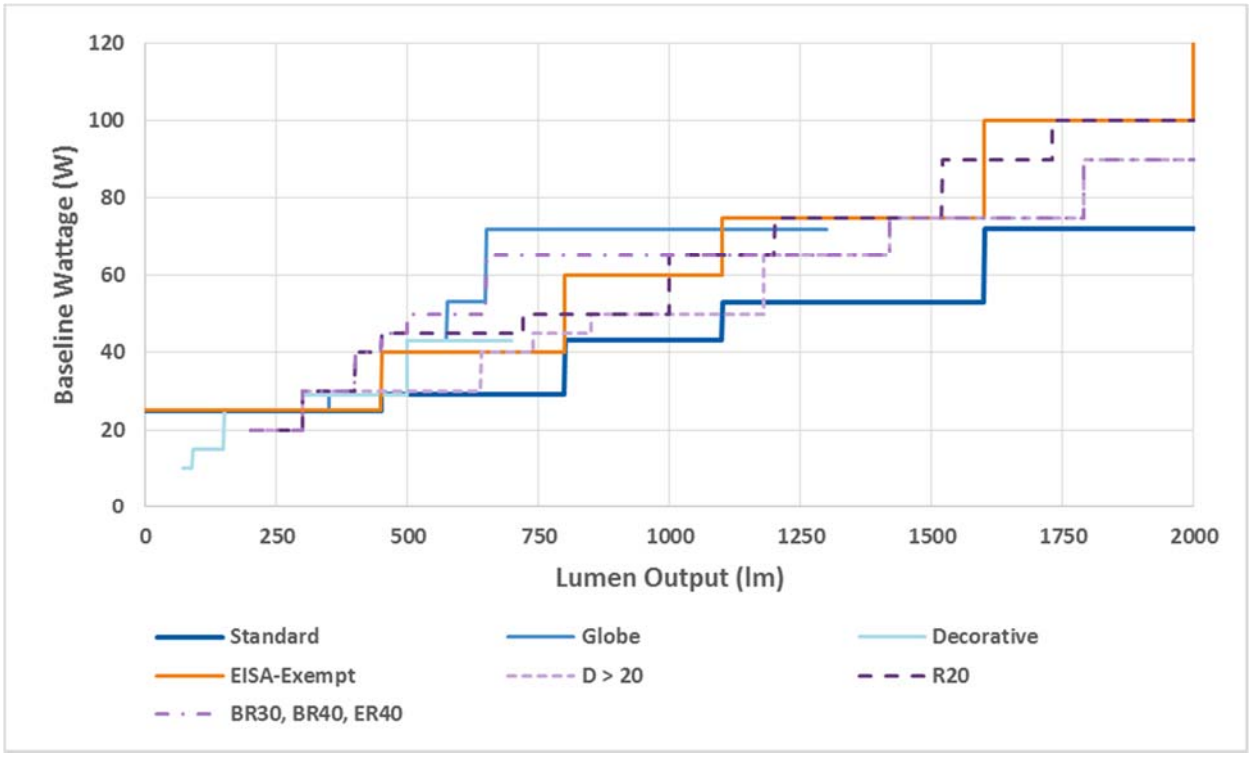
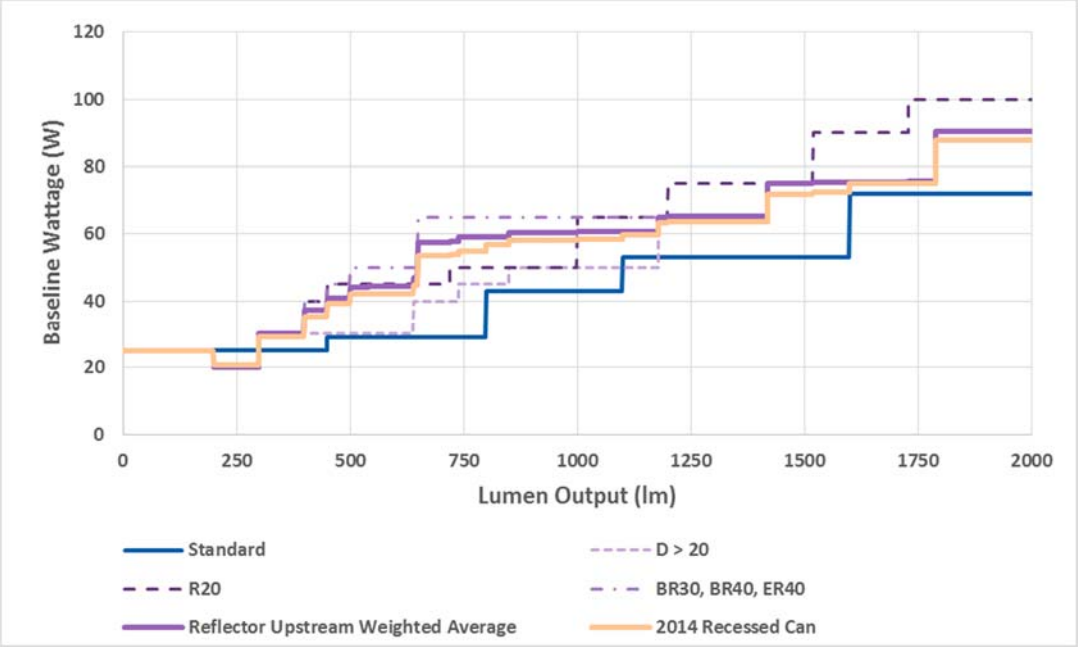


Figure B2 also displays lumen bins and baseline wattages for standard bulbs and the three most common reflector types. It also displays the average combined reflector lumen bins, weighted by quantities, and the average recessed can lumen bins, weighted by bulb type saturation in recessed can receptacles. Standard and recessed can baseline wattages reflect 2014 values.

Figure B2: Plot of Cadmus-created Weighted Reflector and 2014 Recessed Can Baseline Wattages



Watts vs. Lumen ENERGY STAR Linear Fits

Figure B3 through Figure B10 show watts vs. lumens from the ENERGY STAR database for eight different lamp categories. Standard, reflector, and specialty LED and CFL lamps are represented. When lumens could not be determined for a particular model of bulb, these linear fits were used to obtain that bulb's lumen output.

Figure B3: Median Lumens vs. Wattage for ENERGY STAR-Qualified Standard CFLs

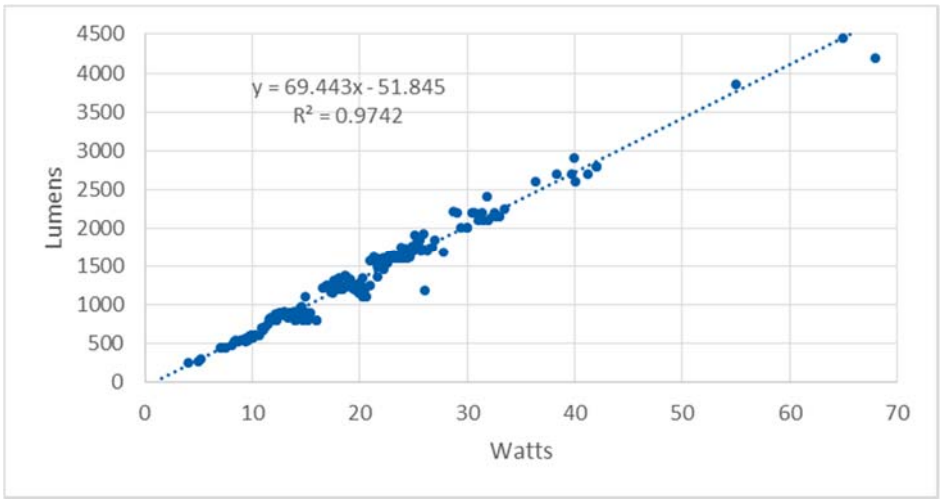


Figure B4: Median Lumens vs. Wattage for ENERGY STAR-Qualified Reflector CFLs

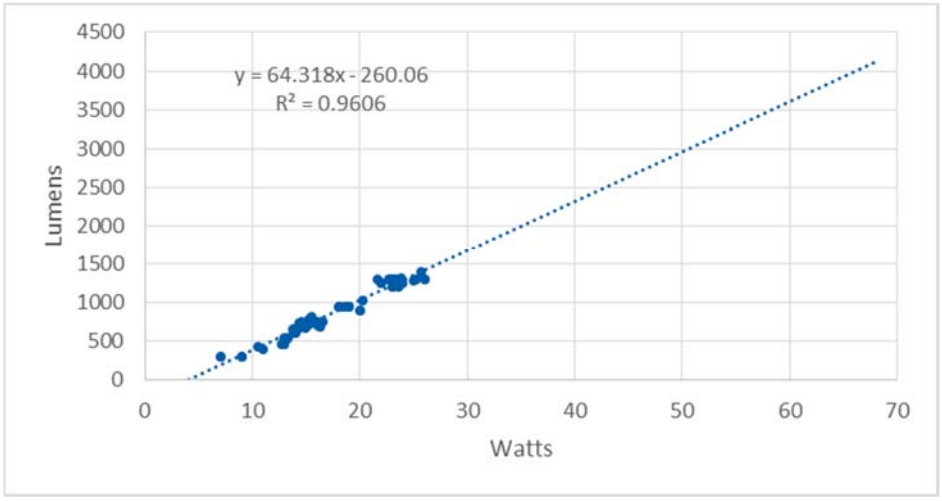


Figure B5: Median Lumens vs. Wattage for ENERGY STAR-Qualified Specialty CFLs

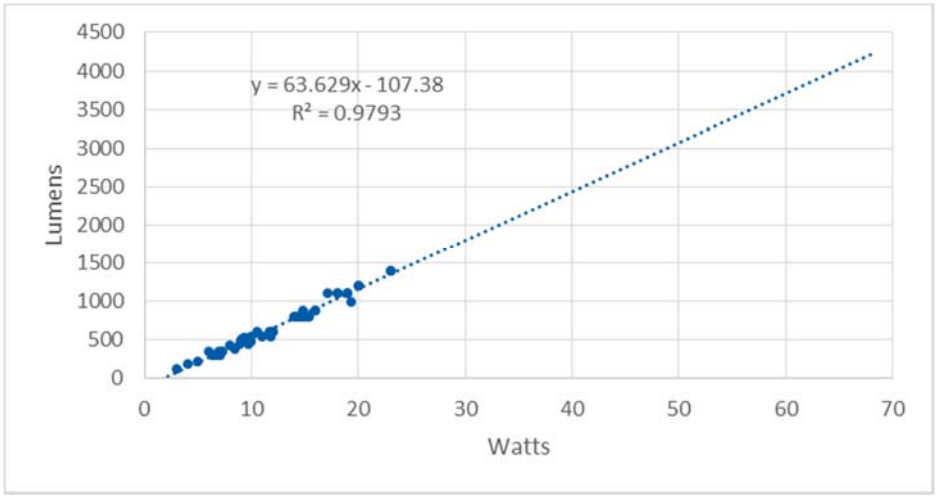


Figure B6: Median Lumens vs. Wattage for ENERGY STAR-Qualified CFL Fixtures

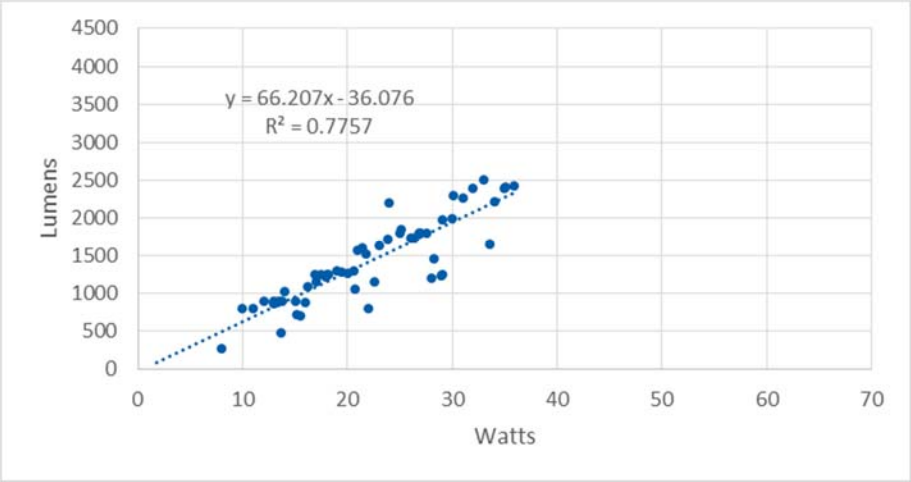


Figure B7: Median Lumens vs. Wattage for ENERGY STAR-Qualified Standard LEDs

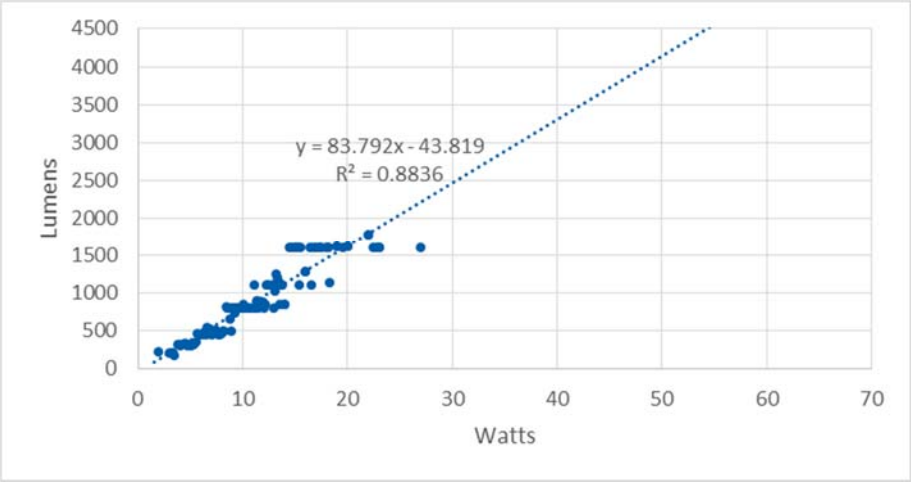


Figure B8: Median Lumens vs. Wattage for ENERGY STAR-Qualified Reflector LEDs

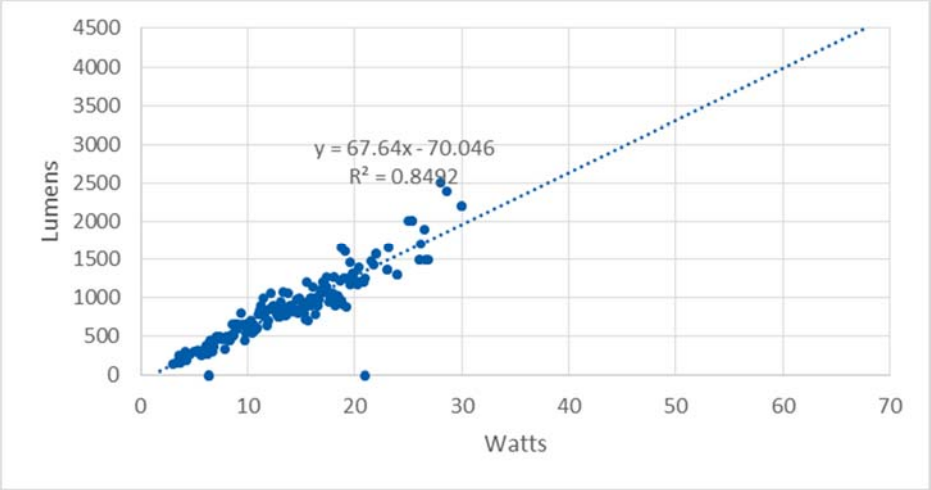


Figure B9: Median Lumens vs. Wattage for ENERGY STAR-Qualified Specialty LEDs

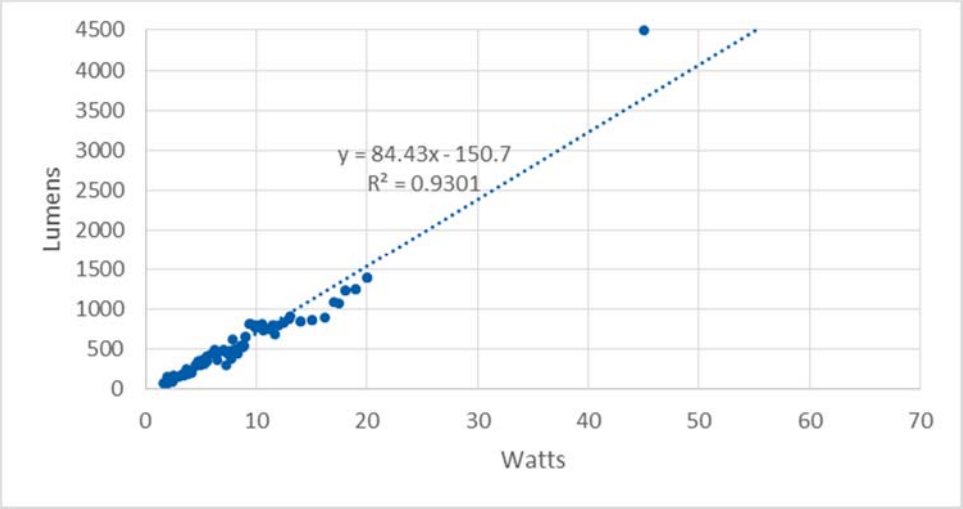
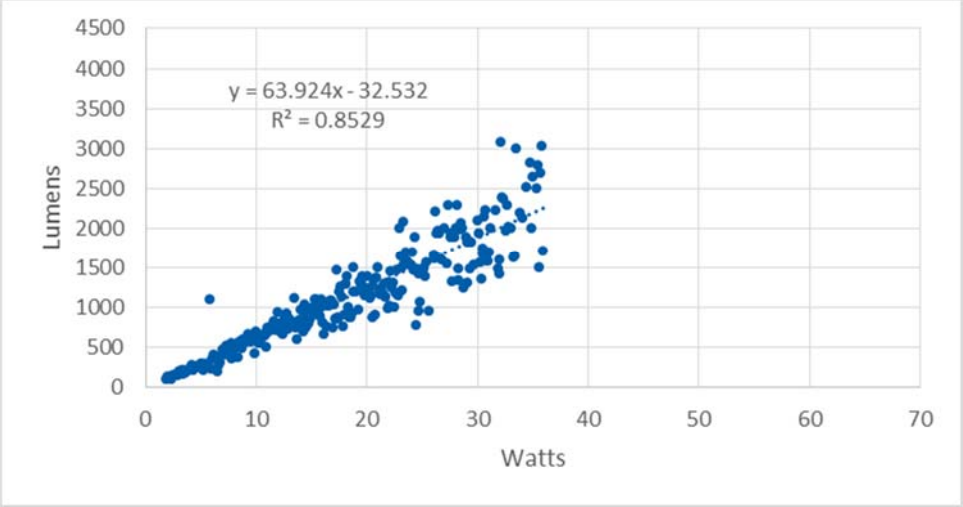


Figure B10: Median Lumens vs. Wattage for ENERGY STAR-Qualified LED Fixtures



Cross-Sector Lighting Sales

Cadmus performed intercept surveys in Utah, Washington, and Idaho to collect information from customers about efficient bulb purchases and whether they intended to install these bulbs in residential or commercial applications, then using these data to calculate a cross-sector sales percentage. Cadmus combined the data from the three states to maximize the confidence and precision around the estimate. The estimated cross-sector lighting sales factor not applied to the gross savings analysis for this evaluation.

During these surveys, field staff intercepted customers as they left stores if they purchased lighting products from a participating retail; staff asked customers questions addressing their efficient bulb purchases. For cross-sector sales purposes, staff asked customers about their intentions to install the purchased bulbs in residential or commercial applications. Table B12 summarizes respondent results. In

total, Cadmus completed 630 surveys, and 363 of the respondents purchased one or more efficient bulbs. Of all respondents, 347 said they intended to install their bulbs in residential applications and 16 intended to install them in commercial applications.

Table B12. Cross-Sector Respondent Counts

Respondent Count	Application	
	Residential	Commercial
CFL	125	10
LED	227	6
CFL or LED	347	16
Total Respondents*		**363**

***Results aggregated across three states: interviews were conducted in Utah, Washington, and Idaho, but only one respondent intended to install bulbs in commercial applications in Washington and Idaho.

Table B13 summarizes the quantity of bulbs purchased by respondents. In total, respondents intended to install 1,536 CFLs and LEDs in residential applications and 62 in commercial applications.

Table B13. Cross-Sector Bulb Counts

Bulb Count	Application	
	Residential	Commercial
CFLs	632	50
LEDs	904	12
Total Bulbs	**1,536**	**62**

Cadmus used the bulb quantities shown in Table B13 to calculate a cross-sector sales percentage of 3.9% using the following equation:

$$\frac{Commercial\ CFLs\ \&\ LEDs}{All\ CFLs\ \&\ LEDs} = \frac{62}{1{,}598} = 3.9\%$$

The denominator in the equation represents the total number of efficient bulbs installed in residential and commercial facilities (1,536 + 62 = 1,598). Cadmus determined a 90% confidence interval of 2.2%–5.5% for the cross-sector sales percentage of 3.9%.

Demand Elasticity Modeling

As lighting products incur price changes and promotion over the program period, they provide valuable information regarding the correlation between sales and prices. Cadmus developed a demand elasticity model to estimate freeridership for the upstream markdown channel in program years 2013 and 2014. A description follows detailing the methodology and analysis results.

Demand Elasticity Methodology

Demand elasticity modeling draws upon the same economic principle that drives program design: changes in price and promotion generate changes in quantities sold (i.e., the upstream buy-down approach). Demand elasticity modeling uses sales and promotion information to achieve the following:

- Quantify the relationship of price and promotion to sales;
- Determine likely sales levels without the program's intervention (baseline sales); and
- Estimate freeridership by comparing modeled baseline sales with actual sales.

After estimating variable coefficients, Cadmus used the resulting model to predict the following:

- Sales that would occur *without* the program's price impact; and
- Sales that would occur *with* the program (and should be close to actual sales with a representative model).

Once the model predicted sales that would occur with and without the program, Cadmus applied evaluated savings values, calculated as part of this evaluation.

Cadmus then calculated savings net of freeridership[3] using the following formula:

$$Net\ of\ FR\ Ratio = \left(\frac{Savings\ with\ Program - Savings\ without\ Program}{Savings\ with\ Program}\right)$$

Input Data

As the demand elasticity approach relies exclusively on program data, a model's robustness depends on data quality. Though, overall, available data achieved a sufficient quality to support the analysis, the data also presented several issues of note:

1. Inconsistent model numbers between 2013 and 2014.
2. Lack of schedule ID number in 2013 data.
3. Inconsistent bulb type designations within each model number (e.g., spiral and candelabra, reflector and general purpose spiral/a-line).
4. Inconsistent reported quantities within a given sales period.

Cadmus had to make the most reasonable assumptions possible when preparing the data to support the analysis (e.g., assessing whether two model numbers with different formats and detail levels were the same).

[3] Net of FR are sales net of freeridership, or 1-FR, used to calculate the net-to-gross (NTG) ratio where NTG = 1 – FR + Spillover. For this evaluation, spillover was assumed to be 0%.

Price Variation

As desired for analysis, sales data displayed relatively high amounts of price variations. Variation was measured within unique part number/retailer location combinations: that is, a given bulb model within a unique retail location.

Promotional Displays

The program administrator, did not collect and could not provide detailed data on product merchandising (e.g., clip strips, end caps, pallet displays). Therefore, the model may not have captured all program impacts.[4]

Evaluations in other jurisdictions have found that product merchandising can generate sales lift between 60% and 120%. Capturing and providing this level of detail ensures that the program is credited for all activities.

Stocking Patterns

In preparing to model the sales data, Cadmus observed dramatic sales drops that did not correspond to programmatic activity or to expected seasonal variation. Cadmus' model implicitly assumed supply would meet demand at the given price. Analysis included screening the data for instances where this assumption appeared untrue.

Cadmus looked for patterns in these drops that suggested changes in stocking patterns or retailers temporarily unable to stock certain products. The following criteria served to flag changes in stocking patterns:

1. **Average monthly sales for a product were greater than 10 packs**. For those fewer than 10 packs per month, Cadmus assumed it would be more likely that some months would have zero sales.[5]
2. **Two-thirds of monthly observations of the same product across multiple store locations proved less than one pack.**[6] For example, if a 13-watt GE spiral CFL was sold at 18 different store locations, and 14 locations had sales of less than one pack during the month of June.

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[4] To the degree that product merchandising and prices co-vary, elasticity estimates may capture some sales lift generated by merchandising. However, as data were not available to incorporate into the model, it impossible to estimate separate impacts.

[5] The 10 packs cutoff assumed that products with average monthly sales fewer than 10 would be more likely to have months with zero sales due to naturally occurring variability.

[6] Because the sales data are reported at intervals that do not follow regular calendar months, the sales are transformed to daily sales and then aggregated by calendar month. This leads to fractional package sales within a given month though overall quantities remain the same.

If products met both criteria, Cadmus flagged them as out of stock and included a binary variable in the model to control for such drops and to separate this effect from price changes. Not doing so could have biased elasticity estimates.

Seasonality Adjustment

In economic analysis, it proves critical to separate data variations resulting from seasonality from those resulting from relevant external factors. For example, suppose prices had been reduced on umbrellas at the beginning of the rainy season. Any estimate of this price shift's impact would be skewed if the analysis did not account for the natural seasonality of umbrella sales.

To adjust for seasonal variations in sales, Cadmus used a monthly seasonal trend provided by an evaluation partner. This represented national sales from a major lighting products manufacturer. Ideally, a trend would derive from historical data on aggregate sales of lighting products (e.g., inefficient and efficient, program and non-program). Such data would represent overall trends in lighting product sales and would not suffer from potential confounding with programmatic activity to the same degree as CFL sales.[7] The trend, however, indicated aggregated, nationwide CFL sales for a specific manufacturer.

Presumably, the trend included some activity from programs across the nation, which could affect the sales trend, potentially leading to underestimated program impacts. Cadmus assumed, however, that program activity would be somewhat random across all programs that could be included in the sales data used to develop the trend. In that case, program activity would be spread through the year, and the variation between months would be driven primarily by non-program factors.

Nevertheless, not controlling for seasonal variations could lead to program impacts overestimated by falsely attributing seasonal trends to price impacts (to the degree that they co-varied) or vice versa.

For example, sales in July tend to be lower (presumably due to longer daylight hours); so if program activity increased sales in July, not controlling for seasonal variation would underestimate the program's impact. October, on the other hand, sees higher sales, and no control for seasonality would likely overestimate program activity impacts occurring in that month.

The trend, given the national aggregation level, covered non-program products and areas without programs, therefore limiting the degree that the trend correlated with program activity. Absent primary seasonal data from Utah's territory, Cadmus estimated model and subsequent freeridership ratios using the CFL trend.

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[7] This assumes aggregate lighting sales did not change due to promotions; that is, customers simply substituted an efficient product for an inefficient one. While bulb stockpiling could occur during programmatic periods, this should smooth out over time, as the program would not affect the number of sockets in the home.

Model Specification

Cadmus modeled bulb, pricing, and promotional data using an econometric model, addressing these data as a panel, with a cross-section of program package quantities modeled over time as a function of prices, promotional events, and retail channels. This involved testing a variety of specifications to ascertain price impacts—the main instrument affected by the program—on bulb demand. Cadmus estimated the following equation for the model (for bulb model *i*, in month *t*):

$$\ln(Q_{it}) = \sum_{\pi}(\beta_{\pi} ID_{\pi,\mathrm{i}}) + \sum_{\theta}(\beta_{\theta 1}[ln(P_{it}) * (Retail\ Channel_{\theta,\mathrm{i}})]) + \sum_{\theta}(\beta_{\theta 2}[ln(P_{it}) * (Bulb\ Type_{\theta,\mathrm{i}})]) + \beta_{\theta 3} ln(P_{it}) * (Specialty_{\theta,\mathrm{i}}) + \beta_{\theta 4}(Out\ of\ Stock_{\theta,\mathrm{i}}) + \alpha Seasonal\ Trend_{t} + \varepsilon_{i}$$

Where:

ln	=	Natural log
Q	=	Quantity of bulb packs sold during the month
P	=	Retail price (after markdown) in that month
Retail Channel	=	Retail category (Club or non-Club store)
Bulb Type	=	Product category (CFL or LED)
Specialty	=	Dummy variable equaling 1 for specialty bulbs and 0 for standard
Out of Stock	=	Dummy variable equaling 1 if a given product was assumed to have been out of stock in month t and 0 otherwise
ID	=	Dummy variable equaling 1 for each unique retail channel and SKU; 0 otherwise
Seasonal Trend	=	Quantitative trend representing the impact of secular trends not related to the program[8]
ε_{it}	=	Cross-sectional random-error term

The model specification assumed a negative binomial distribution, which served as the best fit of the plausible distributions (e.g., lognormal, poisson, negative binomial, gamma). The negative binomial distribution provided accurate predictions for a small number of high-volume sale bulbs, while the other distributions under predicted sales for those bulbs.

Cadmus adjusted the model to correct for the two factors discussed earlier:

- **Seasonality**: To account for baseline lighting sales tending to follow a seasonal pattern, unrelated to price or promotion, by inserting a seasonal trend into the model.

[8] The time trend for this analysis represented shifts in sales due to non-program-related seasonality.

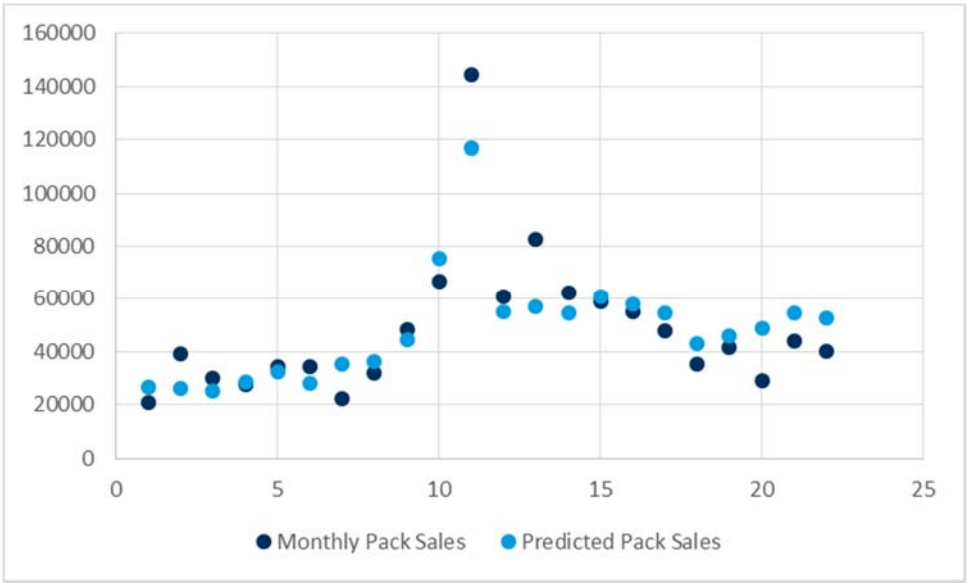
- **Stocking Patterns**: The model assumed supply would always meet demand; after investigating situations where this did not occur, Cadmus controlled for instances where two-thirds or more of monthly observations for the same product with less than one package within a given month.

Using the following criteria, Cadmus ran numerous model scenarios to identify the one with the best parsimony and explanatory power:

- Model coefficient p-values (keeping values less than <0.1);[9]
- Explanatory variable cross-correlation (minimizing where possible);
- Model Akaike's Information Criteria (AIC) (minimizing between models);[10]
- Minimizing multicollinearity; and
- Optimizing model fit.

The model's fit can be examined by comparing model-predicted sales with actual sales. As shown in Figure B11, the model-predicted sales matches very closely with actual sales. The model under predicted a couple of months, but it also over predicted a couple of months without persistent bias in a single direction (over- or under-predicting), indicating the model fit the data well. Overall, the model fell within 0.4% of actual sales.

Figure B11. Predicted and Actual Sales



[9] Where a qualitative variable had many states (such as bulb types), Cadmus did not omit variables if one state's was insignificant; rather, the analysis considered the joint significance of all states.

[10] The Team used AIC to assess model fit, as nonlinear models do not define the R-square statistic. AIC also offers a desirable property in that it penalizes overly complex models, similarly to the adjusted R-square.

Findings

Cadmus estimated a combined CFL and LED net of freeridership of 62%. Table B14 shows the estimated net of freeridership ratio by bulb type. LEDs have lower freeridership than CFLs.

Table B14. Modeling Results by Bulb Type

Bulb Type	Predicted kWh Savings With Program	Predicted kWh Savings Without Program	Freeridership
CFL	41,370,447	16,765,742	40%
LED	24,468,043	8,349,595	34%

Table B15 shows the incentive as a share of the original retail price and the estimated net of freeridership ratio by utility and bulb type. Typically, the proportional price reduction and the net of freeridership trend correlate: the higher the incentive, the lower the freeridership. In addition, specialty LED sales exhibited a greater response to price changes.

Table B15. Modeling Results by Bulb Type

Bulb Type	Final Price per Bulb	Original Price per Bulb	Markdown %	Net of FR
CFL	$ 0.94	$ 2.24	58%	60%
LED	$ 5.70	$10.45	45%	66%

Table B16 presents freeridership estimates by retail channel and bulb type. Club stores had lower prices per bulb as well greater price elasticities. Both of these factors contributed to lower freeridership in club stores.

Table B16. Net of Freeridership by Detailed Retail Channel and Bulb Type

Retail Channel	Bulb Type	Average Price Per Bulb	Markdown %	Net of Freeridership
Non-Club Store	CFL	$ 1.25	51%	44%
	LED	$10.61	31%	23%
Club Store	CFL	$ 0.67	66%	66%
	LED	$ 4.99	49%	70%

Elasticities

The net of freeridership ratios derived from the estimate of a price elasticity of demand. Price elasticity of demand measures the percent change in the quantity demanded, given a percent change in price. Due to the model's logarithmic functional form, these simply represented the coefficients for each price variable. In previous, similar analyses, Cadmus had seen elasticities range from -1 to -3 for CFLs, meaning a 10% drop in price led to a 10% to 30% increase in the quantity sold. As shown in Table B17, non-club elasticity estimates fell a bit below the expected ranges, with some estimates less than one, but, on average, estimates fell within the expected range.

Table B17. Elasticity Estimates by Retail Channel and Bulb Type

Store Type	Bulb Type	Elasticity
Club Store	CFL-Specialty	-1.15
Club Store	CFL-Standard	-1.00
Club Store	LED-Specialty	-1.86
Club Store	LED-Standard	-1.71
Non-Club	CFL-Specialty	-0.92
Non-Club	CFL-Standard	-0.76
Non-Club	LED-Specialty	-0.90
Non-Club	LED-Standard	-0.74

Net of Freeridership Comparisons

Table B18 compares CFL net of freeridership estimates from several recent evaluations using the elasticity model approach. The table also shows the average, sales-weighted, original retail price of program bulbs and the incentive as a share of the original price, as the percent of markdown serves as a large driver to freeridership estimates.

Though the net of freeridership estimates for Rocky Mountain Power fell within the range of those observed in other programs, they decreased since the 2011–2012 modeling effort. Part of the decline may result from the maturation of the efficient lighting market. As CFLs become a more familiar and accepted technology, demand may become less elastic—that is, for consumers willing to substitute CFLs for less-efficient bulbs, their willingness to buy CFLs will become less variable. For those less inclined to substitute CFLs, their decision may remain the same, regardless of price changes.

A lack of merchandising data could present another potential factor. Without data to explicitly control for sales lift due to merchandising, price elasticity estimates may absorb some impacts of product merchandising to a degree that merchandising and price changes co-vary. This could lead to larger elasticity estimates when merchandising and prices positively correlate or lower elasticity estimates when they negatively correlate.

Table B18. Comparisons of CFL Net of Freeridership and Incentive Levels

Utility	Bulb Type	Original Price per bulb	Markdown per bulb	Markdown %	Net of Freeridership
Rocky Mountain Power Utah 2011-2012	Standard	$2.18	$1.37	63%	83%
Mid-Atlantic Utility 1	Standard	$1.97	$1.41	72%	73%
Mid-Atlantic Utility 3	Standard	$2.10	$1.59	76%	73%
New England	Standard	$2.11	$1.00	47%	68%
Mid-Atlantic Utility 2	Standard	$2.14	$1.43	67%	65%
Mid-Atlantic Utility 4	Standard	$2.22	$1.46	66%	65%

Rocky Mountain Power Utah 2013-2014	Standard	$2.21	$1.30	58%	60%
Midwest Utility	Standard	$1.82	$1.13	62%	57%
Southeast	Standard	$2.15	$1.09	51%	52%

CADMUS

Appendix C. HES Billing Analysis

Cadmus conducted three billing analyses to estimate gross and net savings for the following measures:

- Insulation (attic, wall, or floor)
- Ductwork (duct sealing and/or duct insulation)
- Cooling Equipment (central air conditioners and evaporative coolers)

The following sections outline the methodology and results for each effort.

Insulation Billing Analysis

Cadmus conducted billing analysis to assess actual net energy savings associated with insulation measure installations.[1] Cadmus determined the savings estimate using a pooled, conditional savings analysis (CSA) regression model, which included the following groups:

- 2013–2014 insulation participants (combined attic, wall, and floor insulation); and
- Nonparticipant homes, serving as the comparison group.

The billing analysis resulted in a 105% net realization rate for insulation measures (a net result rather than gross as it compares participant usage trends to a nonparticipant group, accounting for market conditions outside of the program).

Insulation Program Data and Billing Analysis Methodology

Cadmus used the following sources to create the final database for conducting the billing analysis:

- ***Participant program data,*** collected and provided by the program administrator (including account numbers, measure types, installation dates, square footage of insulation installed, heat sources, and expected savings for the entire participant population).
- ***Control group data,*** which Cadmus collected from a census of nearly 500,000 nonparticipating customers in Utah. Cadmus matched energy use for the control group to quartiles of the participants' pre-participation energy use to ensure comparability of the two groups. To ensure adequate coverage of the nonparticipating population, Cadmus included four times the number of nonparticipants than participants.
- ***Billing data***, provided by Rocky Mountain Power, which included all Utah residential accounts. Cadmus matched the 2013–2014 participant program data to the census of Utah's billing data for participants installing only insulation measures (i.e. did not install other measures through HES). Billing data included meter-read dates and kWh consumption from January 2012 through August 2015. The final sample used in the billing analysis consisted of 6,928 participants and 27,712 control customers.

[1] Billing analysis performed for customers installing only attic, wall, or floor insulation measures.

- ***Utah weather data***, including daily average temperatures from January 2012 to August 2015 for 11 weather stations, corresponding with HES participant locations.

Cadmus matched participant program data with billing data, mapping daily heating degree days (HDDs) and cooling degree days (CDDs) to respective monthly read date periods using zip codes. Cadmus defined the billing analysis pre-period as 2012, before measure installations occurred. This meant defining the post-period as September 2014 through August 2015.[2]

Data Screening

To ensure the final model used complete pre- and post-participation and nonparticipant billing data, Cadmus selected accounts with the following:

1. Participant addresses matching to the billing data provided.
2. A minimum of 300 days in each of the pre- and post-periods (i.e., before the earliest installation, and after the latest reported installation in 2012).
3. More than 1,264 kWh per year or less than 102,678 kWh per year (the lowest and highest participant usage to remove very low- or high-usage nonparticipants).
4. Gas-heated accounts (99% of homes in Utah) showing a consumption change of less than 30% of pre-program usage, ensuring a better match between participants and the control group; electrically heated accounts with consumption up to 50%.
5. Expected savings under 70% of household consumption (i.e., accounts with a mismatch between participant database and billing data or with pre-period vacancies).

Cadmus also examined individual monthly billing data to check for vacancies, outliers, and seasonal usage changes. If the usage patterns remained inconsistent between pre- and post-periods, the analysis dropped accounts. Table C1 shows participant and nonparticipant screening criteria used for the insulation billing analysis.

Table C1. Screen for Inclusion in Billing Analysis

Screen	Attrition		Remaining	
	Nonparticipant	Participant	Nonparticipant	Participant
Original measures database (insulation installations only) and nonparticipant population	N/A	N/A	495,588	15,027
Matched billing data sample (reduced to nonparticipant, single-family residential accounts in participant zip codes;	66,849	2,912	428,739	12,115

[2] As participants installing measures in late 2014 had less than 10 months of post-period data, the analysis excluded them. Similarly, the analysis excluded customers participating in 2013 with measure installation dates before November 2012 had less than 10 months of pre-period data.

Screen	Attrition		Remaining	
	Nonparticipant	Participant	Nonparticipant	Participant
participant accounts that could be matched to the billing data addresses)				
Reject accounts with less than 300 days in pre- or post-period	111,876	2,905	316,863	9,210
Reject accounts with less than 1,264 kWh or more than 102,678 kWh in pre- or post-period	390	-	316,473	9,210
Reject accounts with consumption changing by more than 30% from pre- to post-period for gas-heated homes and more than 50% for electrically heated homes	42,598	1,057	273,875	8,153
Reject accounts with expected savings over 70% of pre-period consumption	-	16	273,875	8,137
Reject accounts with billing data outliers, vacancies, and seasonal usage	25,779	1,209	248,096	6,928
Nonparticipant sample selection (random sample of nonparticipants to match participant pre-period usage by quartile; four times more than participants)	220,834	-	27,712	6,928
Final Sample			**27,712**	**6,928**

Regression Model

After screening and matching accounts, the final analysis group consisted of 6,928 participants and 27,712 nonparticipants.

Of the final sample, 95% of participant homes installed attic insulation, 6% installed wall insulation, and none of the participant home installed floor insulation. As determining separate wall or floor insulation savings proved impossible, Cadmus estimated a combined realization rate for all insulation measures.

Cadmus used the following CSA regression specification to estimate HES Program insulation savings:

$$ADC_{it} = \alpha_i + \beta_1 HDD_{it} + \beta_2 CDD_{it} + \beta_3 POST_t + \beta_4 PARTPOST_{it} + \varepsilon_{it}$$

Where for customer (i) and month (t):

ADC_{it} = Average daily kWh consumption

HDD_{it} = Average daily HDDs (base 65)

CDD_{it} = Average daily CDDs (base 65)

$POST_t$ = Indicator variable of 1 in the post-period for participants and nonparticipants, 0 otherwise

$PARTPOST_{it}$ = Indicator variable of 1 in the post-period for participants, 0 otherwise

β_4 served as the key coefficient determining average insulation savings. The coefficient averaged daily insulation savings per program participant, after accounting for nonparticipant trends. Cadmus included individual customer intercepts (α_i) as part of a fixed-effects model specification to ensure no participants or nonparticipants exerted an undue influence over the final savings estimate; this resulted in a more robust model.[3]

Insulation Results

Cadmus estimated overall insulation savings of 284 kWh per participant. Average insulation had expected savings of 271 kWh, translating to a 105% net realization rate for insulation measures. With average participant pre-usage of 12,690 kWh, savings represented a 2% reduction in total energy usage from insulation measures installed. Table C2 presents the overall net savings estimate for wall, floor, and attic insulation.

Table C2. Insulation Net Realization Rates

Model	Billing Analysis Participants (n)	Reported kWh Savings per Premise	Evaluated Net kWh Savings per Premise	Net Realization Rate	Relative Precision at 90% Confidence	90% Confidence Bounds
Overall	**6,928**	**271**	**284**	**105%**	**±10%**	**95%–116%**
Electric Heat	88	1,913	1,652	86%	±14%	74%-98%
Gas Heat	6,840	249	267	107%	±11%	95%-118%

Cadmus only used overall model results to determine the measure-level net savings, while also providing results by space heating fuel: electric and non-electric.

Overall, electrically heated homes achieved insulation savings of 1,652 kWh per home. Average electrically heated expected insulation savings were 1,913 kWh, translating to an 86% realization rate. With average electrically heated participant pre-usage of 15,317 kWh, savings represented an 11% reduction in energy usage from insulation measures.

[3] Due to the complexity of estimating the model with separate intercepts, Cadmus estimated a difference model, subtracting out the customer-specific averages for both the dependent and independent variables. This method produced results identical to the fixed effects models with separate intercepts; however, using a difference model proved simpler in estimating savings and presenting final model outputs.

Gas-heated homes achieved insulation savings of 267 kWh per home. Expected savings from average insulation were 249 kWh, translating to a 107% realization rate. With gas-heated, participant pre-usage of 12,656 kWh, savings represented a 2% reduction in energy usage from insulation measures.

Table C3, Table C4, and Table C5 summarize model outputs for the regression models Cadmus used to determine the realization rates.

Table C3. Insulation Regression Model for Utah (Overall Model)

Source	Analysis of Variance				
	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	53,890,798	13,472,700	181,547	<.0001
Error	830,260	61,613,956	74.2104		
Corrected Total	830,264	115,504,754			
Root MSE		8.61455	R-Square		0.4666
Dependent Mean		2.55E-17	Adj. R-Square		0.4666
Coefficient of Variation		3.37E+19			
Source	**Parameter Estimates**				
	DF	**Parameter Estimates**	**Standard Error**	**t value**	**Prob. t**
Post	1	-1.28009	0.02126	-60.21	<.0001
PartPost	**1**	**-0.77886**	**0.04733**	**-16.45**	**<.0001**
AvgHdd	1	0.27489	0.00111	248.76	<.0001
AvgCdd	1	1.88143	0.00252	747.95	<.0001

Table C4. Insulation Regression Model for Utah (Electric Heat)

Source	Analysis of Variance				
	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	40,751,436	10,187,859	132,131	<.0001
Error	666,853	51,417,268	77.1044		
Corrected Total	666,857	92,168,704			
Root MSE		8.78091	R-Square		0.4421
Dependent Mean		2.51E-17	Adj. R-Square		0.4421
Coefficient of Variation		3.49E+19			

Source	Parameter Estimates				
	DF	Parameter Estimates	Standard Error	t value	Prob. t
Post	1	-1.30258	0.02170	-60.02	<.0001
PartPost	**1**	**-4.52573**	**0.38342**	**-11.80**	**<.0001**
AvgHdd	1	0.28068	0.00126	223.55	<.0001
AvgCdd	1	1.84625	0.00287	644.13	<.0001

Table C5. Insulation Regression Model for Utah (Gas Heat)

Source	Analysis of Variance				
	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	53,846,505	13,461,626	182,234	<.0001
Error	828,155	61,175,834	73.8700		
Corrected Total	828,159	115,022,339			
Root MSE		8.59477	R-Square		0.4681
Dependent Mean		2.40E-17	Adj. R-Square		0.4681
Coefficient of Variation		3.59E+19			
Source	**Parameter Estimates**				
	DF	**Parameter Estimates**	**Standard Error**	**t value**	**Prob. t**
Post	1	-1.27920	0.02121	-60.30	<.0001
PartPost	**1**	**-0.73047**	**0.04747**	**-15.39**	**<.0001**
AvgHdd	1	0.27430	0.00110	248.45	<.0001
AvgCdd	1	1.88311	0.00251	749.06	<.0001

Ductwork Billing Analysis

Cadmus conducted a billing analysis to assess net energy savings associated with duct sealing and duct insulation measure installations,[4] determining the savings estimate from a pooled, CSA regression model, which included the following groups:

- 2013–2014 ductwork participants (combined duct sealing and duct insulation); and
- Nonparticipant homes, serving as the comparison group.

The billing analysis resulted in a 107% net realization rate for duct sealing and duct insulation measures. This produced a net result (rather than gross) as it compared participant usage trends to a nonparticipant group, accounting for market conditions outside of the program.

[4] Billing analysis performed for customers installing only duct sealing and/or duct insulation measures.

Ductwork Program Data and Billing Analysis Methodology

Cadmus used the following sources to create the final database for conducting the billing analysis:

- ***Participant program data,*** collected and provided by the program administrator (including account numbers, measure types, installation dates, square footage of insulation installed, heat source, and expected savings for the entire participant population).
- ***Control group data,*** which Cadmus collected from a census of nearly 500,000 nonparticipating customers in Utah. This included matching energy use for the control group to quartiles of the participants' pre-participation energy use to ensure comparability of the two groups. To ensure adequate coverage of the nonparticipating population, Cadmus included four times the number of nonparticipants than participants.
- ***Billing data***, provided by Rocky Mountain Power, included all Utah residential accounts. Cadmus matched the 2013–2014 participant program data to the census of billing data for the state (only for participants installing duct sealing and/or duct insulation measures).The data included meter-read dates and kWh consumption from January 2012 through August 2015. The final sample used in the billing analysis consisted of 753 participants and 3,012 control customers.
- ***Utah weather data***, including daily average temperatures from January 2012 to August 2015 for 11 weather stations, corresponding with HES participants' locations.

Cadmus matched participant program data with billing data and mapped daily heating and CDDs to respective monthly read date periods using zip codes. Cadmus defined the pre-period for the billing analysis as 2012, before any measure installations occurred, and defined the post-period as September 2014 through August 2015.[5]

Data Screening

To ensure the final model used complete pre- and post-participation and nonparticipation billing data, Cadmus selected accounts with the following:

1. Participant addresses matching to the billing data provided.
2. A minimum of 300 days in each of the pre- and post-periods (i.e., before the earliest installation and after the latest reported installation in 2012).
3. More than 2,497 kWh per year or less than 42,759 kWh per year (the lowest and highest participant usages to remove very low or high usage nonparticipants).
4. Gas-heated accounts (99% of homes in Utah) showing a change in consumption of less than 30% of pre-program usage; this ensured a better match between participants and the control group: electrically heated accounts with consumption up to 50%.

[5] As participants installing measures in late 2014 had less than 10 months of post-period data, Cadmus removed them from the analysis. Similarly, customers who participated in 2013 with measure installation dates before November 2012 had less than 10 months of pre-period data and were removed from the analysis.

5. Expected savings under 70% of household consumption (accounts for either a mismatch between participant database and billing data or pre-period vacancies).

Further, Cadmus examined the individual monthly billing data to check for vacancies, outliers, and seasonal usage changes. If usage patterns proved inconsistent between the pre- and post-periods, the analysis dropped the accounts. Table C6 shows participant and nonparticipant screening criteria used in the billing analysis.

Table C6. Screen for Inclusion in Billing Analysis

Screen	Attrition		Remaining	
	Nonparticipant	Participant	Nonparticipant	Participant
Original measures database (insulation installations only) and nonparticipant population	N/A	N/A	495,588	2,653
Matched billing data sample (reduced to nonparticipant, single-family residential accounts in participant zip codes; participant accounts that could be matched to the billing data addresses)	66,849	1,009	428,739	1,644
Reject accounts with less than 300 days in pre- or post-period	111,876	587	316,863	1,057
Reject accounts with less than 1,264 kWh or more than 102,678 kWh in pre- or post-period	4,560	-	312,303	1,057
Reject accounts with consumption changing by more than 30% from the pre- to post-period for gas-heated homes and more than 50% for electrically heated homes	40,010	111	272,293	946
Reject accounts with expected savings over 70% of pre-period consumption	-	1	272,293	945
Reject accounts with billing data outliers, vacancies, and seasonal usage	27,706	192	244,587	753
Nonparticipant sample selection (random sample of nonparticipants to match participant pre-period usage by quartile: four times more than participants)	241,575	-	3,012	753
Final Sample			**3,012**	**753**

Regression Model

After screening and matching accounts, the final analysis group consisted of 753 participants and 3,012 nonparticipants.

Cadmus used the following CSA regression specification to estimate duct sealing and duct insulation savings from the HES Program:

$$ADC_{it} = \alpha_i + \beta_1 HDD_{it} + \beta_2 CDD_{it} + \beta_3 POST_t + \beta_4 PARTPOST_{it} + \varepsilon_{it}$$

Where for customer (i) and month (t):

- ADC_{it} = Average daily kWh consumption
- HDD_{it} = Average daily HDDs (base 65)
- CDD_{it} = Average daily CDDs (base 65)
- $POST_t$ = Indicator variable of 1 in the post-period for participants and nonparticipants, 0 otherwise
- $PARTPOST_{it}$ = Indicator variable of 1 in the post-period for participants, 0 otherwise

β_4 served as the key coefficient that determined average duct sealing and duct insulation savings. This coefficient averaged daily duct sealing and duct insulation savings per program participant, after accounting for nonparticipant trends. Cadmus included individual customer intercepts (α_i) as part of a fixed-effects model specification to ensure no participants or nonparticipants had an undue influence over the final savings estimate, resulting in a more robust model.[6]

Ductwork Results

Cadmus estimated overall duct sealing and duct insulation savings of 344 kWh per home. Expected average duct sealing and duct insulation savings were 323 kWh, translating to a 107% net realization rate for duct sealing and insulation measures. With average participant pre-usage of 10,925 kWh, savings represented a 3% reduction in total energy usage from duct sealing and duct insulation measures installed. Table C7 presents the overall savings estimate for duct sealing and duct insulation.

Table C7. Ductwork Net Realization Rates

Model	Billing Analysis Participant (n)	Reported kWh Savings per Premise	Evaluated Net kWh Savings per Premise	Net Realization Rate	Relative Precision at 90% Confidence	90% Confidence Bounds
Overall	**753**	**323**	**344**	**107%**	**±23%**	**82%–131%**
Electric Heat	7	2,472	1,683	68%	±44%	38%-98%
Gas Heat	746	303	331	110%	±24%	84%-135%

[6] Due to the complexity of estimating the model with separate intercepts, Cadmus estimated a difference model, which, for both the dependent variable and the independent variables, subtracted out customer-specific averages. This method produced identical results to the fixed-effects models with separate intercepts; however, using a difference model proved simpler to estimate savings and present final model outputs.

Cadmus used only the overall model results to determine measure-level net savings, but provided results by space heating fuel: electric and non-electric.

Overall, electrically heated homes achieved duct sealing and duct insulation savings of 1,683 kWh per home. Expected average electrically heated duct sealing and duct insulation savings were 2,472 kWh, translating to a 68% net realization rate. With average electrically heated participant pre-usage of 16,037 kWh, savings represented a 10% reduction in energy usage from duct sealing and duct insulation measures.

Gas-heated homes achieved duct sealing and duct insulation savings of 331 kWh per home. Expected average duct sealing and duct insulation savings were 303 kWh, translating to a 110% realization rate. With gas-heated participant pre-usage of 10,877 kWh, savings represented a 3% reduction in energy usage from duct sealing and duct insulation measures. Table C8, Table C9, and Table C10 summarize the model outputs for the regression models Cadmus used to determine the realization rates.

Table C8. Ductwork Regression Model for Utah (Overall)

Source	Analysis of Variance				
	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	4,815,886	1,203,971	19,844	<.0001
Error	90,214	5,473,531	60.6727		
Corrected Total	90,218	10,289,416			
Root MSE		7.78927	R-Square		0.4680
Dependent Mean		-1.74E-16	Adj. R-Square		0.4680
Coefficient of Variation		-4.48E+18			
Source	**Parameter Estimates**				
	DF	**Parameter Estimates**	**Standard Error**	**t value**	**Prob. t**
Post	**1**	-0.84897	0.0583	-14.56	<.0001
PartPost	**1**	**-0.94291**	**0.12986**	**-7.26**	**<.0001**
AvgHdd	1	0.23301	0.00302	77.21	<.0001
AvgCdd	1	1.63528	0.00661	247.51	<.0001

Table C9. Ductwork Regression Model for Utah (Electric Heat)

Source	Analysis of Variance				
	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	3,393,807	848,452	13,599	<.0001
Error	72,403	4,517,252	62.3904		
Corrected Total	72,407	7,911,059			
Root MSE		7.89876	R-Square		0.4290
Dependent Mean		-1.59E-16	Adj. R-Square		0.4290
Coefficient of Variation		-4.96E+18			

Source	Parameter Estimates				
	DF	Parameter Estimates	Standard Error	t value	Prob. t
Post	1	-0.86464	0.05923	-14.60	<.0001
PartPost	**1**	**-4.61044**	**1.22022**	**-3.78**	**0.0002**
AvgHdd	1	0.24145	0.00343	70.41	<.0001
AvgCdd	1	1.60773	0.00778	206.75	<.0001

Table C10. Ductwork Regression Model for Utah (Gas Heat)

Source	Analysis of Variance				
	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	4,815,009	1,203,752	19,902	<.0001
Error	90,046	5,446,473	60.4855		
Corrected Total	90,050	10,261,482			
Root MSE		7.77724	R-Square		0.4692
Dependent Mean		-1.71E-16	Adj. R-Square		0.4692
Coefficient of Variation		-4.54E+18			
Source	**Parameter Estimates**				
	DF	**Parameter Estimates**	**Standard Error**	**t value**	**Prob. t**
Post	1	-0.84718	0.05821	-14.55	<.0001
PartPost	**1**	**-0.90815**	**0.13014**	**-6.98**	**<.0001**
AvgHdd	1	0.23282	0.00302	77.19	<.0001
AvgCdd	1	1.63784	0.00661	247.82	<.0001

Cooling Equipment (Cool Cash) Billing Analysis

Cadmus conducted billing analyses to assess gross energy savings associated with high-efficiency air conditioners and evaporative coolers. The analysis required construction of three regression models:

1. A central air conditioners and sizing and installation measures (SEER 15+) model.[7]
2. An evaporative cooling model.
3. A model of SEER 13 nonparticipant units (to serve as the baseline).[8]

[7] This model contained sizing + TXV and proper installation central air-conditioning measures. The realization rate calculated with this model applied to these two measures.

[8] A central assumption underlying this assessment was that participants would have installed a base-efficiency (13 SEER) unit had they not participated in the program. Based on this assumption, Cadmus used a control

Cooling Equipment Program Data Billing Analysis Methodology

Cadmus used following regression model to estimate consumption for all three groups:

$$ADC = \alpha + \beta_1 CDD + \beta_2 SQFT + \varepsilon$$

Where:

ADC = Average daily kWh consumption

CDD = Average daily CDDs

SQFT = Home square feet

The equation determined energy consumption, defined as average daily kWh consumption, by average daily CDD and home size.

Some estimation error (ε) exists in the regression relationship after accounting for weather and home size. The β_1 coefficient measures energy consumption per CDD. Cadmus estimated average savings for each of the participating groups (15+ SEER and evaporative cooling models) as the difference between their respective model coefficient of CDD and the estimated model coefficient of CDD for the 13 SEER group, multiplied by the average 10-year CDD for Utah.

The models estimated savings by isolating weather impacts from other factors contributing to energy consumption. The savings were determined using only 2015 billing data in the cooling season (where CDD were greater than 0) following their installation of the high-efficiency unit.[9]

Cadmus used the following sources to create the final database for conducting the billing analysis:

- ***Participant program data,*** collected and provided by the program implementer. These data included account numbers, site addresses, unit types, and installation dates for the entire participant population.
- ***Billing data***, including meter-read dates, days in billing cycle, and kWh consumption from January 2012 through August 2015 for all 2013–2014 participants receiving cooling equipment and control group participants. Rocky Mountain Power only provided billing data for active residential customer accounts.

group composed of 2005 Cool Cash Program participants known to have received a 13 SEER air-conditioning unit—without sizing + TXV or proper installation incentives—as their primary cooling system. SEER 13 air-conditioning equipment represented the federal minimum efficiency level for residential central air conditioners manufactured after January 2006.

[9] Cadmus used the entire 2015 cooling season for the program nonparticipant control group.

- ***Utah weather data***, including daily minimum and maximum temperatures and CDDs from January 2002 to August 2015.
- ***Square footage data,*** collected by Cadmus through a real estate listing service.[10]

The billing analysis results provided gross realization rates for central air conditioners and evaporative cooler equipment types across both years. Cadmus then applied the appropriate equipment-specific realization rate to reported savings to determine evaluated gross measure savings estimates.

Cooling Equipment Results

Cadmus used three regression models to estimate program energy savings: SEER 13 (baseline), central air conditioners and sizing and installation measures (SEER 15+), and evaporative coolers. Cadmus used billing data from January 2015 through August 2015 to ensure availability of adequate data for participants receiving an incentive in the early months of 2013 or in the later months of 2014. Prior to model specification, Cadmus conducted a detailed quality-assurance review of all available data to identify missing values or data quality issues; the review found that few data points missing. Following standard analytical practice, Cadmus screened data for extreme kWh values and eliminated outliers from the analysis.

The models revealed that several variables could be excluded, primarily those for groups with similar characteristics. For example, the evaporative coolers model did not incorporate home types and numbers of stories as these variables highly correlated with square footage, which the model already included. Further, to increase the number of customers considered for analysis, Cadmus did not include variables such as whether the occupant completed a recent renovation or added, changed out, or removed electric appliances in the home.

Table C11 shows the regression model results.[11] SEER 13 units' average consumption per CDD, estimated at 1.42 kWh, represented the baseline or consumption level occurring in the program's absence.[12] Cadmus used this baseline to estimate savings from each participating central air conditioner and evaporative cooler unit.

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[10] http://www.zillow.com/

[11] For all three models, the F-test proved statistically significant. In most instances, parameters for other independent variables proved significant and had the correct signs. The F-test determined whether two population variances were equal by comparing the ratio of their variances. If the variances were equal, the variances' ratio would be 1. Typically, this test is used to compare the validity of models.

[12] Cadmus considered SEER 13 as the baseline, given that it served as the federal minimum efficiency level for residential, central air conditioners manufactured after January 2006; thus, it could be assumed to represent the efficiency of cooling equipment that would have been purchased in the program's absence.

Table C11. Cool Cash Billing Data Regression Results

Group	Consumption per CDD (kWh)	Annual Consumption Based on 1,391 Average CDD (kWh)	Evaluated Gross Savings (kWh)
SEER 13 (Baseline)	1.42	1,979	N/A
Evaporative Cooling	0.32	448	1,531
Central Air Conditioner	1.01	1,409	570

Figure C1 illustrates calculations used to derive estimated annual kWh savings.

Figure C1. Derivation of kWh Savings

Cadmus estimated overall evaporative cooler savings of 1,531 kWh per participant. The average evaporative cooler produced expected savings of 1,495 kWh, translating to a 102% gross realization rate.

Cadmus estimated overall central air conditioner savings of 570 kWh per participant. The average central air conditioner produced expected savings of 510 kWh, translating to a 112% gross realization rate.

Table C12 presents overall gross savings estimates and realization rates for 2013–2014 cooling equipment.

Table C12. Cooling Equipment Gross Realization Rates

Measure	Billing Analysis Participants (n)	Reported kWh Savings per Premise	Evaluated Gross kWh Savings per Premise	Gross Realization Rate	Relative Precision at 90% Confidence	90% Confidence Bounds
Evaporative Coolers	1,252	1,495	1,531	102%	±10%	92% - 113%
Central Air Conditioners	2,455	510	570	112%	±27%	81% - 142%

These realization rates indicated, on average, cooling equipment incented in the 2013–2014 program period saved between 102%–112% more energy than reported.

Table C13, Table C14, and Table C15 present model outputs for each of the three analysis groups.

Table C13. SEER 13 Central Air Conditioner Nonparticipant Regression Model Output

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	88,821	44,411	292.54	<.0001
Error	1,102	167,293	151.81		
Corrected Total	1,104	256,114			
Root MSE		12.3211	R-Square		0.3468
Dependent Mean		30.7046	Adj R-Sq		0.3456
Coeff Var		40.1277			
Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	10.2808	1.0802	9.52	<.0001
Avgcdd	1	1.4226	0.0656	21.69	<.0001
Sqft	1	0.0056	0.0005	10.97	<.0001

Table C14. Evaporative Cooling Equipment Participant Regression Model Output

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	36,296	18,148	253.48	<.0001
Error	4,917	352,034	71.59		
Corrected Total	4,919	388,330			
Root MSE		8.4614	R-Square		0.0935
Dependent Mean		21.1655	Adj R-Sq		0.0931
Coeff Var		39.9772			
Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	14.1336	0.3379	41.83	<.0001
Avgcdd	1	0.3223	0.0213	15.15	<.0001
Sqft	1	0.0028	0.0002	17.37	<.0001

Table C15. SEER 15 Central Air Conditioner Participant Regression Model Output

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	2	363,067	181,534	1685.92	<.0001
Error	9,432	1,015,601	107.68		
Corrected Total	9,434	1,378,668			
Root MSE		10.3767	R-Square		0.2633
Dependent Mean		30.3103	Adj. R-Square		0.2632
Coeff Var		34.2350			
Parameter Estimates					
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	1	16.1670	0.3052	52.98	<.0001
Avgcdd	1	1.0129	0.0193	52.54	<.0001
Sqft	1	0.0034	0.0001	27.13	<.0001

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Appendix D. Self-Reported Net-to-Gross Methodology

Net-to-gross (NTG) estimates are a critical part of demand-side management program impact evaluations, because they allow utilities to determine portions of gross energy savings that were influenced by and are attributable to their DSM programs. Freeridership and participant spillover are the two NTG components calculated in this evaluation. True freeriders are customers who would have purchased an incented appliance or equipment without any support from the program (e.g. taking the incentive). Participant spillover is the amount of additional savings obtained by customers investing in additional energy-efficient measures or activities due to their program participation. Various methods can be used to estimate program freeridership and spillover; for this evaluation, Cadmus used self-reports from survey participants to estimate NTG for appliances, HVAC and weatherization measure categories, as this method can gauge net effects for many measures at once and enables Cadmus to monitor freeridership and spillover over several evaluation efforts.

Survey Design

Direct questions (such as: "Would you have installed measure X without the program incentive?") tend to result in exaggerated "yes" responses. Participants tend to provide answers they believe surveyors seek; so a question becomes the equivalent of asking: "Would you have done the right thing on your own?" An effective solution, and an industry standard, for avoiding such bias involve asking a question in several different ways, then checking for consistent responses.

Cadmus used industry tested survey questions to determine why customers installed a given measure, and what influence the program had on their decisions. We used the survey to establish what decision makers might have done in the program's absence, via five core freeridership questions:

1. Would participants have installed measures without the program?
2. Had participants ordered or installed the measures before learning about the program?
3. Would participants have installed the measures at the same efficiency levels without the program incentive?
4. Would participants have installed the same quantity of measures without the program?
5. In the program's absence, when would respondents have installed the measures?

Cadmus sought to answer three primary questions with our participant spillover survey design:

1. Since participating in the program evaluated, did participants install additional energy-efficient equipment or services incented through a utility program?
2. How influential was the evaluated program on the participants' decisions to install additional energy-efficient equipment in their homes?
3. Did customers receive incentives for additional measures installed?

Freeridership Survey Questions

The residential survey's freeridership portion included 12 questions, addressing the five core freeridership questions. The survey's design included several skip patterns, allowing interviewers to confirm answers previously provided by respondents by asking the same question in a different format. The freeridership questions (as asked in the survey format) included:

1. When you first heard about the incentive from Rocky Mountain Power, had you already been planning to purchase the measure?
2. Had you already purchased or installed the new measure before you learned about the incentive from the Home Energy Savings Program?
3. *[Ask if question 2 is Yes*] Just to confirm, you learned about the Rocky Mountain Power rebate program after you had already purchased or installed the new measure?
4. [*Ask if question 2 or 3 is No or Don't Know*] Would you have installed the same measure without the incentive from the Home Energy Savings Program?
5. [*Ask if question 4 is No or Don't Know*] Help me understand, would you have installed something without the Home Energy Savings Program incentive?
6. [*Ask if question 4 or 5 is Yes*] Let me make sure I understand. When you say you would have installed the measure, would you have installed the same one, that was just as energy efficient?
7. *[Ask if question 4 or question 5 is Yes AND measure quantity > 1]* Would you have installed the same quantity?
8. [*Ask if question 4 or question 5 is Yes*] Would you have installed the measure at the same time?
9. [*Ask if question 5 is No*] To confirm, when you say you would not have installed the same measure, do you mean you would not have installed the measure at all?
10. [*Ask if question 9 is No or Don't Know*] Again, help me understand. Would you have installed the same type of measure, but it would not have been as energy-efficient?
11. *[Ask if question 9 is No or Don't Know AND measure quantity > 1]* Would you have installed the same measures, but fewer of them?
12. [*Ask if question 9 is No or Don't Know*] Would you have installed the same measure at the same time?

Participant Spillover Survey Questions

As noted, Cadmus used the results of the spillover questions to determine whether program participants installed additional energy-saving measures since participating in the program. Savings that participants received from additional measures were spillover if the program significantly influenced their decisions to purchase additional measures, and if they did not receive additional incentives for those measures.

With the surveys, we specifically asked residential participants whether they installed the following measures:

- Clothes washers
- Refrigerators
- Dishwashers
- Windows
- Fixtures
- Heat pumps
- Ceiling fans
- Electric water heaters
- CFLs
- Insulation

If the participant installed one or more of these measures, we asked additional questions about what year they purchased the measure, if they received an incentive for the measure, and how influential (highly influential, somewhat influential, not at all influential) the HES Program was on their purchasing decisions.

Cadmus combined the freeridership and spillover questions in the same survey, asked over the telephone with randomly selected program participants. Prior to beginning the survey effort, Cadmus pre-tested the survey to ensure that all appropriate prompts and skip patterns were correct. Cadmus also monitored the survey company's initial phone calls to verify that:

- Survey respondents understood the questions; and
- Adjustments were not required.

Freeridership Methodology

Cadmus developed a transparent, straightforward matrix for assigning freeridership scores to participants, based on their responses to targeted survey questions. We assigned a freeridership score to each question response pattern, and calculated confidence and precision estimates based on the distribution of these scores (a specific approach cited in the National Action Plan for Energy Efficiency's *Handbook on DSM Evaluation*, 2007 edition, page 5-1).

Cadmus left the response patterns and scoring weights explicit so that they could be discussed and changed. We used a rules-based approach to assign scoring weights to each response from each freeridership question. This allows for sensitivity analysis to be performed instantaneously and test the

stability of the response patterns and scoring weights. Scoring weights can be changed for a given response option to a given question. This also provided other important features, including:

- Derivation of a partial freeridership score, based on the likelihood of a respondent taking similar actions in absence of the incentive.
- Use of a rules-based approach for consistency among multiple respondents.
- Use of open-ended questions to ensure quantitative scores matched respondents' more detailed explanations regarding program attribution.
- The ability to change weightings in a "what if" exercise, testing the stability of the response patterns and scoring weights.

This method offered a key advantage by including partial freeridership. Our experience has shown that program participants do not fall neatly into freerider and non-freerider categories. We assigned partial freeridership scores to participants who had plans to install the measure before hearing about the program, but for whom the program exerted some influence over their decisions. Further, by including partial freeridership, we could use "don't know" and "refused" responses rather than removing those respondents entirely from the analysis.

Cadmus assessed freeridership at three levels:

1. We converted each participant survey response into freeridership matrix terminology.
2. We gave each participant's response combination a score from the matrix.
3. We aggregated all participants into an average freeridership score for the entire program category.

Convert Responses to Matrix Terminology

Cadmus evaluated and converted each survey question's response into one of the following values, based on assessing participants' freeridership levels for each question:

- Yes (Indicative of freeridership)
- No (Not indicative of freeridership)
- Partial (Partially indicative of freeridership)

Table J1 lists the 12 freeridership survey questions, their corresponding response options, and the values they converted to (in parentheses). "Don't know" and "refused" responses converted to "partial" for all but the first three questions. For those questions, if a participant was unsure whether they had already purchased or were planning to purchase the measure before learning about the incentive, we considered them as an unlikely freerider.

Table J1. Assignments of HES Survey Response Options into Matrix Terminology*

Already planning to purchase?	Already purchased or installed?	Confirmatory: Already purchased	Installed same measure without	Installed something without incentive?	Installed same efficiency?	Installed same quantity?	Installed at the same time?	Would not have installed measure?	Installed lower efficiency?	Installed lower quantity?	Installed at the same time?
Yes (Yes)	Yes (Yes)	Yes (Yes)	Yes (Yes)	Yes (Yes)	Yes (Yes)	Yes (Yes)	Same time (Yes)	Yes (Yes)	Yes (Yes)	Yes (Yes)	Same time (Yes)
No (No)	No (No)	No (No)	No (No)	No (No)	No (No)	No (No)	Within one year (P)	No (No)	No (No)	No (No)	Within one year (P)
DK (No)	DK (No)	DK (No)	DK (No)	DK (P)	DK (P)	DK (P)	Over one year (No)	DK (P)	DK (P)	DK (P)	Over one year (No)
RF (No)	RF (No)	RF (No)	RF (No)	RF (P)	RF (P)	RF (P)	DK (P)	RF (P)	RF (P)	RF (P)	DK (P)
							RF (P)				RF (P)

* In this table, (P) = partial, RF = refused, and DK = don't know.

Participant Freeridership Scoring

After converting survey responses into matrix terminology, Cadmus created a freeridership matrix, assigning a freeridership score to each participant's combined responses. We considered all combinations of survey question responses when creating the matrix, and assigned each combination a freeridership score of 0% to 100%. Using this matrix, we then scored every participant combination of responses.

Program Category Freeridership Scoring

After assigning a freeridership score to every survey respondent, Cadmus calculated a savings-weighted average freerider score for the program category. We individually weighted each respondent's freerider scores by the estimated savings from the equipment they installed, using the following calculation:

$$Savings\ Weighted\ Freeridership = \frac{\sum(Respondent\ Score) * (Rebated\ Measure\ kWh\ Savings)}{\sum(Rebated\ Measure\ kWh\ Savings\ of\ All\ Respondents)}$$

The Cadmus Freeridership Scoring Model

Cadmus developed an Excel-based model to use for calculating freeridership, and to improve the consistency and quality of our results. The model translated raw survey responses into matrix terminology, and then assigned a matrix score to each participant's response pattern. Cadmus then aggregated the program participants into program categories to calculate average freeridership scores.

The model incorporated the following inputs:

- Raw survey responses from each participant, along with the program categories for their incented measures, and their energy savings from those measures, if applicable;
- Values converting raw survey responses into matrix terminologies for each program category; and
- Custom freeridership scoring matrices for each unique survey type.

The model displayed each participant's combination of responses and corresponding freeridership score, then produced a summary table with the average score and precision estimates for the program category. The model used the sample size and a two-tailed test target at the 90% confidence interval to determine the average score's precision.

Participant Spillover Methodology

For the HES Program, Cadmus measured participant spillover by asking a sample of participants about their purchases and whether they received an incentive for a particular measure (if they installed another efficient measure or undertook another energy-efficiency activity because of their program participation). We also asked these respondents to rate the HES Program's (and incentive's) relative influence (highly, somewhat, or not at all) on their decisions to pursue additional energy-efficient activities.

Participant Spillover Analysis

Cadmus used a top-down approach to calculate spillover savings. We began our analysis with a subset of data containing only survey respondents who indicated they installed additional energy-savings measures after participating in the HES Program. From this subset, we removed participants who said the program had little influence on their decisions to purchase additional measures, thus retaining only participants who rating the program as highly influential. We also removed participants who applied for an HES incentive for the additional measures they installed.

For the remaining participants with spillover savings, we estimated the energy savings from additional measures installed. Cadmus calculated savings values, which we matched to the additional measures installed by survey participants.

Cadmus calculated the spillover percentage by dividing the sum of additional spillover savings by the total incentivized gross savings achieved by all respondents in the program category:

$$Spillover\ \% = \frac{\sum Spillover\ Measure\ kWh\ Savings\ for\ All\ Survey\ Respondents}{\sum Program\ Measure\ kWh\ Savings\ for\ All\ Survey\ Respondents}$$

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Appendix E. Nonparticipant Spillover Analysis

Effective program marketing and outreach generates program participation and increases general energy efficiency awareness among customers. The cumulative effect of sustained utility program marketing can affect customers' perceptions of their energy usage and, in some cases, motivate customers to take efficiency actions outside of the utility's program. This is generally called nonparticipant spillover (NPSO)—results in energy savings caused by, but not rebated through, utilities' demand-side management activities.

To understand whether Rocky Mountain Power's general and program marketing efforts generated energy efficiency improvements outside of the company's incentive programs, Cadmus collected spillover data through the general population survey, conducted with randomly selected residential customers.

Methodology

Cadmus randomly selected and surveyed 250 customers from a sample of 10,000 randomly generated residential accounts provided by Rocky Mountain Power. From the 250 customers surveyed, Cadmus screened out customers who self-reported that they participated in a Rocky Mountain Power residential program during 2013 or 2014. When estimating NPSO, Cadmus excluded these customers from analysis, focusing on identified nonparticipants; thus the analysis avoided potential double-counting program savings and/or program-specific spillover.

Cadmus limited the NPSO analysis to the same efficiency measures rebated through Rocky Mountain Power programs (known as "like" spillover). Examples included installing a high-efficiency clothes washer and installing high-efficiency insulation for which participants (for whatever reason) did not apply for and receive an incentive. Cadmus did exclude one notable category of "like" measures: lighting products. This precluded potentially double-counting NPSO lighting savings already captured through the upstream lighting incentives.

Using a 1 to 4 scale, with 1 meaning "not at all important" and 4 meaning "very important," the survey asked customers to rate the importance of several factors on their decisions to install energy efficient equipment without receiving an incentive from Rocky Mountain Power. This question determined whether Rocky Mountain Power's energy efficiency initiatives motivated energy-efficient purchases. The surveys asked respondents to address the following factors:

- Information about energy efficiency provided by Rocky Mountain Power;
- Information from friends or family who installed energy-efficient equipment and received an incentive from Rocky Mountain Power; and
- Their experiences with past Rocky Mountain Power incentive programs.

Cadmus estimated NPSO savings from respondents who rated any of the above factors as "very important" for any energy-efficient actions or installations reported.

Cadmus leveraged measure-level estimated gross savings from the 2013–2014, residential wattsmart evaluation activities for the reported NPSO measures.

Using the variables shown in Table E1, Cadmus determine total NPSO generated by Rocky Mountain Power's marketing efforts during the 2013–2014 evaluation year.

Table E1. NPSO Analysis Method

Variable	Metric	Source
A	Number of "like spillover" nonparticipant measures	Survey data
B	Total Customers Surveyed	Survey disposition
C	Weighted Average of Per Unit Measures Savings in kWh	Variable C from Table E2
D	Total Residential Customer Population	PacifiCorp December 2014 305 Report
E	NPSO kWh Savings Applied to Population	[(A÷B)×C)] × D
F	Total Gross Reported Savings	2013-2014 Evaluation
G	NPSO as a Percentage of Total residential Portfolio Reported Savings	F ÷ G

Results

Of 250 Rocky Mountain Power Utah customers surveyed, seven nonparticipant respondents reported installing seven measures attributed to Rocky Mountain Power's influence. Table E2 presents measures and gross evaluated kWh savings Cadmus attributed to Utah Rocky Mountain Power, generating average savings per NPSO measure of 144 kWh.

Table E2. NPSO Response Summary

Reported Spillover Measures	Respondents	Unit Energy Savings (kWh)*	Total Savings (kWh)	Average Savings Per Spillover Measure (kWh)
ENERGY STAR Refrigerator	1	80 per unit	80	n/a
Efficient Central Air Conditioner	1	385per unit	385	
Attic insulation	2	0.22 per sqft	223	
ENERGY STAR Windows	2	1.04 per sqft	20	
ENERGY STAR Clothes Washer	1	301 per unit	301	
Total	**7**		**1,009**	**144 (Variable C)**

*Unit energy savings (kWh) estimated for each measure were generated from average 2013–2014 HES evaluated gross savings by measure.

Table E3 presents variables used to estimate overall NPSO for the HES Program, a figure Cadmus estimated as 1% of total Rocky Mountain Power residential wattsmart program reported savings.

Table E3. NPSO Analysis Results

Variable	Metric	Value	Source
A	Number of Like Spillover Nonparticipant Measures	7	Survey data
B	Total Customers Surveyed	250	Survey disposition
C	Weighted Average of Per Unit Measures Savings in kWh	144	Calculated in Table E2
D	Total Residential Customer Population	745,363	PacifiCorp December 2014 305 Report
E	NPSO kWh Savings Applied to Population	3,008,204	((A÷B)×C)) × D
F	Total Gross Reported Savings	273,970,098	2013-2014 Residential wattsmart Reported Savings
G	NPSO as a Percentage of Total Residential Portfolio Reported Savings	1%	F ÷ G

Cadmus then distributed the residential, portfolio-level result of 3,008,2014 kWh NPSO to Rocky Mountain Power's residential programs, based on each program's size in terms of total gross reported kWh savings. Two programs were credited with achieving the greatest NPSO: Home Energy Savings (accounting for almost 63% of total reported energy savings) at 1,884,336 kWh; and Home Energy Reporting (accounting for 26% of total energy savings) at 781,328 kWh. The distribution of NPSO savings for each program, based on their percentage of the combined residential reported portfolio savings, resulted in a 1% NPSO percentage for each program relative to their total reported gross savings.

Table E4. NPSO by Residential Program

Residential wattsmart Program	Program Reported Gross Savings (kWh)	Total NPSO (kWh)	Percentage of Combined Savings	Program-Specific NPSO (kWh)
Home Energy Savings	171,614,661	3,008,204	63%	1,884,336
Low Income Weatherization	858,414		0%	9,425
Refrigerator Recycling	25,893,046		9%	284,307
New Homes	4,445,067		2%	48,807
Home Energy Reporting	71,158,910		26%	781,328
Total	**273,970,098**	**3,008,204**	**100%**	**3,008,204**

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Appendix F. Lighting Retailer Allocation Review

Rocky Mountain Power subsidizes CFL and LED costs throughout its service territory. As shown in the leakage study findings (main report), some individuals who are not Rocky Mountain Power customers benefit from the program. These discounted bulbs "leak" outside of the service territory.

Cadmus met with the program administrator in early October 2015 to review the RSAT and any updates made since last year's analysis. Overall, the process of calculating a store's RSAT score followed the same process outlined below. Updates included streamlining a number of data processing steps to reduce the likelihood of human error. In addition, the tool can now handle LED purchases.

The program administrator developed a screening process to minimize the number of leaked bulbs. Using a proprietary RSAT[1] and Buxton Company's MicroMarketer[2] software, the program administrator only targeted stores where 90% or more of CFL purchases could be attributed to Rocky Mountain Power customers.

Through a series of meetings, e-mail exchanges, and software documentation reviews, Cadmus evaluated the program administrator's process for reducing CFL and LED leakage. This section outlines six key aspects of this:

1. Retail customer drive-time calculation.
2. Retailer locations.
3. Retailer trade areas.
4. Rocky Mountain Power's service territory.
5. Customer purchasing power.
6. Retail sales allocation.

Retail Customer Drive-Time Calculation

The time a customer willingly takes to drive to purchase efficient lighting from a brick-and-motor store greatly impacts the degree of leakage. Partnering with the Buxton Company, the program administrator determined three main factors that affected customer drive times: retail class, products sold, and urban density.

Retail Class

The program administrator/Buxton Company research indicated store types affect customer drive times. For example, customers commonly drive farther to a Costco than to a local hardware store. The program

[1] http://www.peci.org/retail-sales-allocation-tool

[2] Buxton specializes in retailer analysis and customer profiling: http://buxtonco.com/

administrator divided the retailer list into five classes (classes A through F), based on the North American Industry Classification System (NAICS).[3] Table F1 provides examples of NAICS classes.

Table F1. NAICS Classification Examples

NAICS Code	NAICS Title
44411	Home Centers
44413	Hardware Stores
443141	Household Appliance Stores

Products Sold

The program administrator categorized products sold by retailers into three classes: White Goods; Over the Counter (Retrofit); and Over the Counter (Plug and Play).[4] CFLs fell within the last of these categories.

Urban Density

The program administrator assigned stores with an urban or rural designation, based on the Buxton Urban Density Score (BUDS), which examines population per square foot to account for population density changes when moving farther from an urban center.

The program administrator modeled the 30 possible drive time factor combinations with over 500,000 survey responses from seven states to establish the amount of time customers drove for a given product and store type. Figure F1 reflects the drive time results capturing 80% of product sales for a particular retail class.

[3] http://www.census.gov/eos/www/naics/

[4] White Goods include clothes washers, refrigerators, and freezers. Characterized as major purchases, customers usually undertake a degree of product research and/or assistance from a store sales person. Over the Counter (Retrofit) includes lighting fixtures (both CFLs and LEDs) and lighting controls. Characterized as midrange cost ($20–$200) products, the category sells as over-the-counter home improvement or retrofit products. Over the Counter (Plug and Play) includes bulbs (both CFLs and LEDs) and showerheads. Characterized as low-cost ($1–$20) products, this category sells through a variety of store types; an average consumer can reasonably install these products without assistance.

Figure F1. Example of Product Drive-Time Calculation

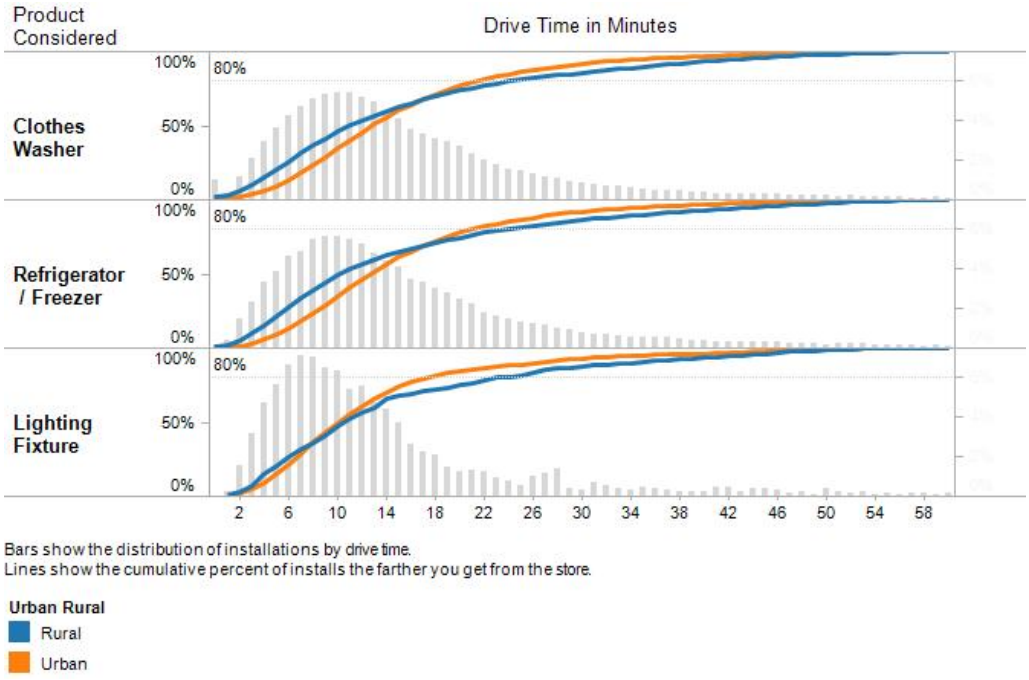


Table F2 summarizes the program administrator's calculated drive times by retail class and product type.

Table F2. Drive Times Calculated by Program Administrator

Retail Class	Product Type	Trade Area Drive Time	
		Urban	Rural
Class A	White Goods	12	17
	Over the Counter (Retrofit)	9	19
	Over the Counter (Plug and Play)	7	14
Class B	White Goods	17	22
	Over the Counter (Retrofit)	15	24
	Over the Counter (Plug and Play)	13	16
Class C	White Goods	22	27
	Over the Counter (Retrofit)	15	23
	Over the Counter (Plug and Play)	11	17
Class D	White Goods	24	26
	Over the Counter (Retrofit)	20	22
	Over the Counter (Plug and Play)	15	16
Class E	White Goods	21	26
	Over the Counter (Retrofit)	18	22
	Over the Counter (Plug and Play)	13	16
Class F	White Goods	22	29
	Over the Counter (Retrofit)	23	34
	Over the Counter (Plug and Play)	17	25

Retailer Locations

Retailers and manufacturers provided retailer address information to the program administrator, which geocoded[5] the addresses using a Coding Accuracy Support System (CASS) certified[6] geocoder, housed within the Buxton Company's MicroMarketer software and loaded into a geographic information system (GIS). If the geocoder could not find a match, the program administrator used Google Earth to visually geocode a store. Overall, the program administrator reported a 98% geocoding match rate.

Retailer Trade Areas

The program administrator created drive-time polygons, representing retailer trade areas using NAVTEQ's Guzzler™ utility,[7] housed within the Buxton Company's MicroMarketer software. Drive-time calculations require a specialized road network dataset that contains roads, indicators for one-way roads, locations of turn restrictions (e.g., no left turn intersections), the grade (slope) of roads, and other

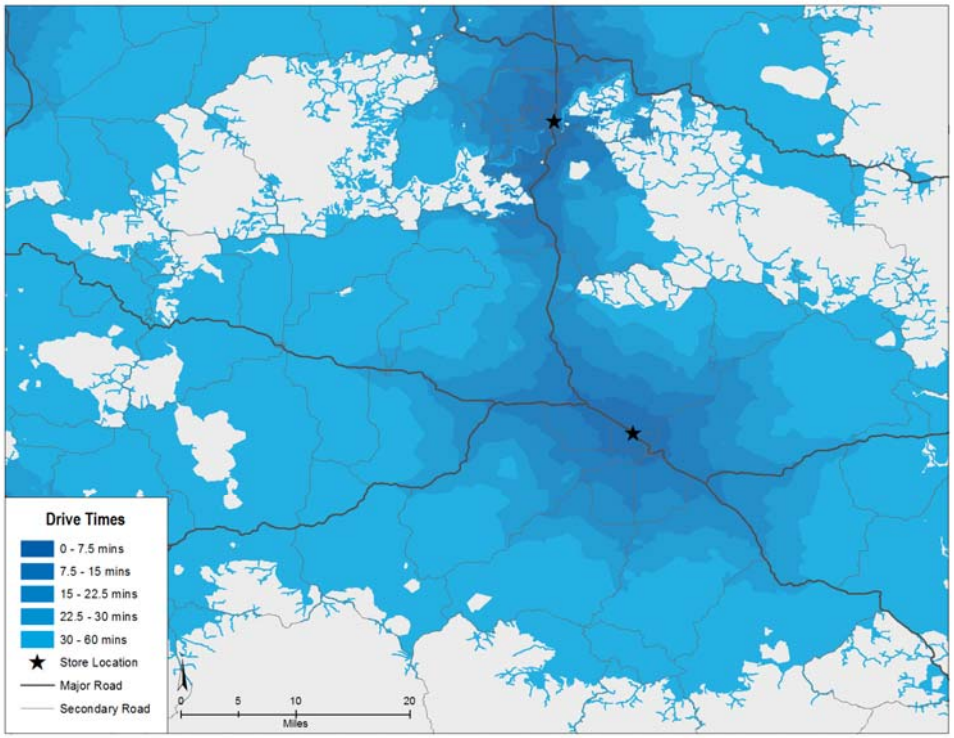
[5] This process converts a street address to latitude and longitude coordinate points.

[6] The United States Postal Service (USPS) developed CASS to evaluate the accuracy of software that provides mailing-related services to customers: https://www.usps.com/business/certification-programs.htm

[7] http://www.navmart.com/drivetime_by_guzzler.php.

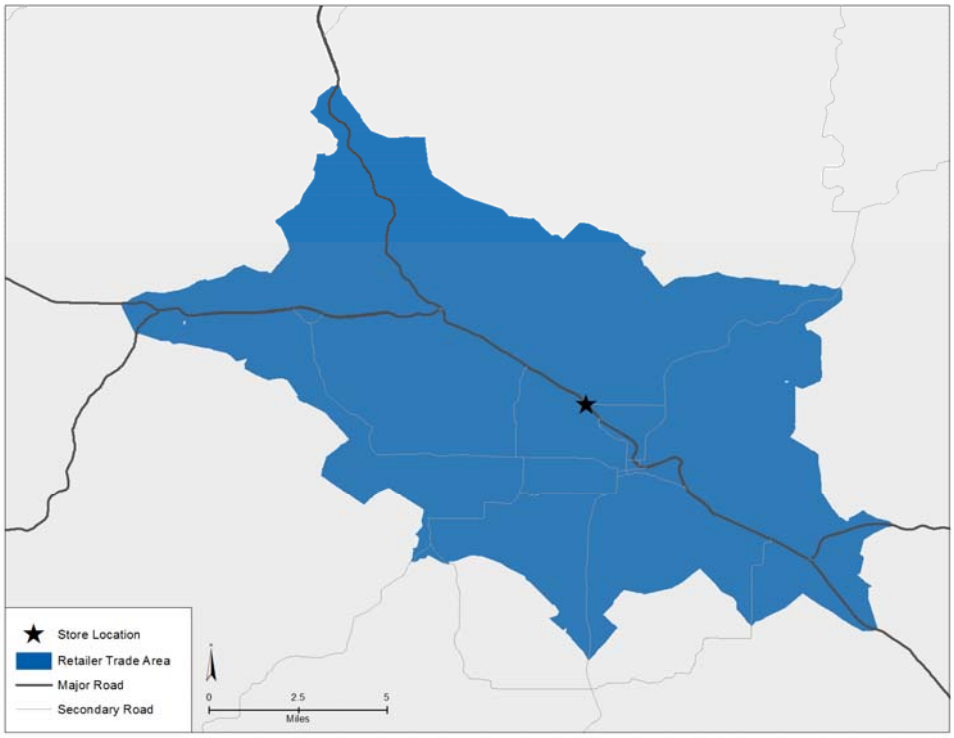
ancillary attributes that impact drive times. Figure F2 provides an example of concentric zones, representing increasing amounts of travel time from a store.

Figure F2. Example of Drive-Time Zones



The program administrator established retailer trade areas for each geocoded store using drive times, capturing 80% of CFL sales, as shown in Figure F3.

Figure F3. Example of Retailer Trade Area



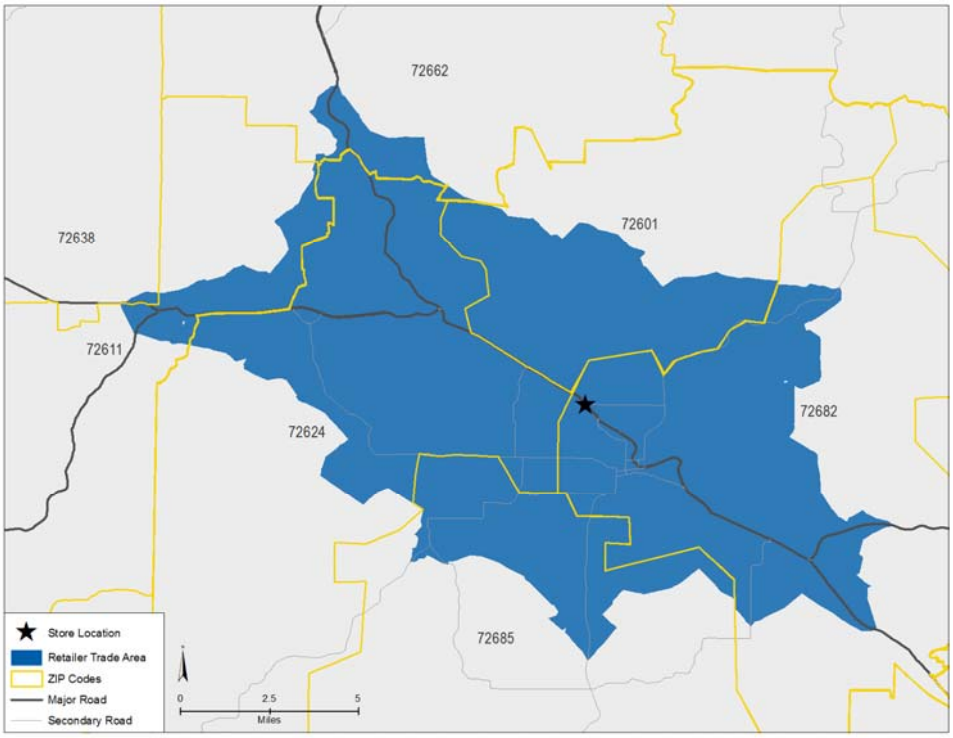
Rocky Mountain Power Service Territory

In 2007, the program administrator purchased utility service area data through a DOE contractor for all utilities in the Pacific Northwest and the Western parts of the United States. The data lists utilities serving each zip code. Data also include a utility's type (municipal or other) and whether it serves as a zip code's primary electric provider.

After contacting utilities to confirm their zip code-based territory, the program administrator created a Rocky Mountain Power GIS data layer using Zip Code Tabulation Area boundaries.[8] The administrator laid this service area designation over the retailer trade area layer to identify intersecting zip codes. In the example shown in Figure F4, all zip codes intersect with the retailer trade area.

[8] Generalized aerial representations of USPS zip code service areas. Available online: http://www.census.gov/geo/reference/zctas.html

Figure F4. Example of Zip Codes and a Retailer Trade Area



While the program administrator still relies on zip code-based tables to define utility service areas, the use of utility service area polygons is being explored. Given not all utility service areas can be cleanly defined by within polygons and due to situations with multiple utility service area polygons overlapping, the program administrator has yet to decide whether to pursue this polygon approach.

Customer Purchase Power

For each retailer trade area, the program administrator determined the likelihood that households within the area would purchase CFLs or LEDs and weighted zip code household counts within a retailer's trade area, based on a GreenAware[9] index score and the retailer's core market segments.

[9] These categories are outlined online: http://www.fusbp.com/pdf/BeGreenBeAwareBeGreenAware.pdf.

GreenAware Index Score

Experian's Marketing Mosaic® USA software[10] assigns each household[11] to one of 71 unique market segments. According to the GreenAware segmentation system, each market segment receives a score[12] on a scale of 0–200 for each of the four GreenAware categories: Behavioral Greens, Think Greens, Potential Greens, and True Browns.

The program administrator applied weights to GreenAware category scores, based on the category's propensity to buy energy efficiency products. Table F3 provides category names, descriptions, and weights.

Table F3. GreenAware Categories, Descriptions, and Weights

Category Name	Description	Weight
Behavior Green	Think and act green, hold negative attitudes toward products that pollute, and incorporate green practices on a regular basis.	3x
Think Green	Think green, but do not necessarily act green.	2x
Potential Green	Neither behave nor think along particularly environmentally conscious lines, and remain on the fence about key green issues.	1x (no weighting)
True Brown	Not environmentally conscious, and may have negative attitudes about the green movement.	-1x (negative weighting)

The sum of weighted GreenAware category scores divided by five determined a new weighted GreenAware score for each market segment. The program administrator considered a market segment as "Green Aware" if it received a weighted GreenAware score greater than 100.

Core Market Segments

The program administrator applied weights to market segment household counts identified as a retailer's core[13] market segment, and calculated new weighted household counts using the weights shown in Table F4.

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[10] A household-based consumer lifestyle segmentation system that classifies all U.S. household and neighborhoods. More information is available online: http://www.experian.com/assets/marketing-services/brochures/mosaic-brochure.pdf

[11] Households are assigned at the block group level. See: http://www.census.gov/geo/reference/pdfs/geodiagram.pdf.

[12] Determined by Experian.

[13] Determined by Experian.

Table F4. Core Market Segment Weighting

Segment Category	Weight
Green Aware *and* part of the core retail segment	3x
Either Green Aware *or* part of the core retail segment	2x
Neither Green Aware *nor* part of the core retail segment	1x (no weighting)

The sum of weighted market segment household counts determined a new weighted population count for each zip code.

Retail Sales Allocation

Using the weighted zip code population count and utility service area data, the program administrator determined a Total Utility Score for each zip code corresponding to retailer's trade area. The weight '*w*' of the $'i'^{\text{th}}$ utility was expressed as:

$$W_i = \frac{p_i + m_i + 1}{U + M + 1}$$

Where:

p_i = 1 if the $'i'^{th}$ utility is the primary provider, 0 otherwise.

m_i = 1 if the $'i'^{th}$ utility is municipal, 0 otherwise.

U = Total number of utilities.

M = Total number of municipalities.

Thus:

Total Utility Score = $\sum Z_k W_i$

Where:

Z_k = Total weighted household count of the $'k'^{th}$ zip code.

The sum of a retailer's Total Utility Scores, divided by the sum of the weighted zip code population counts, determined a store's retail sales allocation score. The program administrator only approached stores that could allocate 90% or more of CFL purchases to Rocky Mountain Power customers for inclusion in the HES Program.

Overall, Cadmus found the program administrator's method for reducing and controlling for CFL leakage both thorough and innovative. The analysis used current and relevant data in conjunction with computer-aided geospatial analysis techniques to assist the program administrator's store inclusion process. Relevant considerations included drive times, customer purchasing behaviors, and store type/locations, appropriately factored into the overall calculation.

Appendix G. Utah Measure Category Cost-Effectiveness

Completed at the measure category level, cost-effectiveness was reported for evaluated net savings. Net results apply the evaluated NTG to evaluated gross savings. Table G1 shows cost-effectiveness inputs for net results.

Table G1. Utah Measure Category Cost-Effectiveness Inputs

Input Description	2013	2014	Total
Average Measure Life*			
Appliance	15	15	15
HVAC	18	17	17
Lighting	7	7	7
Weatherization	30	30	30
Evaluated Net Energy Savings (kWh/year)**			
Appliance	5,256,138	14,639,289	19,895,427
HVAC	4,567,430	6,569,044	11,136,474
Lighting	46,421,125	26,042,716	72,463,841
Weatherization	4,265,450	3,381,369	7,646,818
Total Utility Cost (including incentives)***			
Appliance	$3,608,043	$12,410,272	$16,018,314
HVAC	$2,938,066	$4,165,710	$7,103,776
Lighting	$10,373,380	$6,371,992	$16,745,372
Weatherization	$3,872,815	$3,222,701	$7,095,516
Incentives			
Appliance	$3,091,539	$10,704,362	$13,795,901
HVAC	$2,418,606	$3,303,377	$5,721,983
Lighting	$7,648,443	$4,462,648	$12,111,091
Weatherization	$3,163,188	$2,568,748	$5,731,936
Retail Rate	**$0.1056**	**$0.1084**	**N/A**

*Weighted average measure category lives are based on individual measure lifetimes and weighted by savings and the frequency of installations.

**Evaluated savings reflect impacts at the customer meter.

***Rocky Mountain Power provided program costs and incentives in annual report data, allocating program costs by weighted savings.

Appliances

Cost-effectiveness results for net savings are shown in Table G2, Table G3, and Table G4. The appliance measure category proved cost-effective from all perspectives except for the RIM (Table G2).

Table G2. Utah Appliance 2013-2014 Net
(2013 IRP East Residential Whole House 35% Medium LF Decrement)

Cost-Effectiveness Test	Levelized $/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
PTRC (TRC + 10% Conservation Adder)	$0.062	$12,471,888	$18,145,911	$5,674,023	1.45
TRC	$0.062	$12,471,888	$16,496,719	$4,024,831	1.32
UCT	$0.076	$15,224,029	$16,496,719	$1,272,690	1.08
RIM		$37,206,262	$16,503,121	($20,703,142)	0.44
PCT		$12,791,261	$39,824,850	$27,033,589	3.11
Lifecycle Revenue Impacts ($/kWh)					$0.000064094
Discounted Participant Payback (years)					1.72

Table G3. Utah Appliance 2013 Net
(2013 IRP East Residential Whole House 35% Medium LF Decrement)

Cost-Effectiveness Test	Levelized $/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
PTRC (TRC + 10% Conservation Adder)	$0.076	$4,207,735	$4,847,527	$639,792	1.15
TRC	$0.076	$4,207,735	$4,406,843	$199,107	1.05
UCT	$0.065	$3,608,043	$4,406,843	$798,800	1.22
RIM		$9,451,286	$4,406,843	($5,044,444)	0.47
PCT		$4,557,076	$10,305,420	$5,748,344	2.26
Lifecycle Revenue Impacts ($/kWh)					$0.000016072
Discounted Participant Payback (years)					2.23

Table G4. Utah Appliance 2014 Net
(2013 IRP East Residential Whole House 35% Medium LF Decrement)

Cost-Effectiveness Test	Levelized $/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
PTRC (TRC + 10% Conservation Adder)	$0.057	$8,832,892	$14,213,579	$5,380,687	1.61
TRC	$0.057	$8,832,892	$12,921,901	$4,089,010	1.46
UCT	$0.080	$12,415,398	$12,921,901	$506,503	1.04
RIM		$29,665,073	$12,928,744	($16,736,330)	0.44
PCT		$8,800,862	$32,000,257	$23,199,396	3.64
Lifecycle Revenue Impacts ($/kWh)					$0.000052232

Discounted Participant Payback (years)	0.69

HVAC

Table G5, Table G6, and Table G7 show HVAC measure category cost-effectiveness results for net evaluated savings. The HVAC measure category proved cost-effective from all perspectives (Table G5).

Table G5. Utah HVAC 2013-2014 Net
(2013 IRP East Residential Cooling 10% Medium LF Decrement)

Cost-Effectiveness Test	Levelized $/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
PTRC (TRC + 10% Conservation Adder)	$0.066	$8,188,521	$26,298,322	$18,109,801	3.21
TRC	$0.066	$8,188,521	$23,907,566	$15,719,044	2.92
UCT	$0.055	$6,835,551	$23,907,566	$17,072,015	3.50
RIM		$20,568,747	$23,907,566	$3,338,818	1.16
PCT		$7,366,045	$21,856,669	$14,490,625	2.97
Lifecycle Revenue Impacts ($/kWh)					($0.000010336)
Discounted Participant Payback (years)					1.98

Table G6. Utah HVAC 2013 Net
(2013 IRP East Residential Cooling 10% Medium LF Decrement)

Cost-Effectiveness Test	Levelized $/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
PTRC (TRC + 10% Conservation Adder)	$0.092	$4,896,173	$11,191,012	$6,294,839	2.29
TRC	$0.092	$4,896,173	$10,173,647	$5,277,474	2.08
UCT	$0.055	$2,938,066	$10,173,647	$7,235,582	3.46
RIM		$8,720,776	$10,173,647	$1,452,871	1.17
PCT		$4,315,896	$9,217,383	$4,901,487	2.14
Lifecycle Revenue Impacts ($/kWh)					($0.000004629)
Discounted Participant Payback (years)					3.55

Table G7. Utah HVAC 2014 Net
(2013 IRP East Residential Cooling 10% Medium LF Decrement)

Cost-Effectiveness Test	Levelized $/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
PTRC (TRC + 10% Conservation Adder)	$0.047	$3,518,928	$16,146,995	$12,628,068	4.59
TRC	$0.047	$3,518,928	$14,679,086	$11,160,159	4.17
UCT	$0.055	$4,165,710	$14,679,086	$10,513,377	3.52
RIM		$12,663,348	$14,679,086	$2,015,738	1.16
PCT		$3,260,060	$13,509,122	$10,249,062	4.14
Lifecycle Revenue Impacts ($/kWh)					($0.000006291)
Discounted Participant Payback (years)					0.78

Lighting

Table G8, Table G9, and Table G10 show cost-effectiveness results for net savings. The lighting measure category proved cost-effective from all perspectives except for the TRC and RIM (Table G8).

Table G8. Utah Lighting 2013-2014 Net
(2013 IRP East Residential Lighting 48% Medium LF Decrement)

Cost-Effectiveness Test	Levelized $/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
PTRC (TRC + 10% Conservation Adder)	$0.085	$36,073,538	$32,320,842	($3,752,696)	0.90
TRC	$0.085	$36,073,538	$29,382,584	($6,690,954)	0.81
UCT	$0.038	$16,335,087	$29,382,584	$13,047,497	1.80
RIM		$59,854,110	$29,382,584	($30,471,526)	0.49
PCT		$50,259,089	$81,832,345	$31,573,255	1.63
Lifecycle Revenue Impacts ($/kWh)					$0.000129241
Discounted Participant Payback (years)					3.68

Table G9. Utah Lighting 2013 Net
(2013 IRP East Residential Lighting 48% Medium LF Decrement)

Cost-Effectiveness Test	Levelized $/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
PTRC (TRC + 10% Conservation Adder)	$0.072	$19,602,991	$20,453,476	$850,486	1.04
TRC	$0.072	$19,602,991	$18,594,069	($1,008,921)	0.95
UCT	$0.038	$10,373,380	$18,594,069	$8,220,689	1.79
RIM		$37,840,414	$18,594,069	($19,246,345)	0.49
PCT		$26,469,853	$51,994,349	$25,524,496	1.96
Lifecycle Revenue Impacts ($/kWh)					$0.000086606
Discounted Participant Payback (years)					2.46

Table G10. Utah Lighting 2014 Net
(2013 IRP East Residential Lighting 48% Medium LF Decrement)

Cost-Effectiveness Test	Levelized $/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
PTRC (TRC + 10% Conservation Adder)	$0.108	$17,604,051	$12,684,078	($4,919,973)	0.72
TRC	$0.108	$17,604,051	$11,530,980	($6,073,071)	0.66
UCT	$0.039	$6,371,992	$11,530,980	$5,158,988	1.81
RIM		$23,528,678	$11,530,980	($11,997,698)	0.49
PCT		$25,426,411	$31,891,446	$6,465,035	1.25
Lifecycle Revenue Impacts ($/kWh)					$0.000052812
Discounted Participant Payback (years)					5.05

Weatherization

Table G11, Table G12, and Table G13 show weatherization measure category cost-effectiveness results for net evaluated savings. The weatherization measure category proved cost-effective from the UCT and RIM perspectives (Table G11).

Table G11. Utah Weatherization 2013-2014 Net
(2013 IRP East Residential Cooling 10% Medium LF Decrement)

Cost-Effectiveness Test	Levelized $/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
PTRC (TRC + 10% Conservation Adder)	$0.237	$25,849,748	$24,931,255	($918,494)	0.96
TRC	$0.237	$25,849,748	$22,664,777	($3,184,971)	0.88
UCT	$0.063	$6,888,010	$22,664,777	$15,776,767	3.29
RIM		$19,714,900	$22,664,777	$2,949,877	1.15
PCT		$24,697,293	$18,537,852	($6,159,441)	0.75
Lifecycle Revenue Impacts ($/kWh)					($0.000007469)
Discounted Participant Payback (years)					0.00

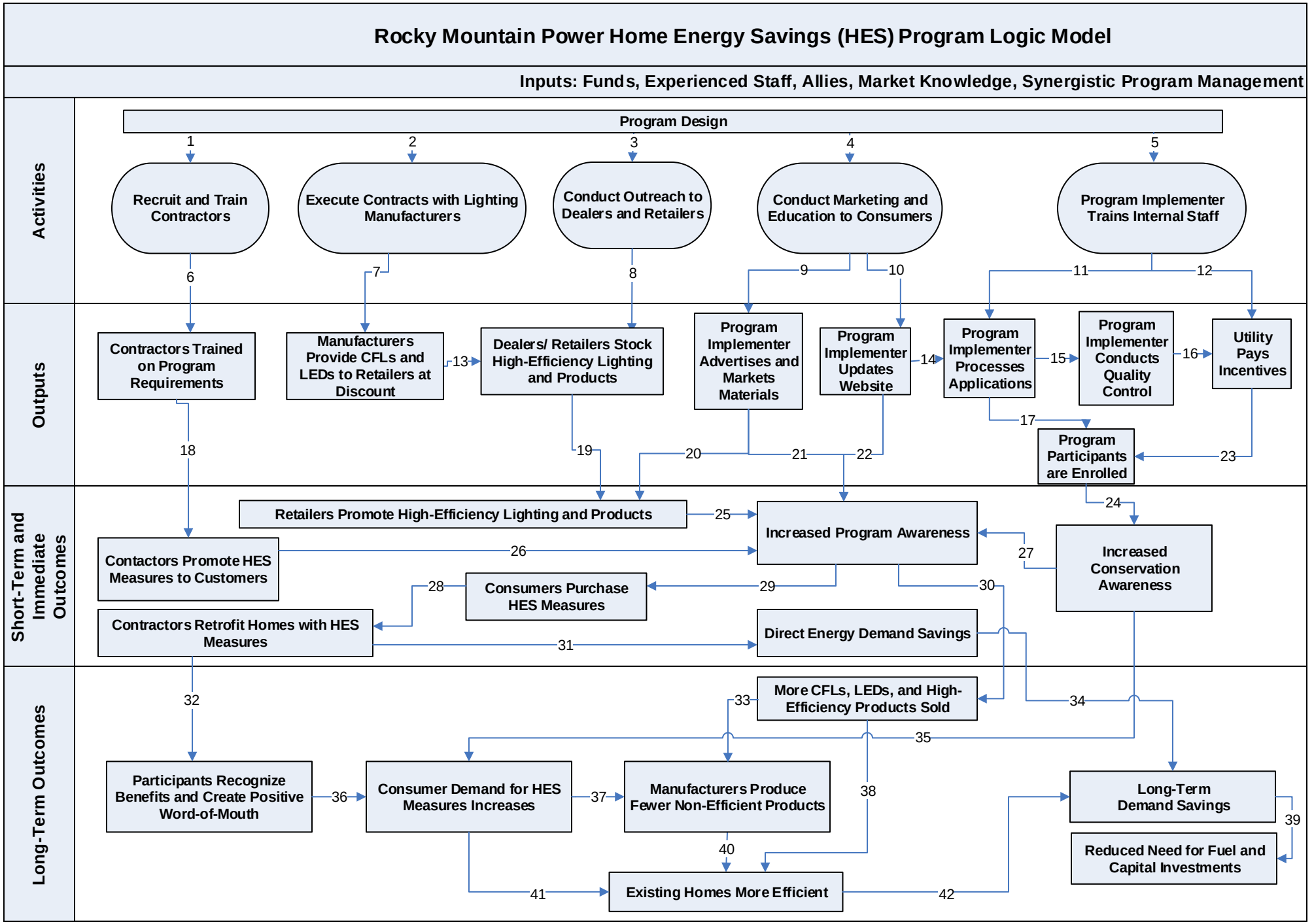
Table G12. Utah Weatherization 2013 Net
(2013 IRP East Residential Cooling 10% Medium LF Decrement)

Cost-Effectiveness Test	Levelized $/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
PTRC (TRC + 10% Conservation Adder)	$0.227	$14,209,860	$14,163,801	($46,059)	1.00
TRC	$0.227	$14,209,860	$12,876,183	($1,333,677)	0.91
UCT	$0.062	$3,872,815	$12,876,183	$9,003,367	3.32
RIM		$11,099,552	$12,876,183	$1,776,631	1.16
PCT		$13,541,505	$10,472,461	($3,069,044)	0.77
Lifecycle Revenue Impacts ($/kWh)					($0.000004566)
Discounted Participant Payback (years)					0.00

Table G13. Utah Weatherization 2014 Net
(2013 IRP East Residential Cooling 10% Medium LF Decrement)

Cost-Effectiveness Test	Levelized $/kWh	Costs	Benefits	Net Benefits	Benefit/Cost Ratio
PTRC (TRC + 10% Conservation Adder)	$0.251	$12,440,946	$11,508,470	($932,476)	0.93
TRC	$0.251	$12,440,946	$10,462,245	($1,978,700)	0.84
UCT	$0.065	$3,222,701	$10,462,245	$7,239,544	3.25
RIM		$9,208,256	$10,462,245	$1,253,989	1.14
PCT		$11,923,530	$8,620,451	($3,303,079)	0.72
Lifecycle Revenue Impacts ($/kWh)					($0.000003156)
Discounted Participant Payback (years)					0.00

Appendix H. HES Logic Model


Rocky Mountain Power Home Energy Savings (HES) Program Logic Model
Inputs: Funds, Experienced Staff, Allies, Market Knowledge, Synergistic Program Management
Activities
Outputs
Short-Term and Immediate Outcomes
Long-Term Outcomes
Program Design
1
2
3
4
5
Recruit and Train Contractors
Execute Contracts with Lighting Manufacturers
Conduct Outreach to Dealers and Retailers
Conduct Marketing and Education to Consumers
Program Implementer Trains Internal Staff
6
7
8
9
10
11
12
Contractors Trained on Program Requirements
Manufacturers Provide CFLs and LEDs to Retailers at Discount
13
Dealers/ Retailers Stock High-Efficiency Lighting and Products
Program Implementer Advertises and Markets Materials
Program Implementer Updates Website
14
Program Implementer Processes Applications
15
Program Implementer Conducts Quality Control
16
Utility Pays Incentives
17
Program Participants are Enrolled
18
19
20
21
22
23
24
Retailers Promote High-Efficiency Lighting and Products
25
Increased Program Awareness
Contactors Promote HES Measures to Customers
26
27
Increased Conservation Awareness
28
Consumers Purchase HES Measures
29
30
Contractors Retrofit Homes with HES Measures
31
Direct Energy Demand Savings
32
More CFLs, LEDs, and High-Efficiency Products Sold
33
34
35
Participants Recognize Benefits and Create Positive Word-of-Mouth
36
Consumer Demand for HES Measures Increases
37
Manufacturers Produce Fewer Non-Efficient Products
38
Long-Term Demand Savings
39
40
Reduced Need for Fuel and Capital Investments
41
Existing Homes More Efficient
42